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SOLOMON FABRICANT

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The New Format and the Old

Occasional Papers, of which this issue is No. 1, take the place of the National Bureau's Bulletin, of which the last issue was No. 80. Subscribers will receive *Occasional Papers* instead of the Bulletins for which they have paid. Some, like No. 1, will give preliminary and partial results of studies that will later be published in full in book form. Others will bring reports up to date. Still others will be sufficient unto themselves. We may have to revert to the larger format now and then but we shall try to bring our tables within the pocket size.

Both the new format and the new title have advantages. *Occasional Papers*, with their stiff covers, can be stood on library shelves beside our books, and they will live up to their name in appearing not on set dates, on scheduled themes, and in stereotyped form, but when occasion calls, on the themes about which we have something brief to say, in pages of this size if it suffices, of the old size if it does not.

We shall continue to send five issues for $1 and to try to publish five within each calendar year. But the exigencies of statistical research have delayed the fulfilment of our obligation again this year. We are sorry, but beg to assure subscribers that they will receive their full quotas. In fact richly, for the manuscript intended for publication as *Occasional Paper 2*, now in the hands of the National Bureau Directors, runs over twice the size we usually publish. If the Directors approve, this manuscript, How Cost is related to Output, An Experimental Study of a Leather Belt Shop, by Joel Dean, will appear in January. We shall then still owe one more issue in the 1940 series.

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THIS paper discusses a few selected findings of an analysis of trends in factory output since the opening of the century. It is neither a summary nor digest. The entire study will be published by the National Bureau of Economic Research in January under the title, *The Output of Manufacturing Industries, 1899–1937*.

The study upon which this paper and the volume are based was made possible by funds granted by the Maurice and Laura Falk Foundation of Pittsburgh. The Falk Foundation is not, however, the author, publisher, or proprietor of these publications, and is not to be understood as approving or disapproving by virtue of its grant any of the statements made or views expressed herein.

THE exceptionally severe and prolonged recession following the collapse of 1929 brought the physical output of American manufacturing industries to an extremely low level. In 1932 factory output was barely higher than in 1913. The great gains of nearly two decades of war and post-war prosperity had been practically wiped out.

The downward movement halted in 1932, and the ensuing revival raised output to another peak in 1937. The five-year expansion, though at a slower rate than the recession that preceded it, was long enough to pull factory output up to a point higher than the preceding peak in 1929. According to the National Bureau index, total manufacturing output in 1937 was 3 per cent greater than in 1929. Since contrary notions concerning the state of business in recent years prevail rather widely, this paper describes in detail the basis for this conclusion.

The index of output of all manufacturing industries combined is the summary average of changes in the physical output of many thousands of processed products. It is the end result of the series of computations described below. Because it is determined by the hierarchy of indexes for individual industries and groups of industries upon which it rests, its validity can be appraised only after review of them.

At each stage of computation certain technical questions arise. One concerns the choice of the weight-base period. Since there was wide variation among manufacturing industries in respect of the net change in output between 1929 and 1937, as will be shown below, how the indexes for individual industries are welded into an aggregate for all manufacturing may be crucial. Was the 3 per cent rise in total factory output merely a consequence of the statistical procedures or would other reasonable procedures have yielded indexes that also rise? Another question has to do with the degree of coverage. Indexes of output are not avail-

able for each and every industry. Even the most comprehensive sources provide only a sample. How large is the sample and to what degree, if any, is it biased?

The most comprehensive statistics on manufacturing output are those gathered biennially by the United States Census of Manufactures from a substantially complete list of manufacturing establishments; only very small establishments are deliberately omitted. The data on physical output in this Census, supplemented by figures collected by the United States Bureau of Internal Revenue and the United States Bureau of Mines relating to certain industries not covered in detail in the Census. are the basis for the index computed for this study.

Output of Individual Manufacturing Industries

In the Census and other sources just mentioned, data on individual products constitute an adequate basis for indexes of physical output of as many as 139 manufacturing industries. These industries are ranked in Table 1 according to the percentage change in their output from 1929 to 1937.

Even a cursory glance at the table reveals that many industries achieved important net gains in output during these troubled years. Of the 139 industries, 42 increased their output one-fifth or more. The output of another 15 industries rose between one-tenth and one-fifth, while 17 made smaller gains, less than one-tenth. In other words. over half of the 139 industries increased their output by some amount, large or small; 2 had the same output in 1929 and 1937; that of the other 63 declined. As the lower part of the table shows, some of those that declined lost heavily: the output of 24 declined one-fifth or more, and of 15 of these, three-tenths or more.[1]

[1] As noted in Table 1. the indexes are adjusted, whenever possible. for changes in the coverage of the samples. Most of the unadjusted indexes differ only slightly from the adjusted. See the Technical Note at the end of this paper.

Since distributions of indexes of physical output are characterized by wide dispersion, we had to cover as many industries as possible if we were to describe the course of aggregate output accurately. Consequently we made every effort to include in Table 1 small as well as large industries, new as well as old, industries engaged in the later as well as in the primary stages of fabrication, industries turning out the same product by different methods or from different materials, both perishable and durable goods industries.

Most of the industries at the extremes of the list—those with huge gains or drastic declines—are among the smaller and less basic. The great manufacturing industries—meat packing, cotton goods, boots and shoes, lumber mill products, steel mill products, automobiles, bread and cake, men's and women's clothing, printing and publishing, chemicals, petroleum refining, and tires and tubes—are, with few exceptions, clustered around the mid-point.[2] This distribution is not surprising. Trends in basic industries are closely bound up with the run of average business; furthermore, large industries, whether basic or not, tend to behave like aggregates merely by reason of their size, and therefore infrequently experience sweeping changes in output.[3] Here too, however, there are noteworthy exceptions: the output of such important industries as lumber mill products, women's clothing, and chemicals changed more than one-fifth from

[2] Some very important industries, including electrical machinery, furniture, and machine shop products, do not appear in Table 1 because adequate data are lacking. This deficiency is discussed later.

[3] Some of the large industries are in fact aggregates because of the way industries are classified by the Bureau of the Census. The boot and shoe industry, for example, could quite justifiably have been divided into several independent branches. The more recent Censuses, such as the 1935 and 1937, have a finer industrial breakdown than the 1929 Census, but in order to compare 1937 with 1929 we had to use the classification given for the earlier year.

TABLE 1

Individual Manufacturing Industries Ranked in Order of Net Percentage Change in Physical Output, 1929–1937 [1]

INDUSTRY	PERCENTAGE CHANGE	INDUSTRY	PERCENTAGE CHANGE
Liquors, distilled	+10,600	Petroleum refining	+19
Liquors, malt	+1,420	Artificial leather	+18
Liquors, vinous	+975	Wool shoddy	+18
Refrigerators, mechanical	+217	Outerwear, knit	+17
Rayon	+210	Paper	+15
Hats, wool felt	+156	Hosiery, knit	+15
Malt	+145	Woolen & worsted goods	+14
Pens & points	+121	Shoes, leather	+12
Cane sugar, n. e. m.	+92	Leather	+12
Sausage, n. e. m.	+82	Rubber goods, other	+12
Flavorings	+74	Wall plaster & board	+12
Glass	+63	Feeds	+11
Tin cans & tinware, n. e. c.	+60	Confectionery	+11
Hats, straw, men's	+58	Roofing	+10
Lace goods	+54	Wall paper	+10
Fruits & vegetables, canned	+51	Ice cream	+9
Shortenings	+48	Paints & varnishes	+9
Washing & ironing machines	+46	Soap	+9
Radios	+44	Typewriters	+9
Asphalted felt base floor covering	+44	Firearms	+7
Jute goods	+43	Rice	+6
Chemicals, n. e. c.	+41	Biscuits & crackers	+6
Pulp	+41	Fertilizers	+6
Clocks, watches & materials	+39	Files	+6
Glue & gelatin	+39	Butter	+5
Gases, compressed	+38	Caskets & coffins	+4
Silk & rayon goods	+35	Fish, canned	+4
Cigarettes	+34	Underwear, knit	+2
Carbon black	+33	Lime	+2
Pencils	+30	Printing & publishing	+2
Corsets	+29	Tanning & dye materials	+1
Cheese	+29	Wood-distillation products	+1
Milk, canned	+28	Sewing machines	0
Buttons	+26	Hats, fur felt	0
Oleomargarine, n. e. m.	+26	Cotton goods	−1
Asbestos products	+26	Clothing, men's	−1
Clothing, women's, n. e. c.	+25	Gloves, leather	−2
Secondary metals, non-precious	+24	Agricultural implements	−2
Collapsible tubes	+24	Gloves, textile, n. e. m.	−3
Chocolate	+24	Steel mill products	−3
Macaroni	+23	Salt	−3
Beet sugar	+20	Bread & cake	−4
		Shoes, rubber	−5
		Meat packing	−6

INDUSTRY	PERCENTAGE CHANGE	INDUSTRY	PERCENTAGE CHANGE
Cars, railroad, n. e. m.	—7	Brooms	—19
Shirts & collars, men's	—7	Tires & tubes	—19
Explosives	—7	Turpentine & rosin	—19
Carpets & rugs, wool	—8	Ships & boats	—20
Cordage & twine	—8	Cigars	—20
Concrete products	—8	Copper	—20
Sporting goods, n. e. c.	—9	Fuel briquettes	—21
Wrought pipe, n. e. m.	—9	Linen goods	—23
Automobiles	—10	Cereals	—23
Wire, n. e. m.	—10	Ice	—25
Cane sugar refining	—11	Lumber mill products, n. e. c.	—28
Carriages & sleds, children's	—11	Carriages, wagons & sleighs	—29
Nonferrous metal products, n. e. c.	—12	Excelsior	—30
Blast furnace products	—12	Cement	—32
Coke oven products	—13	Cast iron pipe	—32
Scales & balances	—13	Sand-lime brick	—34
Belting, leather	—14	Pianos	—34
Handkerchiefs	—14	Oilcloth	—34
Linseed products	—14	Clay products, n. e. c.	—34
Zinc	—14	Planing mill products, n. e. m.	—36
Flour	—14	Baking powder	—37
Corn products	—16	Cooperage	—37
Tobacco products, other	—17	Elastic woven goods, n. e. m.	—37
Boxes, wooden, cigar	—17	Lead	—42
Cottonseed products	—17	Locomotives, n. e. m.	—45
Linoleum	—17	Hats, cloth	—47
		Charcoal	—57

[1] The underlying indexes of physical output were constructed from basic data in the U. S. Census of Manufactures and other sources, by methods described in *The Output of Manufacturing Industries, 1899–1937*, Appendix A. When possible, the indexes were adjusted to take account of changes in the coverage of the samples. The industry titles are abbreviated. Full titles appear in the index to the volume cited. 'N e. m.' means 'not elsewhere made'; 'n. e. c.' means 'not elsewhere classified.'

1929 to 1937. On the other hand, the output of many small industries scarcely changed.

New or revived industries head the list. The liquor industries shot up, of course, upon the repeal of prohibition.[4]

[4] Legal production alone is covered by our indexes. It may be questioned whether the shift from illegal to legal production following the repeal of the prohibition amendment should be allowed to affect the measure of manufacturing production. However, as we note below, complete exclusion of the beverage industries does not materially affect the final index for all manufacturing industries combined.

Also in the forefront are such obviously new industries as mechanical refrigerators, rayon, washing machines, radios; and industries producing, in addition to well established commodities, new products or products for which demand had recently been stimulated, including flavorings, glass (beverage and food containers), chemicals, compressed and liquefied gases, and silk and rayon goods. These industries are too frequently omitted from current indexes of manufacturing output. Older industries that cannot be said to have reached maturity also appear in the upper third of the list: tin cans, canned fruits, vegetables, and milk, cigarettes, carbon black, asbestos products, and petroleum refining. Among the declining industries at the lower end of the list are charcoal, locomotives, clay products (brick), pianos, carriages and wagons, lumber mill products, ice, linen goods, and cigars.

For an adequate appreciation of the significance of changes in the total it is essential to cover also output at various stages of production. Output at primary stages does not necessarily fluctuate in the same manner as at advanced stages. We may take the flour and bakery industries as an example. Flour output declined 14 per cent between 1929 and 1937, while biscuits and crackers rose 6 per cent and bread and cake fell 4 per cent. Since flour is much the less important industry (the value added by flour manufacture in 1929 was $190 million as against $790 million by bakeries), the index for all three industries combined dropped less sharply than that of flour alone. The decline in the export of flour helps to explain the discrepancy. A similar divergence is to be observed in the primary nonferrous metal smelting and refining industries, whose output is often taken to represent the output of nonferrous metal products at later stages of production as well. During 1929–37 the output of zinc fell 14 per cent, of copper 20 per cent, and of lead, 42 per cent. Yet the output of the major industry

at the next stage of production, 'nonferrous metal products, not elsewhere classified', fell only 12 per cent. In terms of value added in 1929, the latter industry is twice as large as all three primary industries together. The discrepancy between output at the two stages of production reflects, among other things, the increased output (a gain of 24 per cent from 1929 to 1937) of secondary metals salvaged from scrap. Clearly, changes in output at the primary stage of manufacture do not reflect at all adequately changes at all stages.

The growth of the secondary nonferrous metals industry relative to that of the primary smelting and refining industries illustrates also how the outputs of different industries fabricating the same product in different ways or from different materials vary. There are other examples. The indexes for beet sugar, sugar refined from imported cane sugar ('cane sugar refining'), and cane sugar made from domestic cane ('cane sugar not elsewhere made') reveal percentage changes, between 1929 and 1937, of + 20, − 11, and + 92, respectively. The sausage, shortenings, and oleomargarine industries specialize in products made also in meat packing establishments. Since the output of the meat packing industry, including many other products as well as these three, fell 6 per cent, while the output of the three specialist industries rose 82, 48, and 26 per cent, respectively, the index for meat packing can hardly be accepted as an adequate index for the related specialist industries. Indeed, the index for the combined output of all four industries rose about one per cent from 1929 to 1937, in contrast to the drop of 6 per cent for meat packing alone. Again, the index of the wood distillation industry, of which charcoal, turpentine, and rosin are products, cannot be taken as representative of the output of all charcoal and all turpentine and rosin. Charcoal is produced also in the specialist industry 'charcoal', and turpentine and rosin, in the specialist industry 'turpentine and rosin' as well. The indexes for these

three industries—wood distillation products, charcoal, and turpentine and rosin—show changes of +1, −57, and −19 per cent, respectively.

Finally, we must consider the relative standing of the perishable and durable goods industries. There are, of course, many exceptions. but in general output in the perishable goods industries increased. The semi-durable products industries are scattered through the ranks, but most are above the median point. The industry manufacturing silk and rayon goods is the highest representative of importance, followed by women's clothing, knit outerwear, hosiery, woolen and worsted goods, shoes, and leather. Cotton goods and men's clothing declined fractionally. The tires and tubes industry was the only large one producing semi-durable goods whose output declined drastically. The most important durable goods industries—agricultural implements, steel mill products, railroad equipment. automobiles, nonferrous metals, ships and boats, lumber mill products, cement, planing mill products, and locomotives—all declined in output. Hardest hit were the industries manufacturing materials used in building. Indeed, of the 15 listed industries that are devoted largely to construction materials,[5] 9 declined, some drastically. The other 6 produce appreciable amounts of goods other than construction materials and, as in the case of paints and varnishes, materials used in both new construction and the maintenance of buildings and equipment.

Output of Major Groups of Industries

The available indexes of the output of individual industries are summarized in group 'sample' indexes in the first column

[5] Asbestos products, wall plaster and board. roofing, wall paper, paints and varnishes, lime. explosives, concrete products. wrought pipe. lumber mill products, cement, cast iron pipe, sand-lime brick, clay products, and planing mill products.

of Table 2. We call them 'sample' indexes because they do not usually cover all the industries in the respective groups for which they are averages. Only 3 indexes, those for tobacco products, rubber products, and printing and publishing, are supported by a coverage of all the industries in the group. For beverages, machinery, and miscellaneous products, the samples are too inadequate to justify the computation of group indexes. For all other groups the coverage exceeds 40 per cent,[6] the minimum base we consider sufficiently broad for building tolerably reliable indexes. (The percentages of coverage for all groups are given in the Technical Note at the end of this paper.)

[6] The percentage of coverage for a group is determined by dividing the aggregate value added (value of products less cost of materials and fuel) of the sample industries by the value added of the entire group, and multiplying the result by 100.

TABLE 2

Major Groups of Manufacturing Industries

Net Percentage Changes in Physical Output, 1929–1937 *

	NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT, 1929–1937, ACCORDING TO	
	Sample index	Sample index adj. for change in coverage of sample
Foods	+3	+4
Tobacco products	+17	+17
Textile products	+10	+6
Leather products	+11	+8
Rubber products	−9	−9
Paper products	+20	+22
Printing & publishing	+2	+2
Chemical products	+35	+24
Petroleum & coal products	+13	+14
Stone, clay & glass products	0	0
Forest products	−28	−24
Iron & steel products	−2	−11
Nonferrous metal products	−8	−11
Transportation equipment	−11	−9

* The basic indexes are published in detail in *The Output of Manufacturing Industries, 1899–1937*.

It is clearly important to have at least some minimum level of coverage if trustworthy indexes are to be made. In addition, a *change* in the percentage of coverage must be given serious consideration. It seems reasonable, on the basis of empirical tests, to assume that changes in coverage reflect a rise or fall of an equivalent amount in the ratio of the aggregate output of the sample industries to the aggregate output of all the industries in the group. If this is true, it is simple, as explained in the Technical Note, to adjust the sample indexes so that they will depict more adequately the output of the entire group. The results of this sort of adjustment are given in the second column of Table 2, which shows that for most groups the changes in coverage were small between 1929 and 1937.[7] The unadjusted and adjusted indexes agree rather closely: essentially the same picture is traced by both.

An outstanding feature of Table 2, in which the groups are listed approximately in the order customary in the Census of Manufactures, is the number of plus signs in the upper section and of minus signs in the lower. The industrial groups devoted to perishable and semi-durable consumer goods (except rubber products) all increased their output from 1929 to 1937. (The beverage group must have augmented its output too, although the rise cannot be measured because adequate data for nonalcoholic beverages are lacking.) The groups producing durable goods declined, except stone, clay and glass products, which remained unchanged. It is probable that the output of machinery also was approximately the same in 1929 and 1937. The value added by this group, deflated by the average index of value added per unit of physical output of all the industries for which such indexes can be computed, indicates a slight rise

[7] During earlier periods, when most of the samples were smaller, the changes in coverage were larger; see *The Output of Manufacturing Industries, 1899–1937*, Appendix B.

in its physical output, perhaps about 3 per cent. The gross value of machinery output, deflated by the available indexes of machinery prices, indicates a somewhat greater rise in the number of machines turned out, approximately 7 per cent.[8] On the other hand, deflation of the group's value added by the average index of value added per unit of all the metal products industries for which such indexes can be computed suggests a decline in machinery output of about 3 per cent.[9] It seems fairly safe to conclude that there was a moderate increase in machinery output, or at worst a slight decline. In either case the behavior of this group was another exception to the behavior of the durable goods industries as a group. Such an inference does not seem invalid: the electrical machinery industry, which has been characterized by a rising secular trend, is an important component of the group, as are also the radio and certain other growing industries.[10]

Whatever the trend for machinery, and whether the adjusted or the unadjusted indexes are accepted as the more accurate measure for the other groups, it is clear from Table 2 that there were net increases between 1929 and 1937 in the output of many groups of manufacturing industries—including the important foods, textiles, printing and publishing, and chemicals. Indeed, the rises in chemicals, and also in paper, tobacco, and petroleum and coal products, were quite large. On the other hand, the decline in forest products was severe; and the metal industries and transportation equipment, substantial. Even in terms of groups, then, the record for 1929–37 is mixed: there was no marked similarity among the net changes in the group indexes.

[8] These computations by W. H. Shaw will be published by the National Bureau.
[9] See the *Federal Reserve Bulletin*, August 1940.
[10] As we note below, inclusion or exclusion of the data for machinery affects our indexes for total manufacturing to merely a slight degree.

Output of All Manufacturing Industries Combined

Since some of the most important manufacturing groups increased their output substantially between 1929 and 1937, it is not surprising that the index of output for all manufacturing industries combined should show a net increase. According to it, total output in 1937 was 3 per cent above the preceding peak, in 1929; this means, of course, that in 1937 manufacturing output was higher than that of any previous year in our history.

Although the gain of 3 per cent does not seem unreasonable in the light of the output of the 139 individual manufacturing industries, it should be compared with the movements of the indexes derived by certain other statistical procedures. We computed our final index in the following way. First we averaged the adjusted indexes of the 14 groups for which there was sufficiently adequate coverage.[11] (Each group index was appropriately weighted by the value added by the group in both 1929 and 1937.)[12] The preliminary index thus obtained does not cover all groups: three groups, beverages, machinery, and miscellaneous products, are omitted, except for one or two component industries. Nor is it adjusted for changes in the relative importance of the sample of 14 groups (measured in terms of value added). It is, therefore, an 'unadjusted' index. This unadjusted index indicates a negligible rise from 1929 to 1937—four-tenths of one per cent. But, as we know, the output of beverages certainly increased considerably between 1929 and 1937, while that of machinery either rose slightly or at least held its own. Miscellaneous products seem to have

[11] In this combination we included also the few individual machinery, miscellaneous products, and beverage industries that could not be incorporated into any group index.

[12] We used an algebraic transformation of the Edgeworth formula; see *The Output of Manufacturing Industries, 1899–1937*, p. 370.

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declined somewhat, if we may judge from the value added in their manufacture, but the group is of small importance compared with beverages and machinery. Consequently, it is probable that the combined output of the three groups omitted rose more than the average for the other groups. As explained in the Technical Note, we adjusted the 14-group 'unadjusted' index to make it cover also the output of the three groups for which we did not compute separate indexes. This yields our final index, with its indication of a 3 per cent increase in total factory output between 1929 and 1937.

An index of total manufacturing output can be derived in another way. It can be constructed not from group indexes but directly from the indexes of 131 component industries, appropriately weighted by the values added by each in 1929 and 1937.[13] An index made in this way also indicates a rise of 3 per cent, though it omits most beverage industries, most machinery industries, and most miscellaneous products industries, as well as several important industries in other groups, notably paper products, forest products, and nonferrous metal products. The changes in the value added by these missing industries suggest that their output rose very slightly relatively to the output of the 131 industries. When the index is adjusted for these omissions, it rises 4 per cent from 1929 to 1937.

The four indexes computed by the methods just described are listed in Table 3. The last index in the table is the one we have accepted as most accurate, but the indexes derived by other methods differ only slightly from it. Whether or not we include beverages, whether or not we adjust our sample for changes in coverage, whether or

[13] These are the 139 industries in Table 1, excluding flavorings, wool shoddy, agricultural machinery, radios, mechanical refrigerators, and the three liquor industries. For none are fully comparable detailed data on value added (required as weights) available.

TABLE 3

Four Indexes of Total Manufacturing Output, 1937
(1929 : 100)

Derived from 131 indexes for individual industries	
Unadjusted	102.6
Adj. for change in the coverage of the sample	104.5
Derived from 14 indexes for major groups *	
Unadjusted	100.4
Adj. for change in the coverage of the sample	103.3

*Including also the indexes of the few individual industries, in the 3 remaining groups, for which indexes are available.

not we use other weighting schemes,[14] we must conclude that manufacturing output was slightly higher in 1937 than in 1929, or at least no lower.[15]

Summary

The last peak year of the troubled period prior to the present war is 1937. Whether our industrial economy has embarked upon a new stage of development is a secret of the dark future. It is possible that 1937 will prove to be as widely cited a base year during and after the current world conflagration as 1913 was during the tumultuous

[14] The group adjusted indexes are weighted by the entire value added of the respective groups; the 131 individual indexes, only by the value added by the respective industries. The former weighting implies, in a sense, imputed weights for the individual indexes, while the latter does not.

[15] Brief note may be made of still another possible procedure, which yields similar results. The index of 102.6 in Table 3 was derived from the 131 individual indexes after each had been adjusted, when possible, for change in the coverage of its sample. An unadjusted index of total output derived from the *unadjusted* individual indexes would be about 2 per cent lower than the index derived from the *adjusted* individual indexes (see the Technical Note); i.e., it would be 100 or 101. However, if the unadjusted individual indexes were used, the correction for the change in the relative importance of the products covered by the 131 indexes would have to be greater. The final adjusted index would then be about as great as the index of 104.5 given in Table 3.

years that succeeded it. For this reason it is well to know, as accurately as we may, the relative standing of our manufacturing industries in 1937.

Indexes of the output of 139 individual manufacturing industries give us information that serves to round out impressions built up from fragmentary current statistics. The most comprehensive data confirm the common belief that the output of factories producing construction materials dropped sharply during the recession of 1929–32 and that by 1937 it had not regained the level reached in 1929. They also support the contention that the 1937 output of durable goods in general was below the 1929: railroad equipment, automobiles, lumber products, iron and steel, and nonferrous metals were all lower in 1937 than in 1929. In addition, they indicate what has not been as clearly recognized, that mechanical refrigerators, radios, washing machines, and alcoholic beverages rose substantially; and that rayon, industrial chemicals, glass, tin cans, canned fruits and vegetables, wood pulp, cigarettes, silk and rayon goods continued to gain. From these data we learn also that significant increases characterized the output of women's clothing, petroleum refining, knit goods, paper, woolen and worsted goods, shoes, leather, confectionery, ice cream, paints and varnishes, and soap.

In terms of major groups, there were large gains in chemicals (+24 per cent), paper products (+22 per cent), tobacco products (+17 per cent), and petroleum and coal products (+14 per cent). More moderate were the gains in leather products (+8 per cent), textile products (+6 per cent), and foods (+4 per cent). Beverages undoubtedly gained considerably, though no index is available for the group as a whole. Printing and publishing rose 2 per cent in output, and stone, clay and glass products changed negligibly. The largest decrease was in forest products (−24 per cent). Less severe declines occurred in iron and steel products (−11 per cent), nonferrous metal products

(−11 per cent), transportation equipment (−9 per cent), and rubber products (−9 per cent). It is probable, though not certain, that the output of machinery rose slightly.

The net rise in the output of all manufacturing combined, which we estimate at 3 per cent for 1929–37, is confirmed substantially by other indexes computed in the investigation reported here. These indicate increases ranging from 0.4 to 4.5 per cent. Little doubt can remain that factory output was at least as high in 1937 as in 1929, and probably a bit higher. Judged by the standard of 1929, the lean years following it numbered seven and no more.

While factory output made a net gain of 3 per cent from 1929 to 1937, the nation's population increased 6 per cent. Consequently, per capita output of manufactures declined slightly. The significance to be ascribed to this depends on many things, about which little can be said here. It is possible that 1929, in which already lay imbedded the seeds of the serious recession that followed, set too unusual a standard by which to judge 1937. A comparison of per capita output in 1937 and in 1928, for example, places 1937 in a much more favorable light. But whatever the basis of comparison, a retarded rate of growth—if not an actual decline—in per capita factory output is evident during the period under consideration. We must not forget, however, that though this is an unprecedentedly long period of stagnation, it is not the first time per capita output has been retarded. Even within the 30 years from 1899 to 1929 such periods can be found: between 1907 and 1910, and again between 1916 and 1923, there was no substantial net growth in factory production, and per capita output declined. Yet each of these periods was followed by a period of further growth.

There are signs today that the 1937 peak is being exceeded. The revised Federal Reserve index, which is in close agreement with the index worked out in this study,[16]

[16] The agreement supports the Federal Reserve figures for Census years

falls sharply from 1937 to 1938, then rises again. During 1939 factory output averaged about 4 or 5 per cent below the 1937 peak. Not until 1939 Census figures are finally released can this relative standing be checked, but there is no reason at present for questioning its essential accuracy. In 1940, the Federal Reserve index indicates, output will average 5 to 10 per cent above the 1937 level.

Technical Note

This note summarizes briefly the extent to which statistical procedures that differ in respect of two points yield different indexes. Certain aspects of these and related problems are discussed in more detail in *The Output of Manufacturing Industries, 1899–1937* (Ch. 2 and Appendix A).

The first set of alternatives encountered in constructing index numbers concerns the 'weight-base period'. Since the various products that constitute an industry's output are usually expressed in diverse physical units, it is impossible to add them up to a meaningful sum. The attempt to express the various products of an industry in one simple homogeneous unit, say a pound, gives rise to another difficulty. A pound of silver is not equal in any valid economic sense to a pound of copper, of whose manufacture it is a by-product; therefore a simple sum of the physical weights of the two will not yield a satisfactory index of the output of the copper refining industry. The customary way to avoid the difficulties of incommensurability is to consider the quantity of a dollar's worth of each product in some year or group of years, called the 'weight-base period', as equal to the quantity of a dollar's worth of any other commodity in the same period. That is, the diverse quantities

alone; the monthly movements of the Federal Reserve index cannot be checked by Census data. Since the Federal Reserve index is not completely independent of the National Bureau index (the latter was utilized by the Board of Governors of the Federal Reserve System in some stages of their computations) the agreement is not entirely unexpected.

produced in a given year are multiplied by the weight-base price; these values are added and expressed as a percentage of the sum of the quantities, similarly converted to weight-base prices, for any other year with which a comparison is desired.

We must first, then, select the weight-base year. Since we are interested in a comparison of output in 1937 and in 1929, shall we use 1929 prices, 1937 prices, an average of the two, or the prices of some 'normal' year? The fourth possibility is impracticable in view of the difficulty of determining a normal weight base. We must therefore consider the other alternatives. In this study we selected the average

TABLE 4

Major Groups and Total Manufacturing

Comparison of Three Indexes of Physical Output

	INDEX[1] OF PHYSICAL OUTPUT, 1937 (1929 : 100), BASED ON		
	1929 prices	Average of 1929 and 1937 prices	1937 prices
Foods	103.9	103.0	101.9
Tobacco products	117.2	117.2	117.1
Textile products	110.7	109.7	108.3
Leather products	111.2	111.1	110.9
Rubber products	90.4	90.6	90.9
Paper products	119.5	119.5	119.5
Printing & publishing[2]	101.6	101.6	101.6
Chemical products	138.6	134.6	129.9
Petroleum & coal products	113.3	113.1	112.9
Stone, clay & glass products	101.2	99.8	98.1
Forest products	71.9	71.8	71.7
Iron & steel products	98.5	98.0	97.5
Nonferrous-metal products	92.6	91.5	90.3
Transportation equipment	89.1	88.7	88.3
Total manufacturing	103.6	102.6	101.5

[1] These are the unadjusted group indexes, and the unadjusted index of total manufacturing output based on 131 individual industry indexes. The indexes in the first and third columns are taken from unpublished work-sheets used in the preparation of *The Output of Manufacturing Industries, 1899–1937*.

[2] The index for printing and publishing is based on one series only.

of the two years, 1929 and 1937. Our formula, then, in the usual symbols, is

$$\frac{\Sigma q_{37}\,(p_{29} + p_{37})}{\Sigma q_{29}\,(p_{29} + p_{37})};$$

rather than

$$\frac{\Sigma q_{37} p_{29}}{\Sigma q_{29} p_{29}}, \text{ if 1929 were used as the weight-base;}$$

or

$$\frac{\Sigma q_{37} p_{37}}{\Sigma q_{29} p_{37}}, \text{ if 1937 were used.}$$

For 1929–37 the differences among the indexes obtained by the use of these three formulas are too slight, according to our computations, to justify reproducing here the three indexes for each individual industry. For the 14 major groups and for total manufacturing, the three sets of indexes are given in Table 4. Here, too, the differences are obviously negligible; e.g., for total manufacturing the combined index for 131 industries referred to above, with 1929 and 1937 prices (value added per unit) as coefficients, is 102.6; with 1929 prices, it is 103.6; and with 1937 prices, 101.5.[17]

More important is the coverage of the samples and the method of adjusting for changes in coverage. Data are seldom complete and the statistician is almost invariably compelled to deal with samples. But how adequate is the sample? Is it biased? Shall we accept the result derived from the sample for a class of products as valid for the entire class, or shall we adjust it for biases even if their extent can only

[17] The indexes in Table 4 that are based on 1937 prices are usually lower than those based on 1929 prices. This relation reflects a negative correlation between changes in prices and in output; see *The Output of Manufacturing Industries, 1899–1937*, Ch. 5.

be estimated? To begin with, we have specified 40 per cent as the minimum coverage adequate for the computation of a reasonably accurate index. For only a few industries have we computed an index unless we could obtain quantity data on at least 40 per cent of the output, measured in terms of value.[18] A summary of the percentages of coverage appears in Table 5. Since for most industries the coverage is high, changes in coverage proved to be of minor import. Never-

[18] For no exception is the coverage less than 35 per cent. For every exception, moreover, the percentage coverage was 40 or higher in most years, falling slightly below 40 in a few.

TABLE 5

Coverage of Indexes of Physical Output

Frequency Distribution of Manufacturing Industries by Percentage of Coverage, Selected Years

PERCENTAGE OF COVERAGE [1]	NUMBER OF INDUSTRIES	
	1929	*1937*
Below 40.0	1	2
40.0–49.9	5	4
50.0–59.9	4	5
60.0–69.9	10	10
70.0–79.9	24	26
80.0–89.9	28	28
90.0–99.9	46	39
100.0 or more [2]	15	15
Total	133	129

Source: *The Output of Manufacturing Industries, 1899–1937*, Table A-6.

[1] The percentage of coverage for an industry is determined by dividing the aggregate value of the products included in the industry's index by the aggregate value of all the products of the industry, and multiplying the result by 100.

Industries for which the exact percentage of coverage is not known are not included in this tabulation. For most of these the coverage is undoubtedly close to 100 per cent.

[2] The percentage for an industry will exceed 100 when the industry's index covers not only the output of the commodities made in that industry but also the output of the same commodities manufactured in other industries ('secondary production'); see *op. cit.*, Appendix A, footnote 37.

theless, whenever possible, we adjusted our sample indexes for any bias due to changes in coverage. The extent to which the adjustments affected the indexes is indicated, in summary form, in Table 6. For 11 industries no adjustment was made because of lack of data and for two others the adjustment was zero. The indexes for 48 industries were adjusted downward because the 1937 coverage of the samples was higher than the 1929. The indexes for the remaining 78 industries were adjusted upward. For only 31 industries did the adjustment alter the indexes more than 10 per cent. The arithmetic average of the ratios in Table 6 is .981; therefore the percentages by which the indexes were altered averaged no more than about +2.

The assumptions basic to the adjustment procedure are treated at length in Appendix A to *The Output of Manufacturing Industries, 1899–1937*. Briefly, it may be said that

TABLE 6

Coverage of Indexes of Physical Output
Changes between 1929 and 1937

Frequency Distribution of Manufacturing Industries by Ratio of 1937 to 1929 Coverage

RATIO, 1937 TO 1929 COVERAGE	NUMBER OF INDUSTRIES
Below .800	5[1]
.800– .849	7
.850– .899	11
.900– .949	23
.950– .999	32
1.000	13[2]
1.001–1.050	27
1.051–1.100	13
1.101–1.150	3
1.151 or more	5[3]
Total	139

Source: *The Output of Manufacturing Industries, 1899–1937*, Appendix B.
[1] The ratios in this class are: .771, .739, .702, .698, .608.
[2] Includes 11 industries the coverage for which could not be determined in one year or both.
[3] The ratios in this class are: 1.161, 1.223, 1.389, 1.433, 1.681.

a change in coverage (i.e., a change in the percentage of the total value of products of an industry that is constituted by the value of the products in the sample for that industry) reflects the net effect of two underlying changes: (1) a change in the relation between the output of the sample commodities and of the commodities not covered by the sample; (2) a change in the relation between the average price of the sample products and of the other products. These changes may be of almost any amount, except that their net effect must equal the relative change in coverage (which, it should be remembered, is computed by dividing the value of the sample goods by the value of the products of the entire industry). To the extent that the first type of change—relative rise or fall in the output of the sample products—has occurred, an index based on a sample for an industry does not adequately represent the changes in the output of the entire industry. Since we do not know, for any individual industry, whether the change in coverage is due chiefly to the relative change in the output of the sample goods or chiefly to the relative change in their average price, an irreducible margin of uncertainty surrounds the industry indexes. If we may assume that the change in coverage is accounted for *entirely* by a change in the relation between the average price of the sample commodities and the average price of all the products of the industry, then the sample index for an industry reflects accurately the change in its total output. On the other hand, if the more correct assumption is that the change in coverage is due *entirely* to a relative change in output, then the adjusted index for an industry is the adequate representative of its total output; for the assumption underlying the adjustment is exactly the second one stated. It has been checked in empirical tests made with indexes for 1937 on the 1929 base.[19] These indicate that the adjustment yields indexes more reliable, in the main, than the unadjusted. The ad-

[19] See *op. cit.*, pp. 366–9.

justment may sometimes distort the index, but not often.

A margin of uncertainty is inherent in every statistical measure. All that can be done to reduce it to a minimum is to base measures on the broadest foundation attainable, as we have sought to do in making these indexes, and to correct them for biases in the samples even if the correction itself is not free from all possibility of error. If the samples were not adjusted for changes in coverage, it would be necessary to adjust the weights assigned them. The latter procedure is no less arbitrary than the former and would probably yield much the same index for total manufacturing.

For some major groups the coverage is quite complete;

TABLE 7

Coverage of Indexes of Physical Output

Percentage of Value Added by Each Group and by All Industries Combined Accounted for by the Respective Samples *

	PERCENTAGE	
	1929	*1937*
Foods	93.9	92.8
Tobacco products	100.0	100.0
Textile products	80.2	82.8
Leather products	81.2	83.2
Rubber products	100.0	100.0
Paper products	59.3	58.1
Printing & publishing	100.0	100.0
Chemical products	66.6	72.4
Petroleum & coal products	95.1	94.7
Stone, clay & glass products	69.9	70.0
Forest products	61.9	58.3
Iron & steel products	59.6	65.5
Nonferrous metal products	47.6	48.6
Transportation equipment	97.6	95.5
Total	65.8	64.6

Source: *The Output of Manufacturing Industries, 1899–1937*, Appendix B.

* Since the coverage for machinery and for miscellaneous products in 1929 and 1937, and for beverages in 1929, is very low, no indexes were computed for these groups.

for others, it is only fair (Table 7). But even in the latter, changes in the coverage of the samples were slight. Table 2 indicates that adjustment for changes in coverage caused only slight variations in most of the group indexes.

As said above, the several methods of passing from the individual industry indexes to the combined index for all manufacturing lead to similar results. The adjusted indexes tend to be slightly higher, mainly because of the growth of the beverage industries. There is empirical justification for the adjustment,[20] and we therefore consider the adjusted indexes more reliable. However, the adjustment has but slight influence on the 1929–37 indexes.

[20] There is a fairly high correlation between changes in physical output and in value added; see *The Output of Manufacturing Industries, 1899–1937*, Ch. 5.

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