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Chapter I

DESCRIPTION OF PRODUCTION STATISTICS

AN INQUIRY into production trends cannot be better than its basic materials. Therefore, an attempt will be made in this chapter to indicate the meaning of production statistics, the extent to which long-range production series are available, and the degree of their correspondence with the quantities of which they purport to be measures. The production series analyzed in detail in this study go back at least to 1885 but no further than 1870. The series relate to the physical volume of production and cover a fairly large portion of the total production area. But the gaps in the data are numerous and important, and the series themselves are at times of uncertain quality. It is only proper that the reader be warned at the start that he may be asked to accept conclusions which do not always have as thorough a factual basis as he has a right to expect.[1]

I. MEASUREMENT OF PRODUCTION

In traditional economic theory, 'production' means the 'creation of valuable utilities'. But the things to which 'valuable utilities' are added by industry have attributes other than price. The output of any given commodity may be viewed not only in terms of monetary value (gross or net),

[1] This chapter is devoted to a general description of the production series which form the backbone of the analysis in Chapters III–V; the production indexes on which the analysis in Chapter VI rests are described in the introductory section of that chapter.

but also in terms of physical volume, in terms of the satisfactions (direct or indirect) of consumers, or from the standpoint of its social value. Let us suppose that one thousand cigars of a standard grade are made in one month and two thousand the next. The physical volume of production may then be said to have doubled. But the gross pecuniary volume of production may have changed in another ratio, depending on the price of cigars in the two months. The net pecuniary volume of production may have changed in still another ratio, depending not only on the price of cigars but also on the prices of the materials entering into the cigars. If the character of the consuming group remained the same over the two months, the volume of created utilities will have increased, though by less than one hundred per cent: if the character of the consuming group changed, the volume of utilities may have increased or decreased in almost any ratio; but in either case the exact change is indeterminate. Finally, the social value of the output of cigars may have changed in any ratio whatsoever, depending on the moral universe of the person or group concerned with the change. According as the production of cigars or any other good is viewed in one or another of these respective ways, a physical, pecuniary, utility, or normative concept of production is embraced. However, since the utility and normative concepts do not generally lead to objective measurements, the physical or pecuniary concepts must be employed, if a study of production is to convey more than the personal bias of an investigator.

The measurable aspects of the things to which valuable utilities are added by industry consist, speaking generally, of certain pecuniary and physical characteristics. The pecuniary characteristics are numerous: the gross value, net value, labor cost, materials cost, and so on. The physical characteristics are likewise numerous: we can express the physical volume of production of wheat in terms of units of weight (the ton),

units of cubic content (the bushel), units of energy (the calorie), units of expended labor (the man-hour), and so on. Constant relations will hold between series of year-by-year measurements of divers pecuniary aspects of a produced commodity, if industrial technique remain constant and prices move in identical ratio; between measurements of divers physical aspects of the commodity other than the labor bestowed upon it, if the commodity be perfectly homogeneous; between measurements of all physical aspects of the commodity, if the commodity be perfectly homogeneous and industrial technique constant; and between measurements of all physical or pecuniary aspects of the commodity, if the commodity be perfectly homogeneous, industrial technique constant, and prices move in identical ratio. However, industrial technique and price changes are ordinarily dynamic; and, although certain commodities are homogeneous (as is true in high degree of copper since the widespread adoption of electrolytic refining, and of Portland cement since 1911), commodities are as a rule heterogeneous. Therefore, series of year-by-year measurements of divers physical or pecuniary aspects of the aggregate of some produced commodity will differ from one another in variable ratio. Granted minute knowledge of the distinguishable units (bushels) of the output of wheat (a heterogeneous product) over a series of years, we could express the production of wheat in terms of gross value, net value, tons, bushels, calories, or man-hours of labor; each of these sets of measurements would express precisely the quantity of that homogeneous attribute of which the particular measurement takes account; but the several sets of measurements would ordinarily bear a more or less inconstant relation to one another. Moreover, we would attain dollar sums, bushel sums, calorie sums, and so on, for a 'bundle' of closely related commodities called 'wheat', not for a unique commodity.

The significance of the various measurable aspects of things to which valuable utilities are added by industry differs, of course, with the purpose at hand. What is most important from the standpoint of farming enterprisers having different grades of wheat for sale, at least so far as their immediate economic status is concerned, is the gross value product; from the standpoint of the welfare of those attached to the wheat-farming industry, the net value product; from the standpoint of the technical branch of the transportation industry, the number of bushels of wheat and their tonnage; from the standpoint of the business branch of the transportation industry, the number of bushels of wheat, their tonnage, and their gross value. All of the measurements are important from a 'social' standpoint: calorific content, because the energy value of wheat is one of the elements entering into its want-satisfying power; the number of bushels of wheat, because of the calorific value of wheat, and even more, the preference of the population for this grain; the quantity of expended labor, because it expresses, when related to the number of bushels of wheat, the effectiveness of man in the mastery of his environment; the net value product, because it enters directly into the economic welfare of one important section of the population and indirectly into the economic welfare of the entire population; and the gross value product, because it bears some relation—however vague, inconstant, and erratic—to the satisfactions accruing to the domestic population from the consumption of wheat or from the consumption of other goods obtained from the outside economy in exchange for wheat.[2]

[2] One might argue that, from a 'social' standpoint, the gross value of a produced commodity is the most significant of its various measurable aspects; for the qualitative differences of, say, wheat are primarily important to the economist when they are attended by utility differentials, which, in turn, always enter into price differentials. This assumes that a series of wheat production expressed in terms of gross value will correspond more closely to utility differentials than will a series of wheat production expressed in some

In this study, our interest centers in the secular changes in the volume and forms of productive activity; to be more explicit, in the development of individual industries and of industry as a whole, and in changes in those economic customs which are expressed in the composition of the 'heap' of national production. In studying the things to which valuable utilities are added by industry, we should, therefore, make use of measurements of gross value, of net value, and of various physical attributes (these will differ, of course, from commodity to commodity). However, the only measurements of production available in reasonable abundance are of gross value, and of physical production as expressed in commercial units (bushels of wheat, number of locomotives, flasks of mercury). Practical limitations on the scope of this investigation make it impossible to utilize even these measurements. Price fluctuations, especially when violent and erratic, complicate the meaning of pecuniary measurements of production; these will therefore be left out of account in this restricted study. The long-term records of the physical volume of production of wheat, coal, cotton, and other commodities reveal more sharply the growth tendencies in specific types of industrial activity, and changes in the channels into which the industrial activity of the population flows.

To be sure, our data on the physical volume of production are expressed in units which are inconstant over time, and this detracts somewhat from the import of the measurements. Fortunately, however, the changes in the qualitative character of the units are generally very gradual.[3] For example, there has been a persistent improvement in the quality of

physical unit, say, bushels. It is not feasible to enter at this point into a discussion of the conditions under which this will be true or false. Suffice it to say, though, that it is altogether impossible to state whether the one or the other measure will generally correspond more closely to the volume of created utilities.

[3] See pp. 25–7.

rails and locomotives since the Civil War, but no sharp variation in quality from year to year. Even when the quality of products varies considerably from year to year, as in most agricultural produce, the trend in quality, whether upward, as in sugar beets, or downward, as in raw wool, is ordinarily gradual. The units of physical output change, as a rule, in a regular manner, especially in the case of raw materials and crude manufactures, which bulk large in the long-range production statistics available. To be sure, sudden and fairly comprehensive qualitative changes in the aggregate production of a commodity take place at times, either as a result of an outstanding technical discovery, as in the case of Goodyear rubber, or a legislative fiat, as in fermented liquors after the Prohibition Amendment. But really discrete and revolutionary changes in the aggregate output of a commodity are rare, and are never an important feature of the economic system as a whole.

II. LIST OF PRODUCTION SERIES

The production series on which the greater portion of this study is founded are listed in Table 1. These series constitute a fairly exhaustive record of the continuous data available for a study of production trends during the period since 1870–85.[4] All of the important series, taking value of product represented as an index of importance, are included, as are also a fairly large number of minor series. Some of the minor production series are used because they represent decadent industries, but the main reason for including such series is to compare the trend characteristics of major and minor industries. Economic theory suggests that the growth tendencies of minor industries will not be marked by the same degree of

[4] Series which do not extend back at least to 1885 are not included, because a shorter period would prove inadequate for the kind of analysis to which the data are subjected.

'stability' as major industries, and it therefore seems desirable to determine empirically such differences as may exist in the trend behavior of the two.

The series listed in Table 1 are arranged under conventional industrial categories,[5] and in the order of the length of period for which they are available. The number of series listed in Table 1 is 104, several of them being duplications

[5] The allocation of the individual series to the several industrial categories is in some instances arbitrary. A number of series which relate to manufactures (according to the usage of the Census Bureau) are placed under agriculture and mining, the purpose being to cover the raw materials group as thoroughly as possible. But this rule could not be followed uniformly. Thus, aluminum is not placed under mining, because its production in this country antedates that of bauxite, and foreign bauxite has played throughout an important rôle in the domestic aluminum manufacture. Nor is roofing slate placed under mining, the ground being that it accounts for only a portion of the output of slate quarries. A similar reason holds for several other series. Insofar as series technically relate to manufactures, but are not so classified in Table 1, they are distinguished in Table 7, being repeated there from tabulations for agriculture and mining. Several border-line cases remain, but there is no need to discuss them.

Another group of arbitrary allocations is found in the transportation and trade divisions. Thus, the series 'postage stamps' and 'postal money orders' are placed in the transportation division, on the view that the postal service is a communication industry. The series 'railway freight' is placed under trade, and 'railway ton-miles' under transportation, on the view that the actual volume of goods shipped is symptomatic of trade activity, and that a compound series of freight and distance is the real measure of the service rendered by the freight branch of the railway transportation industry. The series 'coastal trade' is placed under transportation, on the view that coastal shipping is a distinct branch of the transportation category. But plausible grounds could be advanced for assigning some of the series placed in the transportation category to the trade category, and vice versa.

The arbitrariness at various points of the classification of series in Table 1 is one reason for combining certain of the industrial categories in the substantive tabulations. Thus, trade and transportation series are generally treated together. The manufactures and construction categories are also joined in most of the substantive tabulations, but for another reason. Both manufacture and construction are elaborative industries, the only technical difference between them being that the seat of the activities of the latter is inconstant; this difference is of no significance from the standpoint of secular trends in industry. Finally, the agriculture and fisheries categories are generally joined in the tabulations, in part because they relate commonly to organic raw materials, but primarily on grounds of convenience.

Table 1

PRODUCTION SERIES AND THEIR DATES OF COMMENCEMENT

AGRICULTURE

1. Barley	1870
2. Beet sugar	1870
3. Buckwheat	1870
4. Cane sugar	1870
5. Corn	1870
6. Cotton	1870
7. Hay	1870
8. Molasses and sirup	1870
9. Oats	1870
10. Potatoes	1870
11. Rice	1870
12. Rye	1870
13. Tobacco, raw	1870
14. Wheat	1870
15. Wool	1870
16. Raisins	1872
17. Flaxseed	1879
18. Cattle	1880
19. Hogs	1880
20. Sheep	1880

FISHERIES

21. Cod and mackerel	1870
22. Whale	1870
23. Fish, total	1880

MINING

24. Anthracite coal	1870
25. Bituminous coal	1870
26. Coal, total	1870
27. Copper	1870
28. Gold	1870
29. Lead, domestic	1870
30. Mercury	1870
31. Petroleum	1870
32. Phosphate rock	1870
33. Silver	1870
34. Zinc	1870
35. Asphalt	1880
36. Cement, total	1880
37. Fluorspar	1880
38. Gypsum	1880
39. Iron ore	1880
40. Non-Portland cements	1880
41. Portland cement	1880
42. Pyrites	1880
43. Salt	1880
44. Sulphur	1880
45. Natural gas	1882

MANUFACTURES

46. Cocoa imports	1870
47. Coffee imports	1870
48. Cotton consumption	1870
49. Distilled spirits	1870
50. Fermented liquors	1870
51. Jute imports	1870
52. Lead consumption	1870
53. Lead, total	1870
54. Manila hemp imports	1870
55. Minor fiber imports	1870
56. Pig iron	1870
57. Rails	1870
58. Raw sugar consumption	1870
59. Rubber imports	1870
60. Silk imports, raw	1870
61. Sisal imports	1870
62. Steel	1870
63. Superphosphate	1870
64. Tin imports	1870
65. Vessels	1870
66. Wool consumption	1870
67. Antimonial lead	1871
68. Tin-plate consumption	1871
69. Tobacco and snuff	1871
70. Cottonseed cake and meal	1872
71. Cottonseed oil	1872
72. Nails	1872
73. Zinc consumption	1873
74. Flaxseed consumption	1879
75. Roofing slate	1879
76. Cigarettes	1880
77. Cigars	1880
78. Coke	1880
79. Flour	1880
80. Gold consumption	1880
81. Locomotives	1880
82. Silver consumption	1880
83. Tobacco consumption	1880
84. Aluminum	1883
85. Copper consumption	1883
86. Silk imports, unmanufactured	1883
87. White lead	1884
88. Canned corn	1885
89. Canned tomatoes	1885

Table 1 (cont.)

PRODUCTION SERIES AND THEIR DATES OF COMMENCEMENT

MANUFACTURES (cont.)

90. Rolled iron and steel ... 1885

CONSTRUCTION

91. Rail consumption 1870
92. Building permits 1874

TRANSPORTATION

93. Coastal trade 1870
94. N. Y. canals traffic 1870
95. Postage stamps 1870
96. Postal money orders ... 1870
97. Railway ton-miles 1870
98. S. S. Marie canals traffic 1870
99. Railway passenger-miles. 1882

TRADE

100. Agricultural exports ... 1870
101. Deflated clearings 1870
102. Tonnage entered and cleared 1870
103. Shares traded 1875
104. Railway freight 1882

about which something will be said presently. With minor exceptions, all of the series are continuous annual records, continuity and annual availability being essential for the main tasks of this study. With minor exceptions again, all of the series are analyzed through 1929, so that the dates at which the series begin indicate the exact periods covered by the series in this study.[6]

A word may be said about the nomenclature of the series. When the name of a commodity is given without any further qualifying term, 'production' is almost always implied. The two most frequent qualifying terms are 'imports' and 'consumption'. The former is self-explanatory except that the imports are 'net'; the latter refers in each case to industrial

[6] While the analysis of most of the individual production series is extended through 1929 only, most of the production indexes covered in Chapter VI are analyzed through 1930. Two series, distilled spirits and fermented liquors, are not analyzed beyond 1918; the qualitative change in these commodities, at least so far as the statistically reported product is concerned, was so comprehensive that all that the products before and after this date have in common is their name. Two series, building permits and roofing slate, have a one-year gap (see Appendix B), but this was not deemed a bar to their utilization.

In addition to the series in Table 1, a fairly large number of discontinuous production series are available; they have been used as supplementary materials in one portion of the study where discontinuity of data did not matter much. See Tables 22, 24–25, and Appendix B, II.

consumption, that is, utilization by industrial units, not by final consumers. One of the consumption series, 'rail consumption', calls for special comment: it represents the apparent utilization of rails by railroads, and therefore offers an indication of the volume of railway construction, including repairs. The series 'minor fiber imports' is a composite of sisal, jute, and Manila hemp imports. The series 'coastal trade' measures the tonnage documented for the coastal trade and not the freight moved in coastwise commerce. Similarly, the series 'cod and mackerel' and 'whale' relate to the tonnage documented for these fisheries and not to the quantities of catch. The series 'railway freight' refers to the volume of freight transported over the various railroads, and includes such duplications as shipments moving over the lines of several roads may involve. The series 'lead, domestic' refers to the primary lead refined from domestic ores, while the series 'lead, total' relates to the primary lead refined from all ores or base bullion, irrespective of origin. The series 'cattle', 'sheep', and 'hogs' represent federally inspected slaughter or its estimated equivalent. The series 'silk imports, unmanufactured' differs from 'silk imports, raw' in that it includes cocoons and silk waste in addition to the silk fiber. These comments are confined to those series whose coverage is most vaguely indicated by the synoptic nomenclature of Table 1.[7] For the content of the various series, reference should be made to Appendix B and to the sources there listed.

[7] The use of the terms 'sisal', 'Manila hemp', and 'cocoa' is sanctioned by trade custom. Practically all of the so-called 'sisal' imports are really imports of 'henequen'. The correct name of 'Manila hemp' fiber is 'abacá'. The term 'cocoa' properly refers to the finished product only; the present statistics are for the crude product which, strictly speaking, goes by the name 'cacao'. However, the term 'superphosphate' has been used in preference to the more familiar name 'acid phosphate', in view of the official adoption of the former by fertilizer manufacturers in 1928. The term 'coastal trade', on the other hand, has been used instead of 'coasting trade', which is the preferred term in official reports.

Among the 104 series, there is a certain amount of duplication, that is, a given stage in the production of a commodity is in some cases represented by more than one series. Thus, there are two series for silk imports, varying only in the degree of their inclusiveness. There are series for the total production of coal and cement, and also separate series for the subdivisions of each. The imports of three minor fibers—jute, sisal, and Manila hemp—are covered separately and in combination. There is a series for all rolled iron and steel products and also for rails—a specific kind of rolled product. There are three series for manufactured tobacco products—cigarettes, cigars, and tobacco and snuff—and also a series for tobacco consumption which indirectly subsumes all of them. There is a series for all the fisheries, and also two series for certain divisions of the industry. The various duplications derive in part from the form in which the statistical materials are cast; for example, data of the output of all rolled iron and steel products are available back to 1885, but not for the individual products except rails; or to cite another example, a homogeneous record of unmanufactured silk imports extends back to 1883 only, while a consistent record of raw silk imports is available back to 1870. However, most of the duplications in the list of series result from our interest in the aggregate production of certain industries and also in certain of their subdivisions; though gaps in statistics and practical considerations imposed restrictions on the extent to which subgroups of industries are covered.

The fact that the series in Table 1 involve a certain amount of duplication suggests that the production data lack qualitative homogeneity. Actually, the qualitative differences among the series extend considerably beyond the duplicated areas. In referring to the various series, the term 'industry' is very frequently used in this study; that term, however, does not have

a uniform signification,[8] since the series differ appreciably in the degree of generality of their industrial reference. Thus, several series are included for separate divisions of freight transportation by water, but the series for railways is comprehensive; Portland cement is treated separately, but all other cements are lumped together; there is only a single series for all distilled spirits, yet there is one series for all rolled iron and steel forms and another for a specific kind of rolled product; and the numerous materials consumption series are of a distinctly higher order of generality than the rest. These differences in the industrial dimension of the series result, in part, from practical exigencies which imposed limitations on the use of such materials as are available, but mainly, from the nature, that is, the quantity and quality, of the data which have come down to us. The heterogeneity of the underlying data is in a sense intellectually unsatisfactory; but the inelegancies in the list of series could not be wholly eliminated or even appreciably reduced without discarding a large portion of the usable statistical records of production. The wide differences in the industrial dimension of the series are allowed for in the later analysis, in part through separate treatment of 'basic' series, which include series representing industries of large importance and also series of wide industrial reference, and in part through comparisons of series of production and industrial consumption for identical commodities. It will be seen that the analysis gains in some ways from that very heterogeneity in the form of the data which appears at first sight an unmixed evil.

[8] Several fairly definite conceptions of a national industry which might be used are: (1) a given product turned out by all establishments by a given technical process, (2) a given product turned out by all establishments irrespective of type of technique, (3) related products turned out by all establishments irrespective of type of technique. But it would be difficult to employ strictly any of these conceptions.

III. INDUSTRIAL COVERAGE OF PRODUCTION DATA

Any one who examines the list of series carefully will not fail to note numerous inadequacies in the materials. A large portion of the field of 'service' production is completely unrepresented. To be sure, trade and transportation are covered after a fashion; but the services performed by these industries are mainly adjuncts of the process of producing tangible goods. There are glaring gaps even in the field of 'commodity' production. Among the industries producing raw materials, the mining group alone is covered with reasonable thoroughness. Forestry is not represented at all. The fisheries are completely represented, but by a single general series rather than by component series. No dairy products are included in the agricultural group, and very few fruits or vegetables. The gaps in the manufactures group are numerous and important: the paper, printing and publishing, lumber products, musical instruments, leather, petroleum refining, and machinery industries are untouched, and there are serious omissions in such divisions of manufacture as are represented. The construction industry is represented by the 'building permits' and 'rail consumption' series; but the permits figures, at best, serve as an indication of the volume of urban construction only, since they leave out of account rural and governmental construction. Clearly, the production series included in this study fall far short of a comprehensive coverage of the area of national production.

It is desirable to form a somewhat exact notion of the extent to which the production of the American economy is covered by the series listed. In Table 2 estimates are given of the coverage of the total output of various groups of industries and of all industries during 1925. These estimates are necessarily rough, and are intended merely to give some idea of the ex-

tent of the production area covered by the series.[9] It will be noticed that the coverage of mining, the fisheries, and trade is very high; that the coverage of agriculture, construction, and transportation is rather high; that the coverage of manufactures is low; and that many branches of the service industries are not covered at all. Our series account for about 60 per cent of the output of the seven industrial groups covered, and for about 40 per cent of total national production; but these global estimates are less revealing than estimates for certain

[9] Whenever possible, separate computations were made for 1925, 1926, and 1927, and the results averaged. The percentage coverage of agriculture was computed by expressing the gross farm value of the listed crops and animal products as a ratio to the gross value of total farm production; the data used are those given in *Farm Value, Gross Income, and Cash Income from Farm Production* (Department of Agriculture, 1930). The percentage coverage of mining was obtained by expressing the value of the listed mineral products as a ratio to the total value of mineral production; the data used are those given in *Mineral Resources of the United States* (Bureau of Mines). In view of the difference in the classification of the Bureau of Mines and that of Table 1, it was necessary to modify the latter so that it correspond with the former. It should be noted that the Bureau of Mines surveys of mining overlap in considerable part the field of manufactures; a stricter definition of mining would probably yield a higher estimate of the coverage. The percentage coverage of manufactures was determined by obtaining the 'value added' of the industries included, this requiring estimation in many cases, and then expressing this figure as a percentage of the 'value added' by all manufactures; the data used are those of the *Census of Manufactures*. In view of the difference in the classification practice of the Census Bureau and that in Table 1, it was necessary to modify the latter so that it correspond with the former. The estimate for manufactures is probably somewhat too high, for it was impossible completely to avoid indirect representation of industries. The percentage coverage of construction was determined by (1) subtracting the value of public and rural construction from total construction (the figures used for public and total construction are Wolman's estimates,—see his *Planning and Control of Public Works,* National Bureau of Economic Research, 1930, p. 126; the estimate of rural construction was made by multiplying the estimate of non-public construction by an estimate of the percentage—the basis being the Federal Trade Commission's *National Wealth and Income,* 1926, pp. 366–7—which rural construction constitutes of total non-public construction); and (2), expressing (1) as a percentage of the value of total construction. The percentage coverage of transportation was obtained by (1) adding King's estimates for 1925 of the realized income of steam railroads, the realized income of the water transportation industry, and the wages of postal service employees; (2) adding wages of postal employees to King's estimate of realized

Table 2

ESTIMATES OF THE COVERAGE OF PRODUCTION SERIES, BY INDUSTRIAL GROUPS, IN 1925

Industrial group	Per cent of product accounted for by series
(1) Agriculture	65
(2) Fisheries	100
(3) Mining	83
(4) Manufactures	22
(5) Construction	63
(6) Transportation	69
(7) Trade	100
Above industrial groups, (1) to (7)	60
Above and all other industrial groups	39
All commodity-producing industries	43
All service-producing industries	37
Above industrial groups, except (2), (5), and (7)	46
All industrial groups, except (2), (5), and (7)	26
All commodity-producing industries, except (2) and (5)	40
All service-producing industries, except (7)	15

of the industrial groups. Thus, the coverage of the commodity-producing industries is 43 per cent, a somewhat higher figure than for the service-producing industries. More significant estimates of the industrial coverage of the series are attained

income for the transportation industry; and (3), expressing (1) as a percentage of (2). (King's estimates are given in his *National Income and Its Purchasing Power,* National Bureau of Economic Research, 1930, pp. 95 and 364.) The percentage coverage of the fisheries is given as 100, in view of our use of a series of total fish catch. In the case of trade, the series included do not run in the desired form, that is, they fail to cover separately either distinct branches of trade or the trading transactions in distinct industries. In view of the generality of the series, a 100 per cent coverage is assumed; but because of the unsatisfactoriness of the form of the series, trade is omitted from some of the summary computations.

In order to determine the percentage coverage of all industry and the several combined industrial groups (the fishery was ignored because of its rela-

by excluding construction, trade, and the fisheries; for, although high percentages are recorded for these industrial groups, the series falling in the groups are either very indirect measurements of output or else defective in other ways—more so than the generality of series for other industries. With these omissions, the coverage of all industries drops to 26 per cent, and the gap between the 'commodity' and 'service' industries becomes more pronounced, their estimated coverage being 40 and 15 per cent, respectively. These estimates hold approximately for more recent years; but they are probably much too low for the early years of the period covered by this study. It must also be observed that the estimates do not make allowance for the indirect industrial representation of the series.

It has already been stated that although the series listed fail to cover a large portion of the production area, they constitute a fairly exhaustive record of the long-range production data available. The wide gaps in our historical records of production are, in considerable part, a legacy of the neglect of statistics in earlier days. The reluctance of producers to disclose

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tive insignificance), more extensive use had to be made of King's estimates of the income created by various industries. His estimates for 1925 were used, this being the latest year for which full data are given. As a first step, the net value product of the various industries accounted for by the series included had to be estimated; this was done by applying the estimated percentages of coverage for agriculture, mining, manufactures, construction, and trade to King's estimates of income created by these industries; in the case of transportation, the estimate of net value product was yielded directly by the method earlier indicated. As a second step, minor adjustments were made in certain of King's estimates of income created by industries: (1) the figure for transportation was raised by the amount of wages paid to postal service employees; (2) the figure for government was lowered by the amount of pensions and gratuities, and by the amount paid to postal service employees; (3) income from foreign investments and imputed interest on durable consumption goods were excluded from the 'miscellaneous' category. From this point on, only totals had to be struck and compared. The commodity-producing industries group includes the following of King's groups: agriculture, mining, manufactures, construction, and a small portion of the 'miscellaneous' category. The service-producing industries group includes transportation, trade, government, banking, 'unclassified', and the bulk of the 'miscellaneous' category.

their output was formerly the most serious impediment to a system of national production statistics.[10] The consequences of statistical reticence are most conspicuous in monopolistic industries; for example, the aluminum industry, and the sulphur industry for some years. But such obstacles, originating in the vested interests of private enterprise, might easily have been overcome, had there been greater public appreciation of the importance of regular compilation of authoritative data on production. The extent of earlier public indifference to the recording of national progress is strikingly indicated by the fact that such long-range production series as are now available for other than agricultural and mineral industries are in very considerable part an accidental by-product of various branches of governmental administration—mainly the customs, postal system, internal revenue, and the waterways. Because of their origin, these statistics have a decidedly indiscriminate character as far as the significance of their industrial coverage is concerned, and rarely have the most desirable form for a study of production. In the case of crop production and mining, the government has served posterity more kindly. For these industries the statistical record is relatively ample, by virtue of the annual estimates of crop production which the Department of Agriculture initiated in 1862, and the annual canvasses of mineral production which the Geological Survey began in 1882. It is fortunate that government records do not constitute the only source of long-range production statistics. Data on the output of several industries—especially iron and steel, railway equipment and traffic, and sugar—have come down to us as a result of the diligence of certain private organizations. Moreover, by the use of government and other sources, students have recreated the statistical record of many

[10] Fortunately, that reluctance has diminished considerably; but it is still found—especially in declining industries.

industries—notably the production of certain classes of livestock, of superphosphate, flour, and natural gas.

But with new industries emerging and old industries vanishing, the pattern of national production continually undergoes modification, so that even an ideally complete set of long-range production series could embrace only that portion of the production area which is common to each of the years covered. In view of the considerable current importance of commodities such as automobiles, rayon, radio sets, washing machines, photographic materials, and electrical appliances of all sorts, a set of series reaching back to the 1870's or '80's must necessarily fall short of including important sections of contemporaneous productive activity. Even some of our industries producing raw materials are of rather recent origin: the first shipment of bauxite was made in 1889, and the discovery of Fuller's earth dates back only to 1893. So, the dynamic character of production, no less than the sparseness of statistical records, accounts for the incomplete coverage of the field of production by our long-range series.

IV. DEFECTS OF PRODUCTION DATA

Though the relative industrial coverage of the series listed in Table 1 falls far short of ideal requirements, a point had yet to be stretched in order to achieve this coverage. A number of series which do not report the volume of production directly are included. Several estimated series which have not as yet stood the test of critical review are also included. Moreover, even the production series which are commonly accepted as authoritative have a variety of defects. The defects of physical volume statistics derive, in part, from the dynamic character of production processes, and in part, from the statistical procedures of compiling agencies. Sundry references have already been made to inadequacies in the form of the

production data. It remains now to consider more systematically the nature of the inadequacies.

From a qualitative standpoint, the chief types of defects in the production series are as follows. First, a large number of the series are results of estimates rather than enumerations: practically all the figures of crop production [11] are in this form, and the data for many of the other series are also estimates—the materials consumption series requiring special mention since they are, generally, calculated series. Second, many of the series are indirect measurements of production: about twenty series relate to 'imports' or 'consumption', a few series really measure shipments, and a few volume of equipment. Third, several of the presumptive physical volume series are really pecuniary in form or origin: the series 'postage stamps' runs in dollar units, while the 'building permits' and 'deflated clearings' series are adjusted for changes in price levels. Fourth, the significance of the units in which certain of the series are expressed is open to doubt: this holds particularly for several of the indirect production series, for the series on animal slaughter, and in more or less degree for some other series. Fifth, the real content of the units of practically all of the series lacks temporal constancy: though less pronounced, this is as true of the series 'cattle' and 'copper' as of 'rails' and 'locomotives'. Sixth, the industrial coverage of several series is incomplete: this is true mainly of 'building permits' and of the series on animal slaughter. Seventh, the geographic coverage of some series exceeds or falls short of all of the contiguous areas of the United States: import series cover also some of the possessions, the production data for certain commodities are occasionally limited to the leading producing states, and at times a portion of the output of

[11] At present, the Division of Crop and Livestock Estimates of the Department of Agriculture is engaged in a comprehensive revision of the historical record of crop statistics.

bordering foreign countries is covered by the statistics. Eighth, the time reference of some series is not uniform, as when data are first given on a fiscal and later on a calendar year basis. Finally, a few of the series are spliced, and differences in the exact composition of the joined series may give rise to error: the most conspicuous instances are the several series on minor fiber imports, which relate first to 'imports entered for consumption' and later to 'general imports' minus 'foreign exports'.

This conspectus of the types of defects in production series might be elaborated upon to some advantage, were it not for the fact that certain of the defects are of little importance when the series are used to study production trends. Clearly, inaccuracies in the year-by-year figures will matter little, provided the general trend of the figures is unaffected. Since many of the estimated series rest on the support of census enumerations, their trends may be approximately accurate, even though year-by-year movements at times are not.[12] A constant error in the figures, irrespective of its direction, will exercise no influence on their trend. Lack of uniformity of time reference will affect the general trend but imperceptibly, as will also minor differences in geographic or industrial coverage. And many of the consumption series for metals, though undoubtedly in error for individual years because of insufficient account of stocks, are in all likelihood reasonably accurate in their general drift, being compounded from rather reliable data on production and foreign trade.

However, the series have a variety of defects even from the standpoint of an inquiry into production trends, though their exact importance will vary with the nature of such an inquiry. The limitations are clearest when the data are used to indi-

12 There are often doubts, however, concerning the accuracy of the census base. See Joseph S. Davis, "Some Observations on Federal Agricultural Statistics," *Proceedings of the American Statistical Association,* March, 1928.

cate the average rates of growth of industries.[13] It will therefore be instructive to analyze the 'growth bias' of the series,—meaning by this a persistently increasing or a persistently decreasing percentage differential between the data and the 'real volume' of production throughout the period covered by the series or during some appreciable time segment.

One of the conditions under which a growth bias will arise in a production series is when the coverage of the series has an upward or downward trend. This may be due to a change in the efficiency of collecting the data: in the case of such series as are obtained by the enumerative method, there has probably been a slightly upward growth bias arising from increasing comprehensiveness of reporting. A trend in the relative coverage of a series may also be due to a change in the relative importance of the statistically covered area of an industrial process. Thus, the livestock slaughter series, being limited to federally inspected slaughter or its estimated equivalent, have an upward growth bias, as far as their representation of meat production is concerned, because of the relative decline of 'rural' slaughter. On the other hand, several of the metal production series, insofar as they are used to represent metallurgical rather than mining processes, have a downward growth bias because they are confined to 'primary' metal and exclude 'secondary' metal which is of increasing relative importance.

A growth bias is also likely to arise when an indirect production series has a trend of a somewhat different curvature than the real phenomenon which it is taken to represent. One of the outstanding consequences of technological advance (including improved management) in industry is the increasing yield of materials in the form of fabricated products. Hence, the numerous 'consumption' and 'import' series used in this

[13] When production series are used for other purposes, their defects are more difficult to appraise. See, however, pp. 99–100, note 4, and Appendix C.

study very probably have, on the whole, a downward growth bias, as far as their representation of production volumes is concerned. The same is true of the equipment series; for example, the series of tonnage documented for the cod and mackerel fisheries understates the trend of cod and mackerel catch, for fishing vessels and gear are being used with steadily greater effectiveness. The same factors are operative, but their statistical impact is opposite, when direct production series are used to represent production indirectly—a paradoxical procedure which at times has its advantages, as when cane sugar production is used to represent the production of sugar cane, and beet sugar to represent sugar beets, with a view to attaining a more rounded picture of agriculture. In these two cases, because of improved methods of extraction, the series used have an upward growth bias.

Finally, a growth bias will arise in a production series when the product covered has improved in quality. This may mean either that the quality of a product has been generally raised, or else that the high-quality portion of the output has increased in relative importance. It may be the result of increased care in the selection of seeds, as in crop production; or of breeding for desirable meat strains, as in animal husbandry; or of the development of alloys, as in the manufacture of steel. Observers of the industrial scene differ as to whether the quality of the total national output is improving or worsening. Doubts may be legitimate as far as a large portion of the field of elaborative manufactures is concerned. However, no one with even an elementary knowledge of the history of basic commodities can doubt that there has been, generally, a secular advance in their quality. Accordingly, a considerable number of the production series assembled for this study have a downward growth bias on this score.[14]

[14] It may be argued that the output of by-products associated with some fundamental commodity constitutes an additional source of growth bias when

The factors making for growth bias are compensatory in certain cases and cumulative in others. Thus, as an indicator of beef production, the series of cattle slaughter has an upward growth bias, arising from the increasing relative importance of federal slaughter and the declining weight of cattle at slaughter, but a downward growth bias because of the improving quality of beef. On the other hand, the series of copper consumption, when used as an indicator of the manufactures into which copper enters, has a downward growth bias which derives from the increasing importance of secondary copper, the increasing yield of copper in finished products, and the improving quality of the manufactures based on copper.[15] In most cases, the exact degree of growth bias cannot be ascertained, and the degree to which growth bias is cancelled or cumulated can be determined at best in a qualitative way only. For some industries, such as locomotive production, livestock slaughter, and a few others, auxiliary statistics are available which suggest the probable magnitude of the growth bias, at least as far as single determinants of bias are concerned.[16] Taking the production series as a whole, the one generalization which can safely be made is that their growth bias is in most instances downward.

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the by-products grow at a different rate than the main product. The series of coke production, on this basis, has an appreciable downward growth bias. The problem is, in the last analysis, one of definition. It depends, specifically, on whether 'coke' or 'coke and its manufactures' is taken as the industrial unit.

[15] If a series of sugar beets were used to indicate the production of sugar beets, it would have a downward growth bias originating in the improved quality of beets; if a series of beet sugar were used to indicate the production of sugar beets, it would have an upward growth bias originating in the improved methods of sugar extraction; but, if a series of sugar beets were used to indicate the production of beet sugar, it would have a downward growth bias originating both in the improved quality of beets and in the improved methods of sugar extraction.

[16] See Appendix C, I.

V. LIMITATIONS IMPOSED BY DATA

It is evident that neither in point of quantity nor of quality are the listed long-range production series fully adequate for a serious inquiry into production trends, even when the scope of the inquiry is restricted to physical volume data. The restricted coverage of the production statistics imposes limitations on any generalizations which may be made concerning production trends as a whole. The qualitative deficiencies of the data impose restrictions even on such generalizations as may be limited to the series studied. In working with defective statistical materials, the economist finds himself, to use the apt words of Mr. Meeker, "in much the situation of a chemist compelled always to do his qualitative and quantitative analysis with leaky test-tubes and impure reagents." [17]

The aim of this chapter has been to set forth in general terms the nature of the underlying data of this study, not to impound their defects. In the substantive chapters, the propriety of passing from the specific results obtained to a generalization for the production system as a whole will be considered at each critical point. In some cases, generalization is possible with some assurance, despite the sundry inadequacies of the data. In other cases, an attempt to generalize on the basis of the available materials would be boldness bordering on folly.

The fact is that the inadequacies of the statistical data do not bear equally on all kinds of problems, and each particular question must therefore be settled on its own merits. For example, the statistics are grossly inadequate for the purpose of accurate measurement of the long-term trend of general production.[18] To attempt to achieve this is to tempt faith out of its proper channel. On the other hand, the statistical mate-

[17] J. E. Meeker, *Measuring the Stock Market* (pamphlet by New York Stock Exchange, 1931) sec. VII.

[18] See Ch. VI, sec. I.

rials are quite adequate for the purpose of determining whether industries have grown characteristically at a declining rate, whether a long-term rhythm has been pervasive in industry, and for still other purposes. In certain connections, statistical methods may be used to reduce biases which actually exist or may exist in the data.[19] Also, it is often possible to reckon appropriately, on the basis of general knowledge, with the inadequacies of the data. There is, indeed, no more important check on the validity of conclusions drawn from statistical materials than the reasonableness of the results. If they conform to a priori expectations, or if they admit of a rational explanation, some confidence, however tentative, must attach to them.

These remarks apply to statistical results of a general nature which alone are a matter of real concern in this work. The primary aim of the inquiry is to describe in general terms the trends of the production system as a whole, the interest in individual industries being merely incidental. If the specific numerical results for the individual series are at times in error, that need not detract from the general conclusions reached on the basis of the data taken in the mass. Though the data have been compiled with considerable care, a serious effort having been made to obtain the most authoritative figures, it may still be true that some of the results for individual series reflect faultiness of the data, or of the technique of their analysis, rather than the nature of the actual phenomena. Insofar as the interest of the reader may center in any of the individual results, he would therefore do well to acquaint himself with their full history. To help the reader who may become so engaged, the raw data are presented in Appendix A, Table 44; the sources of the data accompanied by brief comments are listed in Appendix B; and a detailed description of their elaborate treatment is presented in Chapter II and also in portions of the substantive chapters which follow.

[19] See pp. 242–3, note 54.