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# Appendix C

# NOTES ON MEASURES FOR PRODUCTION SERIES

The following notes bear on the defects of various production series, from the standpoint of certain of the analyses to which they are subjected in this study. The notes supplement the text sections indicated below.

## I. AVERAGE RATES OF GROWTH

*(Chapter III, section I, 1)*

It is possible to present quantitative evidence of the inexactness of the average rates of advance shown by certain of the production series. In some cases the evidence indicates definitely the existence of a growth bias.

*Cattle, Hogs,* and *Sheep.* The series 'cattle' and 'sheep' have an upward growth bias arising from the increasing tendency to bring these animals to slaughter at a younger age, which has meant a declining average weight per animal. During 1907–29, the number of federally inspected cattle slaughtered increased at an annual rate of 1.2 per cent, while the dressed weight of the slaughter increased at a rate of only 0.9 per cent; the number of federally inspected sheep slaughtered increased at a rate of 0.4 per cent, but the mutton and lamb yield of the slaughter at a rate of 0.0 per cent. On the other hand, while the number of federally inspected hogs slaughtered increased at a rate of 2.1 per cent, the pork and lard yield increased at a rate of 2.7 per cent. The several series of animals slaughtered have an upward growth bias arising also from the increasing relative importance of federally inspected slaughter. During 1907–29, the dressed yield of the federal slaughter of cattle increased at a rate of 0.9 per cent, but total slaughter at 0.1 per cent; the dressed yield of the federal slaughter of hogs increased at a rate of 2.7 per cent, but the total slaughter at 2.2 per cent. However, there is no discrepancy in the case of sheep during this period. The above calculations are based on data of the Department of Agriculture, given in *Statistics of Meat Production, Consumption and Foreign Trade of the United States, 1900–1930* (mimeographed).

*Cod and mackerel.* The series 'cod and mackerel', which runs in terms of

the vessel tonnage documented for these fisheries, undoubtedly overstates their decline. Fairly complete data on the catch of the American mackerel fleet are available continuously by years, beginning with 1905; see *Fishery Industries of the United States, 1929* (Bureau of Fisheries, Document No. 1095), p. 856. Also, continuous annual data for the period 1893–1926 are available for the eastern cod catch which has been dominant in the cod industry; see O. E. Sette, *Statistics of the Catch of Cod Off the East Coast of North America to 1926* (Bureau of Fisheries, Document No. 1034), pp. 743–4. A composite of the above two series shows an average annual rate of decline of 0.1 per cent for 1905–26, while the series 'cod and mackerel' shows a rate of decline of 2.9 per cent. The discrepancy cannot, however, be so large for the earlier years; for, though the mackerel catch has been on the increase over the past twenty years, the current catch is still low in comparison with the early 'eighties. (See O. E. Sette, *Outlook for the Mackerel Fishery in 1931,* Bureau of Fisheries, Circular No. 4, p. 4.) The eastern cod series shows a rate of decline of 1.6 per cent for 1893–1926, and the series 'cod and mackerel' a rate of decline of 2.3 per cent.

*Whale.* This series, which runs in terms of the vessel tonnage documented for the whalery, may be compared with data on whalebone production (an important product of whaling during much of the period considered); see *Whalebone: Its Production and Distribution* (Bureau of Fisheries, Document No. 626), p. 7. During 1870–1906, whalebone production shows a decline at an annual rate of 2.7 per cent, and the 'whale' series at a rate of 5.3 per cent.

*Copper, Zinc,* and *Lead, domestic.* These series relate to some metallurgical stage, not to mine output. Official estimates of mine output are available since 1907 only; see Bureau of Mines, *Mineral Resources.* In the period 1907–29, the mine output of copper increased at an annual rate of 2.3 per cent, zinc at 4.1 per cent, and lead at 2.6 per cent. For the same period, the series 'copper' shows a rate of increase of 2.5 per cent, 'zinc' 3.7 per cent, and 'lead, domestic' 3.0 per cent.

*Cement, total.* The rate of growth of total cement production is understated somewhat by the series 'cement, total', which is expressed in barrel units. Since the poundage per barrel is greater for Portland than for other cements, and the proportion of Portland to other cements rose sharply during the 'eighties and 'nineties, the series 'cement, total' overstates the output in the early years relative to that of later years. Thoroughly consistent totals of cement output are unattainable: first, because of the inconstant weight of barrels of cement other than Portland; second, in recent years natural and puzzolan cements have not been distinguished in the statistical reports, so that it is impossible even to assign average weights to the different cements for purposes of estimation. If we reduce the cement figures for early years

to a poundage basis (by taking a barrel of Portland cement as equivalent to 380 pounds, natural cement 265 pounds, and puzzolan cement 330 pounds), we find that the annual rate of increase of total cement production was 11.0 per cent during 1890–1900 and 20.5 per cent during 1895–1905, while our series shows rates of 8.7 per cent and 17.0 per cent, respectively. These rates apply to the indicated calendar periods, and are not the same as our 'decade rates' (see Ch. II, sec. II, 2).

*Locomotives.* This series has a sharp downward growth bias (see, however, Appendix B, I), since it is expressed in terms of the number of units of output, taking no account of their quality. Some indication of the trend in quality is afforded by data, available back to 1903, on the average tractive effort of the steam locomotives of Class I railways; see the *Annual Reports on the Statistics of Railways in the United States,* by the Interstate Commerce Commission. During 1903–29 the average tractive effort of locomotives increased at an average annual rate of 2.7 per cent, while the number of locomotives manufactured declined at a rate of 4.6 per cent.

*Tonnage entered and cleared.* The evidence concerning the physical volume of foreign trade, yielded by this series, may be checked against other indicators. For the period 1879–1916, quantity indexes of exports and imports have been constructed by T. J. Kreps; see his "Import and Export Prices in the United States and the Terms of International Trade, 1880–1914," *Quarterly Journal of Economics,* August, 1926. His 'median' and 'aggregative' indexes show average annual rates of increase of 3.1 and 2.5 per cent respectively during 1879–1916 in the case of exports, and 4.0 and 3.6 per cent in the case of imports. In the same period, 'tonnage entered and cleared' increased at a rate of 3.8 per cent. For more recent years a check is available in the indexes of physical volume of exports and imports, published in the *Commerce Yearbook.* According to the indexes with 1923–25 as base, exports increased at a rate of 3.0 and imports at 4.7 per cent during 1919–29. An index of physical volume of foreign trade may be constructed by allocating weights to the indexes of exports and imports proportionate to the aggregate value of exports and imports during 1919–29; such an index shows a rate of increase of 3.7 per cent during 1919–29. In the same period, 'tonnage entered and cleared' increased at a rate of 4.4 per cent.

*Railway freight.* This series relates to 'total revenue tons', and may be checked for the period since 1899 by data on 'revenue tons originated', which are free from duplications. (See *Statistics of Railways.*) During 1899–1929 both series show average rates of increase of 2.8 per cent.

## II. AVERAGE RATES OF RETARDATION

*(Chapter IV, section II)*

Although accelerative series do not have a monopoly on statistical defects,

they seem, as a group, to be more heavily weighted with defects than the others. In any case, those accelerative series whose accuracy is doubtful or whose form is ambiguous are noted here specifically. But it is rarely possible to state definitely whether the defects in the data are of a kind to induce acceleration (see pp. 99–100, note 4).

*Distilled spirits.* This series probably covers more fully the production of late than of early years: 'whiskey frauds' tended to decline, and this may account partly for the acceleration noted.

*Flaxseed consumption.* The figures for flaxseed consumption are not altogether satisfactory, especially for years prior to 1902, since the figures of flaxseed production are estimates based to a considerable extent on data of receipts at primary markets (it should be noted, however, that flaxseed production does show retardation).

*Silk imports, unmanufactured.* Since this series does not include spun silk, it is defective as an indicator of the quantity of silk worked up by the silk industry. Very small quantities of spun silk were imported during the early and late decades of the period covered, but rather considerable quantities during the middle decades. When spun silk is added to unmanufactured silk, the aggregate does not show any acceleration. (It may appear from Table 24 that the two series of silk imports—the series of raw silk imports is the less inclusive—give inconsistent results, but this is not the case when they are compared for the same period: raw silk imports also show a slight acceleration for the period 1883–1929.)

*Coastal trade.* This series does not refer directly to the physical volume of traffic; it simply measures the tonnage capacity of ships documented for the coastal traffic.

*Postage stamps.* The significance of this series is vitiated to some extent by changes in postal rates. Concerning the adequacy of 'postage stamps' as a measure of one branch of the communications industry, see this Appendix, sec. III. ('Postage stamps' is indubitably a poorer indicator of the progress of general trade than 'deflated clearings' or 'Snyder's index of trade'—see p. 11, note 5.)

*Tonnage entered and cleared.* This series measures the tonnage capacity of ships entered and cleared in the foreign trade; it therefore represents incompletely and very indirectly the physical volume of foreign trade. It must also be borne in mind that the series 'tonnage entered and cleared', being symptomatic of the total volume of foreign trade, has a very general industrial reference, and is more comparable in economic dimension with the

volume of production of groups of industries than with the production of 'individual' industries. Of course, the same thing holds for the indicators of 'general trade'—deflated clearings, postage stamps, and so on. See Ch. VI, sec. III.

*Shares traded.* This series has a strong upward growth bias arising mainly from the increasing tendency towards 'split-ups' (using the term broadly to include stock dividends not paid out of accumulated earnings) of shares. Moreover, its measure of retardation is influenced to an excessive degree by the stock-market experience of the latter half of the last decade, as may be seen from the fact that for the period 1875–1925, the series shows an acceleration of only 0.4 per cent.

*Face brick.* As for the production of face brick, the census figures used for the years 1889, 1899, and 1904 may be inaccurate. The figures for these years were obtained by adding the production of 'fancy or ornamental brick' to the production of 'face brick', the reason being that "the best grade of 'face' or 'front' brick appears to have been classified as 'fancy or ornamental' brick" in these years (the quotation is a statement from the Census Bureau). However, so far as the observed acceleration is concerned, the tremendous expansion of production during the past decade is more important than any inaccuracies in early data (see pp. 155–6).

*Hay loaders.* The data on the production of hay loaders in some of the early years appear inaccurate (see *Twelfth Census of the United States*, Vol. X, pp. 351–2). Even if the data are accurate, the annual fluctuations in output are so large as to reduce very considerably the significance of a measure of retardation based on discontinuous data. Then again, the data show very marked retardation for the period since 1889.

### III. TREND-CYCLE PATTERNS

*(Chapter V, section III)*

The defects in the production series bear unequally on the measurements of trend-cycles. The existence of a bias in growth, in retardation, or in both, is likely to exercise little influence on the trend-cycle pattern of a series. But when a series measures production indirectly, its trend-cycle pattern may depart considerably from that of the production volumes which it is taken to represent. When a series is spliced, its trend-cycle pattern may depart from that of the process represented, during the period centering about the date of the splicing. In all cases, other things being equal, the smaller the amplitude of the trend-cycles of a series, the larger are the errors in its trend-cycle pattern likely to be. Statistical defects in the data may, of course, influence the conformity of the series to the standard trend-cycle pattern for

better or worse; but certain of the defects which are likely to influence the trend-cycle patterns of the series for the worse are sufficiently obtrusive to be noted specifically.

*Cod and mackerel,* and *Whale.* These two series relate to the volume of equipment available at yearly dates for use in certain 'fisheries'. The indirectness of the series, and the relatively low trend-cycle amplitude of the first, cast doubt on the fitness of these series to trace out accurately the trend-cycle patterns of the outputs of the respective 'fisheries'.

*Fish, total.* This series is based on very extensive interpolations, which serve to dampen the trend-cycle amplitude and may also distort the trend-cycle pattern. The actual trend-cycle amplitude of the series is low, and this casts further doubt on the reliability of its trend-cycle pattern.

*Raw sugar consumption.* This is a calculated series; and it has a very low trend-cycle amplitude. The data are 'defective' to the extent that the domestically produced cane sugar and imported sugar are not 'raw'; and to the extent that there is lack of synchronism between domestic production and imports, on the one hand, and sugar refining, on the other. In view of the low trend-cycle amplitude of the series, these errors may be sufficiently large to produce a discrepancy to some extent between the trend-cycle pattern of this series and that of sugar refining (other than that of domestic beet sugar).

*Building permits.* It will be seen from Chart 18 that the trend-cycles of 'building permits' differ at several points from the general movement of other series relating to construction. This is prima facie evidence that the series is inexact, which is not surprising in view of its varying and very limited coverage.

*Coastal trade.* This series expresses the volume of equipment available at yearly dates for use in one branch of transportation. The indirectness of the series, considering its relatively low trend-cycle amplitude, may make its trend-cycle pattern unrepresentative to some extent of that of coastal water transportation.

*Postage stamps.* This series reflects abrupt changes in postal rates and in the activities of the postal service. (See, however, C. J. Bullock and others, "Postal Revenues and the Business Cycle," *Review of Economic Statistics,* May, 1931, pp. 47–51.) Considering the low trend-cycle amplitude of the series, the changes in postal rates cast doubt on the capacity of the series to trace out accurately the trend-cycle pattern in the volume of postal service; and considering further the abrupt accessions of new postal func-

tions, on the capacity of the series to trace out accurately the trend-cycle pattern in the volume of 'communications' through letters, printed matter, and parcels.

*Railway ton-miles.* The non-conformity of 'railway ton-miles' (Chart 19) between the central decade years 1875 and 1880 may be due, in part, to inaccuracies of data, which are estimates for years prior to 1883. See, however, p. 225; the conformity, for the corresponding period, of rail production and rail consumption (Chart 18) should also be noted, but it is difficult to evaluate its significance.

*Deflated clearings.* It is reasonable to expect that 'deflated clearings' (Chart 19) should conform perfectly to the standard trend-cycle pattern. Except for the movement between the central decade years 1890 and 1895, this series does conform very closely to the standard pattern. There are some grounds for believing that 'deflated clearings' represent the physical volume of trade somewhat less satisfactorily in early than in recent decades: (1) checks have come to be of increasing importance in the making of payments, (2) the figures on clearings in early years may be distorted to some extent by the continual addition of new clearing centers, as data for them become available, (3) the price deflator is probably more accurate for recent decades.

*Tonnage entered and cleared.* This series expresses in units of capacity the actual use of vessels engaged in foreign trade. The indirectness of the series and its relatively low trend-cycle amplitude combine to cast doubt on the adequacy of its representation of the trend-cycle pattern of the volume of foreign trade.