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CHAPTER X

TEMPORAL CHANGES IN SEASONAL PATTERN

GENERAL CHARACTERISTICS

Seasonal variations are defined for statistical purposes as fluctuations recurrent annually within a twelve-month period. Upon the assumption of persistent recurrence in time, seasonal swings have been measured in Chapters III through IX by means of average seasonal indexes. The value of this recognizably rough assumption, which brings the task of measuring the seasonal swing within practical limits, can now be tested.

Although repeated measurements do often indicate a marked persistence from one period to the next, it is difficult to assume, in view of the continual progress in the material and social technology of economic processes, that seasonal variations are a species of change that persistently recurs in exactly the same way. It is true that the basic factors making for seasonal variations, such as climate, organic seasons, conventions, are highly stable, at least when considered in the time spans that delimit significant economic changes. Summers and winters are much as they were a hundred years ago. But their reflection in economic series may be anything but constant. Many factors may intervene between these stable causal elements and the economic activity that they affect to modify their influence. In series reflecting an economic process for the country as a whole a shift in the geographic center of production involving a transfer from one climatic area to another may result in modifications in either the pattern or the magnitude of the seasonal swing. Technical progress may render the processes relatively less dependent upon climatic or other natural forces (for example, the development of refrigeration). Consumers' habits may change so that a

commodity is consumed for a longer or shorter season than formerly.[1]

This chapter and the next will attempt to measure temporal changes in seasonal variations, first, those in pattern, second, those in amplitude, in order: (a) to ascertain whether there is an increased independence of climatic, organic and conventional factors in recent years as a consequence of the elaboration of technique, the expansion of areas of economic intercourse and the greater skill on the part of the distributive trades in spreading sales through the year; (b) to draw conclusions of some significance from the standpoint of statistical technique.

The results of the analysis are somewhat limited because the choice of the series is confined largely to those analyzed and

[1] The significance of the problem of changing seasonals was recognized and emphasized as early as 1841. J. W. Gilbart, probably the first English student of seasonal problems, wrote "On the Laws of the Currency in Ireland, as exemplified in the changes that have taken place in the Amount of Bank Notes in Circulation in Ireland, since the passing of the Acts of 1845" (*Journal of the Statistical Society of London*, XV (1852), pp. 307-25):

"The following important evidence, given by Mr. Murray before the Committee on Banks of Issue, in the year 1841, shows in what way the monthly variations in the circulation of notes may indicate the degree of agricultural distress:—'The condition of the people is vastly improved within the last fifteen years; and with the permission of the committee I will state a substantial instance of that improvement. In 1825, the crop of Ireland, especially that of the south and west, came to market with extreme rapidity after it was cut, and in very bad condition, being altogether thrashed out in the open fields. Stockyards were not to be seen, or rarely so. The markets were filled to overflowing during the months of October, November and December. In January and February these markets were comparatively thinly attended by the farmers, as the crop was nearly out of their hands. After February, a cargo of wheat or oats could not usually have been collected out of the ordinary markets. The case is now very different. The markets are much less crowded with produce in October, November and December and continue equally well supplied in January and February. In March and April, field-labour occupies the farmers, but in May, June and July, the markets now continue to be well filled where none appeared before, and the corn brought to them in good order; thereby showing that the people are now in a condition to hold over the property which they were formerly, from necessity, compelled prematurely to dispose of.'

In the evidence given by myself (*i.e.*, Gilbart) before the Committee on Banks of Issue in 1841, it was stated that the highest point of circulation was about January, but since the year 1845, the highest point has usually been in November; thus confirming the statement of Mr. Murray, that in seasons of distress the crops are brought earlier to market." (pp. 317-18)

With this recognition of the problem there was, however, no attempt to measure precisely either the stable seasonals or shifts in them.

discussed in the preceding chapters; and because the periods covered include primarily only the last decade and a half. From this limited sample some conclusions, however, stand out clearly, and, in respect to temporal changes in seasonal pattern, may be summarized as follows:

1. Seasonal variations, especially those which are wide, persist in time.

2. Disturbances in seasonal pattern appear to be unrelated to the magnitude of the seasonal swing, when measured absolutely. Hence relative measures of persistence of pattern tend to be high for indexes with wide seasonal amplitudes and low for indexes with narrow seasonal amplitudes.

3. As tested from period to period or from year to year, disturbances in seasonal pattern were concentrated in a few industries, primarily those dealing with the flow of wheat as grain, production of automobiles and production and shipments of some construction materials.

4. Furthermore, the disturbance in seasonal pattern was concentrated in the early post-War years. Since this was a period of rapid adjustment to peace conditions, it was not a favorable time to test stability of seasonal pattern.

5. Series covering stocks of commodities manifest greater stability of seasonal pattern than those dealing with their production, shipments and consumption.

6. The causes of shifts in seasonal pattern seemed to be:

   a. In respect of the supply of raw materials, a shift in the geographic area where the commodities were either produced or consumed. For materials used in more than one industry, a shift in the relative importance of the various industrial users, each subject to a seasonal swing of a different pattern.

   b. In respect of the demand for finished products, the enlargement of the social body of consumers whose demand the activity in question satisfied, technical changes facilitating storage and preservation, and a growing emphasis on the variable fashion and style elements.

DETAILED COMMENTS

1. Methods of Measuring Temporal Changes in Seasonal Pattern [2]

a. *Moving and Average Seasonal Indexes*

Current methods of studying temporal changes in seasonal movements measure the so-called moving seasonal swing by introducing a moving central tendency, either graphically or algebraically on small charts which show the succession of yearly ordinates for each month. This moving central tendency may be determined free-hand,[3] or as a median of a moving period,[4] or as a straight line fitted to the seasonal items,[5] although Dr. Snow, who uses this method, fits his line to the original data, thus correcting at once both for trend and moving seasonal, or as a smoothed moving average, as does the Research Division of the Federal Reserve Board.[6] In each method the attempt is made to fit some line of secular movement to that part of the series which is supposed to represent the seasonal element.[7]

All these methods introduce into the problem of measuring seasonal changes the difficulties of the procedure of establishing secular movements. These difficulties are especially formidable in series that cover a rather short period, for in such series the fitting of a line supposed to reflect secular movements is subject to considerable danger of distortion by the cyclical or random elements. Even if a moving average is fitted to the series to isolate the seasonal elements, the relative deviations from a moving average contain some part of the cyclical swing of the series. It is dangerous, therefore, to introduce mathematical curves describing the secular movement even for periods as long as fifteen years, unless it is

[2] Since the technical problem of measuring temporal changes in seasonal swings is not simple, a brief preliminary explanation follows. Readers who are primarily interested in the results may turn at once to page 284.

[3] See W. I. King, An Improved Method for Measuring the Seasonal Factor, *Journal of the American Statistical Association,* September 1924, pp. 301-13.

[4] See O. Gressens, On the Measurement of Seasonal Variations, *ibid.,* June 1925, pp. 203-10, and W. L. Crum, Progressive Variation in Seasonality, *ibid.,* March 1925, pp. 48-64.

[5] E. C. Snow, Trade Forecasting and Prices, *Journal of the Royal Statistical Society,* May 1923, p. 334.

[6] See *Journal of the American Statistical Association,* September 1928, pp. 241-52.

[7] For a survey of these and other seasonal methods see O. Donner, Die Saisonschwankungen als Problem der Konjunkturforschung; *Vierteljahrshefte für Konjunkturforschung,* Sonderheft 6 (Berlin 1928).

certain that the cyclical and other elements present in the series balance. The same difficulty limits the use of the more elastic moving average fitted to deviations that measure the seasonal element. Even if the period over which the moving average is computed is varied with changes in the duration of cycles, the moving average cannot take account of short-time changes in amplitude of the cyclical element. And a moving average always leaves the ends of the smooth line to be finished free-hand. Any secular line obtained for a short series is subject to grave doubt. Only when a substantial period of time is covered can secular movements in seasonality be measured properly.

Despite the difficulties indicated above, when it is desired to eliminate the seasonal element most thoroughly (in order to reveal more clearly the other fluctuations in the series), moving seasonal indexes may be used to obtain an elastic seasonal correction. Even if the moving seasonal indexes are suspected of including non-seasonal elements, it may be preferable to use them in order to make sure that the seasonal changes are entirely eliminated. But in the present investigation, where interest centers in the analysis of the seasonal variations themselves rather than in their elimination, the doubts concerning the line of the moving seasonal index are too serious to be overlooked. The measures must represent the seasonal element and nothing else. For this reason, a moving seasonal index was used in the present study only in the few series in which the change in seasonal variations was very rapid. If the need arose and the length of the series made it possible, average indexes were computed for more than one short period.

The advantages of such a procedure over the fitting of a continuously changing line of seasonals were manifold. First, it enabled us to deal with only a few seasonal indexes instead of having as many seasonal indexes as there were years in the series. This is an important consideration when the task was that attempted in the earlier chapters, namely, studying the comparable features of typical seasonal swings in related industries. Second, it confined the arbitrariness of the procedure to the choice of the period, while the type of line chosen to describe the secular movements in the seasonal was not affected. Third, by yielding several seasonal indexes, computed independently for one and the same series, it pro-

vided a good check upon the reliability of these constant indexes.

The choice thus made predetermined to a large degree the statistical procedure followed in this chapter. To gauge temporal changes in seasonal variations we have chosen or designed measures based upon average seasonal indexes for successive, rather short periods.

b. *The Index of Similarity and the Pearsonian r*

To estimate the degree of similarity or difference in two seasonal patterns we can no longer rely upon visual comparisons as was done in preceding chapters. We must derive some measure that will reflect more precisely the degree of persistence from one period to the next. For this purpose we choose a coefficient that involves only first moments rather than the frequently used Pearsonian coefficient of second moment correlation, for the squaring of the items in finding the Pearsonian r exaggerates the importance of the larger deviations from the arithmetic mean. Even in the first moment exceptionally large or small items influence the eventual measure, but at least the distortion is not so large and the significance of a measure based upon first moments is much clearer than that of a coefficient of correlation.[8]

The measure used in the present analysis is quite similar to that advocated by Gressens and Mouzon. The steps involved in the computation were as follows:

(1) The seasonal indexes to be compared were taken as deviations from 100, that is, from their arithmetic mean.

(2) These deviations were reduced to a common base. Since in the comparisons below indexes were used for only two periods, the later usually covering the more recent years, the sum of the deviations of the index for this later period was taken as the base. Accordingly, the deviations for the earlier period were raised or lowered to add up to the total for the later period.

(3) The differences between the seasonal indexes, month by month, were summated without regard to sign, and the sum divided by the base.

[8] For a discussion of this entire problem of the application of correlation to time series see O. Gressens and E. D. Mouzon, Jr., The Validity of Correlation in Time Sequences and a New Coefficient of Similarity, *Journal of American Statistical Association,* December 1927, pp. 483-92, and G. R. Davies, First Moment Correlation, *ibid.,* December 1930, pp. 413-27.

(4) The coefficient was obtained by subtracting the result under (3) from 1.

If there is perfect agreement between the two indexes, the result under (3) will be 0 and the coefficient +1. If the movement of the two is perfectly inverse, the result under (3) will be 2 and the final index of similarity will be —1. If definite relationship is lacking, the index will tend to be 0. The following example illustrates the computation of the index of similarity.

BUTTER, FACTORY PRODUCTION

Period	Deviations of Seasonal Index by Months												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1. 1917-22	−27	−33	−20	−9	+35	+58	+46	+23	0	−12	−32	−32	327
2. 1923-31	−19	−23	−12	−1	+31	+46	+35	+15	−6	−13	−28	−25	254
3. 1917-22 reduced to base of 1923-31 ...	−21	−26	−16	−7	+27	+45	+36	+18	0	− 9	−25	−25	255
4. Differences (2)−(3)	+2	+3	+4	+6	+4	+1	−1	−3	−6	−4	−3	0	37

$$\text{Index of Similarity} = 1 - \frac{37}{254} = 1 - 0.15 = +0.85$$

It may be seen that the index of similarity measures the percentage of deviations from 100 that is common to the two seasonal swings compared. In the example, of total seasonal deviations 85 per cent were common to the seasonal indexes for 1917-22 and 1923-31, indicating a considerable degree of similarity between the two indexes.

The measure just presented is used below to describe the similarity in pattern of average seasonal indexes, computed for successive periods, and of a moving seasonal index for any pair of years. To test the persistence of a seasonal pattern year by year within the period for which an average index is computed the deviations of the original data from the moving average might be taken for each calendar year (or any twelve-month period), centered about 100 and compared with the average deviation of the average seasonal index for the period within which the chosen year (or twelve-month period) falls.

In such a comparison, however, the index of similarity cannot be used, because the deviations of the original data from the moving average contain not only the seasonal element but also the random changes and whatever parts of the cyclical

movements have not been eliminated by the moving average. Thus, when we compare these deviations with the average seasonal index for the corresponding period, we are not comparing the pure seasonal swing for the given year with the seasonal swing for the period. The presence of the non-seasonal elements in the deviations of the original data from the moving average will serve to swell the discrepancy in the comparison and as a consequence make for unduly low indexes of similarity.

This difficulty may be overcome by the use of the Pearsonian coefficient of correlation, provided we accept one assumption: that the non-seasonal elements in the deviations of the original data from the moving average are not correlated with the seasonal pattern. If this assumption is granted, and it seems obvious as a matter of definition, then it will be seen that the presence of non-seasonal factors does not influence the product-moment, in which the deviations of the original data from the moving average constitute one of the variables and the deviations of the average seasonal index from 100 another variable. Although the resulting r is affected by any defects in the second moment procedure in time series data, it gives a much better approximation to the measure of similarity of patterns than would a first moment index of similarity under the same conditions.

This coefficient of correlation is then computed by the usual formula

$$r = \frac{\Sigma ds}{\sqrt{\Sigma s^2 \ (\Sigma d^2 - 12c^2)}}$$

where

d = percentage deviations of original data from moving average
s = deviations of corresponding average seasonal index from 100
c = correction to center the d's about 100

This second moment correlation procedure is also used in Chapter XI to study the changes in seasonal amplitude from year to year, again for the reason that, when the first moment measures are applied, regression for single years, like similarity, is too greatly affected by the presence of the non-seasonal variations in the variable d.

2. Persistence of Pattern

a. *From Period to Period*

Table XXXIII presents the indexes of similarity between seasonal patterns in two successive periods for all the series discussed in preceding chapters for which seasonal measures were computed for more than one period. Its significance is limited by the method of selection of the series. (This was determined by the rather fortuitous circumstance of previous discussion and availability of data for a considerable period.) Nevertheless it yields some interesting observations concerning the tendency of seasonal patterns to persist from period to period.

In the majority of the series the two periods compared cover either the post-War years or the War and the post-War years. The later period runs usually from 1923, 1924 or 1925 to 1931, the earlier period from 1917, 1918 or 1919 to 1924, 1925 or 1926. The comparisons therefore cover more or less the same historical period.

TABLE XXXIII

INDEXES OF SIMILARITY BETWEEN AVERAGE SEASONAL INDEXES FOR SUCCESSIVE PERIODS

SERIES RELATING TO THE FLOW OF COMMODITIES

Series	Periods Compared		Total Deviations of Seasonal Index Period		Total Discrepancy between Seasonal Indexes	Index of Similarity
	1	2	1	2		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
FOOD PRODUCTS						
Wheat, Marketing by Farmers	1909-19	1919-30	618	719	243	0.66
Wheat, Receipts at Primary Markets	1920-24	1925-31	442	620	323	0.48
Wheat, Shipments from Primary Markets	1920-24	1925-31	366	435	183	0.58
Wheat Exports (wheat only)	1918-23	1924-31	420	549	256	0.53
Wheat, Visible Supply, U. S.	1918-22	1923-31	432	268	52	0.81
Wheat Flour Production	1918-23	1924-31	151	93	27	0.71

TABLE XXXIII (CONTINUED)

Series	Periods Compared		Total Deviations of Seasonal Index Period		Total Discrepancy between Seasonal Indexes	Index of Similarity
	1	2	1	2		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cattle and Calves, Receipts at Primary Markets	1917-22	1923-31	190	158	29	0.82
Cattle Slaughtered	1907-19	1919-27	141	101	19	0.81
Calves Slaughtered	1919-24	1924-28	98	81	51	0.37
Beef and Veal, Cold Storage Holdings	1917-22	1923-29	246	335	40	0.84
Beef and Veal, Apparent Consumption	1917-22	1923-31	79	58	31	0.47
Sheep and Lambs, Receipts at Primary Markets	1917-22	1923-31	329	259	93	0.64
Sheep and Lambs Slaughtered [a]	1922	1926-30	91	66	30	0.55
Mutton and Lamb, Cold Storage Holdings	1917-22	1923-29	337	272	84	0.69
Mutton and Lamb, Apparent Consumption	1916-22	1923-31	93	50	36	0.28
Hogs, Receipts at Primary Markets	1917-22	1923-31	191	160	36	0.78
Hogs, Commercial Slaughter	1913-21	1922-29	232	169	30	0.72
Pork Products, Cold Storage Holdings	1917-22	1923-29	244	223	26	0.88
Pork Products, Apparent Consumption	1916-21	1922-31	121	71	31	0.56
Butter, Factory Production	1917-22	1923-31	327	254	37	0.85
Butter, Receipts at 5 Primary Markets	1920-24	1925-31	313	232	51	0.78
Butter, Cold Storage Holdings	1915-22	1923-31	711	781	111	0.86
Butter, Apparent Consumption	1917-23	1924-31	164	113	17	0.85
Evaporated Milk, Case Goods, Production	1918-23	1924-31	245	305	70	0.77

[a] Moving seasonal index prior to 1926. The index for 1922 taken as representative of the period 1919-25.

TABLE XXXIII (CONTINUED)

Series	Periods Compared		Total Deviations of Seasonal Index Period		Total Discrepancy between Seasonal Indexes	Index of Similarity
	1	2	1	2		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
American Cheese, Production	1920-24	1925-29	368	348	42	0.88
Cheese, Receipts at 5 Primary Markets	1920-24	1925-31	215	189	62	0.67
Cheese, Cold Storage Holdings	1917-23	1924-31	414	259	14	0.95
Eggs, Receipts at 5 Primary Markets	1919-24	1925-31	572	503	64	0.87
Eggs, Cold Storage Holdings	1915-21	1922-31	809	775	59	0.92
Dressed Poultry, Receipts at 5 Primary Markets	1920-24	1925-31	617	521	118	0.77
Dressed Poultry, Cold Storage Holdings	1916-22	1923-31	465	460	92	0.80
Cottonseed, Receipts at Mills	1919-24	1925-31	1055	1057	115	0.89
Cottonseed Oil, Refined, Production	1919-24	1925-31	634	644	92	0.86
Cottonseed Oil, Refined, Stocks	1920-24	1925-31	412	364	83	0.77
Raw Sugar Meltings	1909-19	1919-28	284	172	87	0.50
Raw Sugar Stocks	1912-24	1922-28	556	487	222	0.54
TEXTILES AND SHOES						
Cotton, Receipts into Sight	1919-24	1925-31	724	911	221	0.76
Cotton, Visible Supply	1919-27	1927-30	344	424	41	0.90
Cotton, Stocks at Public Warehouses	1914-22	1923-31	329	444	99	0.89
Cotton, Stocks at Mills	1912-19	1919-27	231	216	34	0.84
Raw Wool Consumption	1918-23	1924-31	54	61	79	—0.30
Shoe Production	1922-26	1926-31	78	123	103	0.16
AUTOMOBILES AND THEIR MATERIALS						
Crude Rubber Imports	1919-24	1925-31	130	80	73	0.09
Inner Tube Production	1920-26	1925-31	50	121	110	0.09
Fabric Consumed in Automobile Tires	1921-25	1924-31	96	142	73	0.49
Petroleum Output	1913-22	1923-30	28	29	18	0.38

TABLE XXXIII (CONTINUED)

Series	Periods Compared		Total Deviations of Seasonal Index Period		Total Discrepancy between Seasonal Indexes	Index of Similarity
	1	2	1	2		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gasoline Production	1917-23	1924-30	39	26	17	0.35
Gasoline, Domestic Consumption	1918-25	1926-30	189	136	27	0.80
Gasoline, Refineries' Stocks	1919-24	1924-28	203	135	17	0.87
Steel Ingot Production	1920-25	1926-31	77	90	92	— 0.02
Steel Sheet Production	1919-24	1924-28	108	76	39	0.49
Passenger Car Production	1919-25	1925-31	158	263	151	0.43
CONSTRUCTION AND CONSTRUCTION MATERIALS						
Building Permits Issued [b]	1915-21	1922-28	136	128	87	0.36
Contracts Awarded, Total [b]	1919-23	1923-31	216	145	72	0.67
Contracts Awarded, Residential [b]	1919-23	1923-31	150	138	42	0.72
Contracts Awarded, Commercial	1919-23	1923-31	212	122	75	0.39
Contracts Awarded, Educational	1919-23	1923-31	362	222	112	0.50
Contracts Awarded, Public and Semi-public	1919-23	1923-31	302	186	96	0.49
Contracts Awarded, Public Works and Utilities	1919-23	1923-31	358	240	86	0.64
Portland Cement Production	1912-24	1924-30	222	254	48	0.81
Portland Cement Shipments	1912-24	1922-28	364	404	66	0.84
Portland Cement Stocks	1911-24	1924-30	254	230	30	0.87
Southern Yellow Pine Production	1917-23	1923-31	54	42	22	0.48
Western Pine Production	1917-24	1924-31	354	259	45	0.82
Fabricated Structural Steel, New Orders	1915-21	1922-28	108	64	58	0.09
Bath Shipments	1917-24	1924-30	113	162	92	0.43
Bath Stocks	1919-24	1924-30	269	114	36	0.68
Lavatory Shipments	1919-24	1924-30	70	127	91	0.28
Lavatory Stocks	1919-24	1924-30	111	63	32	0.49
Sink Shipments	1919-24	1924-30	79	126	100	0.21
Sink Stocks	1919-24	1924-30	129	90	36	0.60

[b] First period used as base.

The indexes of similarity suggest certain tentative generalizations:

(1) They indicate a rather considerable persistence of seasonal pattern from one period to the next. Of the seventy-one series for which comparisons are made twenty-four or slightly more than one-third show an index of + 0.80 or higher. In only twenty-three series are the indexes below + 0.50 and in only nine series are they below + 0.30. The index of similarity has been defined as the percentage of total variations represented by variations common to both seasonal patterns. If an index of + 0.50 may be considered indicative of a marked persistence, then forty-eight out of seventy-one series may be said to be characterized by relatively stable patterns.

(2) The distinct association between the index of similarity and the amplitude of the seasonal swing is substantial but not perfect, as is indicated by a rank coefficient of correlation for the later period of 0.63. The wider the seasonal swing the higher the index of similarity. In other words, the amount of disturbance that is introduced in the course of time into the seasonal pattern characterizing a given series tends to be the same in series with both wide and narrow seasonal amplitudes. When this disturbance is put on a relative basis, as it is in the computation of an index of similarity, it appears small for series with wide seasonal amplitudes and large for series with narrow seasonal amplitudes. The reason is clear. Changes in seasonal pattern are attributable on the one hand to secular movements in the factors making for seasonal changes, on the other, to the possible influence upon the seasonal indexes of non-seasonal factors, random or cyclical in character. Neither the genuine changes in seasonal pattern nor those attributable to the influence of random or other non-seasonal elements upon the seasonal index need be related to the size of the original seasonal swing.

(3) Seasonal patterns characterizing stocks of commodities seem to be more stable from period to period than those for the flow of commodities, such as production and shipments. This becomes apparent first when it is noted that for the eighteen stock series included among the seventy-one series in Table XXXIII the indexes of similarity run uncommonly high. For twelve of these eighteen series the indexes are + 0.80 or over and only one series has an index below + 0.50.

Of these eighteen stock series sixteen may be compared with series on production, shipments or consumption of the same commodity. In fifteen of these sixteen comparisons the stock series shows a higher index of similarity than the series on the flow of the commodity. This showing is in no way due to the possibility that the seasonal swing in stock series is wider than that in the series on the flow of the commodity, for if, instead of comparing the indexes of similarity, we compare the absolute discrepancy (column *6,* Table XXXIII), we find that the stock series shows a smaller absolute discrepancy, that is, greater persistence of pattern, in eleven of the sixteen comparisons.

It may be suggested that this higher persistence of pattern in stocks is attributable to the cumulative nature of the series. As has often been remarked in preceding discussion, seasonal changes in stocks may be interpreted as a cumulative discrepancy between the seasonal indexes of shipments and production or of shipments and consumption. This may mean that when certain secular movements occur in the seasonal pattern of production, a similar change may be taking place in shipments or in the other related series representing the flow of the commodity. As a result, the successive discrepancies between production and shipments, or shipments and consumption, which determine the seasonal pattern of stocks, may not be changing as much, if at all.

(4) Most of the low indexes of similarity, indicative of a significant change in pattern, are concentrated in one or two industrial groups. The lowest are in wool consumption, steel production, rubber imports, inner tube production, new orders of structural steel, shoe production and shipments of lavatories and sinks. There are very few low indexes in food products or in any series distinctly influenced by recurrent climatic or conventional elements.

The reasons for any significant change in seasonal pattern can be discussed adequately only when industries are examined separately, but some tentative suggestions may be made in the present connection.

Since the original seasonal factors exercise their utmost influence at the two extremes of the flow of commodities the causes of any significant shifts in seasonal pattern should be sought first in the supply of raw materials and the demand for

finished products. In the former one of the most common causes of any modification in seasonal pattern is a change in the geographic area covered by the series. Wheat marketing by farmers in the United States is treated as the same series through the years when the bulk of the grain is winter wheat coming from Kansas and Nebraska and the years when a larger than usual proportion of spring wheat is coming from Minnesota and the Dakotas. Such shifts in the area of influence of seasonal factors also affect series relating to building construction. Thus data on contracts awarded are available for only a certain number of states in one period; and for a larger number in another. Also the seasonal pattern in shipments of some construction materials may reflect a shift in the geographic area where construction is being carried on, a shift that subjects the industry consuming these materials to different seasonal conditions.

In the demand for finished products modifications in seasonal pattern may arise from two somewhat related factors: a change in the product, which makes its use more or less dependent upon seasonal factors creating discontinuity in demand, and the wider diffusion of its consumption, which implies geographic or income group shifts in the consuming body and in its seasonal behavior. Thus in passenger cars both factors were involved. In some food products technological improvements in preservation and changes in consumers' habits were, without doubt, largely influential in forming the seasonal pattern in demand.

In many series changes in the seasonal pattern are a consequence of shifts in seasonal swing in several related series. This is especially true of essential industrial materials such as steel. If more steel is used in railroad construction than in building construction and in the production of automobiles, the seasonal pattern of demand may be vastly altered. As more large residential buildings than one-family houses are built the seasonal pattern of demand for and hence in that of shipments of such commodities as baths, sinks and lavatories may change appreciably.

Indeed, a consideration of all the possible factors that might effect seasonal patterns would lead to the impression that stability should not be expected. The results of the comparison, as shown in Table XXXIII, however, tend to sub-

stantiate the usual assumption of time series analysis that seasonal swings are recurrent from period to period, especially when their amplitudes are relatively large.

In the case of our particular comparison there is reason to believe that the post-War period was not very favorable for the assumption and testing of the stability of seasonal patterns. The early years were affected by the events of the recent past, which may be considered as an important random disturbance. Consequently, seasonal patterns during the years 1924-31 tended to depart further from patterns prevailing in preceding years than would patterns in any similar successive periods characterized by more 'normal conditions'. This becomes clear in the next set of comparisons, between seasonal patterns in any pair of years of a moving seasonal index.

b. *Within Moving Seasonal Indexes of Production and Employment*

For industrial production and employment several constant and moving seasonal indexes were computed by the Research Division of the Federal Reserve Board for the years since 1919. Of the fifty-six series on industrial and mineral production eight were found not to possess consistent seasonal variations, nineteen could be analyzed with the aid of constant seasonal indexes and twenty-nine showed such a change in their seasonal swings that moving seasonal indexes had to be computed. For these last twenty-nine series indexes of similarity were calculated in order to measure the significance of the change in pattern described by the moving seasonal indexes. Most of the indexes were available since 1919 and comparisons were made between the patterns for 1919, 1926 and 1931. For a few series, analyzed only since 1921, comparisons were made between the patterns for 1921, 1926 and 1931.

The following tentative conclusions are suggested by Table XXXIV.

(1) The indexes of similarity generally run below those obtained in Table XXXIII for comparisons of patterns between periods. Thus, in column *11,* in which the indexes run on the whole higher than in column *10,* seven out of twenty-nine indexes run above +0.80, eleven run below +0.50, and as many as seven, below +0.30.

This lower run of indexes is to be expected in view of the greater precision of the moving seasonal indexes in reflecting any changes in seasonal pattern. But even though the indexes of similarity based upon these year-to-year comparisons run lower than those derived from comparisons for periods, it may be seen that the persistence of pattern indicated is fairly high.

(2) As in the preceding comparison there is a definite positive association between the amplitude of the seasonal index and the measure of the persistence of its pattern. Thus, an index of rank correlation between the items in column *6* and in column *11* is +0.45, a value lower than that for Table XXXIII but still indicative of a significant association.

(3) The change in seasonal pattern is greater in the early post-War years than in the more recent period. The indexes in column *11* generally run higher than those in column *10*. Of the twenty-six series for which such comparison is possible eighteen show higher indexes of similarity for the comparison between 1926 and 1931 than for that between 1919 (or 1921) and 1926 (or 1925). In two series the two indexes are about equal, and in only six is the index for the early period higher than that for the later.

TABLE XXXIV

INDEXES OF SIMILARITY BETWEEN MOVING SEASONAL INDEXES FOR SELECTED YEARS

INDUSTRIAL PRODUCTION

Series	Years Compared			Total Deviations of Seasonal Index			Total Discrepancy between Seasonal Indexes		Index of Similarity between	
	1	2	3	1	2	3	1 and 2	2 and 3	1 and 2	2 and 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Wheat Flour Production	1919	1926	1931	190	120	90	66	34	0.45	0.72
Cattle Slaughtered	1919	1926	1931	154	98	98	19	2	0.81	0.98
Calves Slaughtered	1919	1926	1931	126	64	68	30	14	0.53	0.78
Sheep and Lambs Slaughtered	1919	1926	1931	140	54	56	29	16	0.46	0.70
Hogs Slaughtered	1919	1926	1931	234	188	180	38	15	0.80	0.92
Cigar Production	1919	1926	1931	60	130	154	54	30	0.58	0.77
Cotton Consumption	1919	1926	1931	20	70	68	78	32	−0.11	0.54
Wool Consumption	1919	1926	1931	66	82	78	136	11	−0.66	0.87

TABLE XXXIV (CONTINUED)

Series	Years Compared			Total Deviations of Seasonal Index			Total Discrepancy between Seasonal Indexes		Index of Similarity between	
	1	2	3	1	2	3	1 and 2	2 and 3	1 and 2	2 and 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Calf and Kip Leather Production	1921	1926	1931	82	84	146	24	115	0.81	−0.37
Goat and Kid Leather Production	1921	1926	1931	50	84	48	18	90	0.79	−0.07
Shoe Production	1919	1925	1930	64	88	106	20	56	0.77	0.36
Pneumatic Tire Production	1921	1926	1931	82	80	170	22	29	0.72	0.64
Inner Tube Production	1921	1926	1931	50	72	158	45	46	0.38	0.36
Polished Plate Glass Production		1926	1931		46	82		17		0.63
Passenger Cars*	1919	1925	1930	134	134	250	46	51	0.66	0.62
Trucks		1925	1930		122	148		42		0.66
Steel Ingot Production	1919	1926	1931	28	62	76	76	48	−0.23	0.23
Lumber Production	1919	1926	1931	88	52	60	21	14	0.60	0.73
Cement Production	1919	1926	1931	228	230	264	28	24	0.88	0.90
Shipbuilding	1919	1926	1931	94	234	290	221	246	0.06	−0.05
Mechanical Woodpulp Production	1919	1926	1931	162	134	128	40	25	0.70	0.81
Chemical Woodpulp Production	1919	1926	1931	62	32	24	49	19	−0.47	0.41
Box Board Production	1919	1926	1931	58	40	52	33	20	0.18	0.50
Wrapping Paper Production	1919	1926	1931	60	32	18	42	29	−0.31	0.09
Paper Box Production		1926	1931		66	68		45		0.32
Anthracite Coal Output	1919	1926	1931	46	40	102	37	34	0.08	0.15
Bituminous Coal Output	1919	1926	1931	52	100	102	87	4	0.13	0.96
Beehive Coke Production	1919	1926	1931	82	176	160	190	11	−0.08	0.94
Silver Production	1921	1926	1931	42	26	54	30	20	−0.15	0.23

* Passenger cars and trucks combined in 1919.

It is possible that this difference is attributable to differences in the length of the intervals between the indexes compared; only five years elapse between 1926 and 1931 while seven years separate 1919 from 1926. It seems more likely, however, that during the early post-War years the change from the abnormal conditions prevailing at the close of the War and during the first post-armistice years to the more settled

TABLE XXXV

INDEXES OF SIMILARITY BETWEEN SEASONAL INDEXES FOR SELECTED YEARS

EMPLOYMENT IN MANUFACTURING INDUSTRIES

Series	Years Compared			Total Deviations of Seasonal Index			Total Discrepancy between Seasonal Indexes		Index of Similarity between	
	1	2	3	1	2	3	1 and 2	2 and 3	1 and 2	2 and 3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Flour	1919	1925	1930	65	43	25	15	12	0.64	0.73
Baking	1919	1925	1930	22	17	17	9	5	0.45	0.70
Slaughtering and Meat Packing	1919	1925	1930	30	43	25	46	48	−0.07	−0.12
Sugar Refineries (Cane)	1919	1925	1930	99	68	38	26	60	0.62	0.12
Cigars and Cigarettes.		1925	1930		30	36		25		0.30
Chewing and Smoking Tobacco		1925	1930		22	39		32		0.18
Cotton Goods	1919	1925	1930	8	35	21	58	15	−0.64	0.57
Dyeing and Finishing	1919	1925	1930	20	26	22	46	7	−0.77	0.73
Shirts and Collars	1919	1925	1930	29	26	27	25	22	0.05	0.16
Millinery	1919	1925	1930	82	90	120	45	40	0.46	0.56
Shoes	1919	1925	1930	15	32	33	43	17	−0.33	0.47
Rubber Goods and Shoes		1925	1930		53	48		51		−0.06
Automobiles	1919	1925	1930	52	36	59	41	15	−0.15	0.58
Glass	1919	1925	1930	45	29	31	32	32	−0.11	−0.12
Hardware	1919	1925	1930	16	11	13	20	10	−0.81	0.06
Cement	1919	1925	1930	70	54	60	17	6	0.68	0.89
Stoves		1925	1930		49	49		28		0.43
Furniture	1919	1925	1930	18	28	46	30	30	−0.06	−0.05
Fertilizer		1925	1930		244	232		54		0.77

conditions of the years after 1921 was rather rapid and substantial. In other words, the seasonal swings of 1919 still bore the heavy impress of the War while 1926 was a year of much more normal conditions. Confirming evidence is found in the movement of seasonal amplitude.

For employment the Research Division of the Federal Reserve Board computes moving seasonal indexes for nineteen branches of manufacturing industry, most of them from 1919 to 1930. Indexes of similarity between seasonal indexes in 1919, 1925 and 1930 are presented in Table XXXV.

The indexes of similarity run still lower than in industrial production, but it seems probable that this is largely because the seasonal movements in employment are much narrower. Only one index of similarity is above +0.80, eight of the nineteen are above +0.50, and as many as eight are below +0.30.

The association between the seasonal amplitude and the size of the index of similarity is appreciably lower than in the two preceding comparisons although a coefficient of rank correlation of +0.25 is still indicative of some measure of positive association.

Again the indexes of similarity between 1925 and 1930 are on the whole higher than those between 1919 and 1925. This is true of ten out of the fourteen possible comparisons, while in one other the difference between the two indexes is rather slight.

c. *Year by Year*

The changes of seasonal pattern in time have been measured so far only from period to period. But whenever average seasonal indexes are computed, as was done in our study, it becomes important to measure the persistence of the pattern not only from one period to the next but for every year within each period. It is important to find out how greatly short-time changes in seasonal pattern qualify the significance of the seasonal index, assumed to be average for the entire period.

Short-time shifts in seasonal pattern occur quite frequently and their presence can be ascertained rather easily. They affect not only all the numerous time series that deal with the flow of agricultural crops to markets, shipments of crops from central markets, exports and stocks of crops at primary

TABLE XXXVI

CORRELATION YEAR BY YEAR BETWEEN AVERAGE SEASONAL INDEXES AND THE PERCENTAGE DEVIATIONS OF THE ORIGINAL DATA FROM THE MOVING AVERAGE

PRODUCTION, RECEIPTS AND CONSUMPTION

Series	Sum of s^2	Coefficient of Correlation by Years													r for the Period
		1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1930-1	
Wheat, Marketing by Farmers	55,245	0.99	0.96	0.99	0.99	0.97	0.97	0.99	0.95	0.99	0.99	0.91			0.95
Wheat, Receipts at Primary Markets	22,668–44,412			0.83	0.94	0.97	0.96	0.81	0.99	0.87	0.88	0.95	0.98	0.94	0.91–0.91
Wheat Flour Production	2,515–1,021	0.83	0.83	0.84	0.94	0.96	0.96	0.90	0.95	0.90	0.89	0.91	0.96	0.97	0.86–0.90
Wheat Flour Consumption	1,610			0.86	0.94	0.89	0.96	0.89	0.89	0.77	0.79	0.70	0.80	0.80	0.84
Cattle and Calves, Receipts at Primary Markets	4,290–3,262	0.94	0.93	0.93	0.97	0.97	0.96	0.94	0.97	0.93	0.94	0.96	0.93	0.92	0.94–0.95
Beef and Veal Production	661			0.84	0.90	0.93	0.82	0.82	0.88	0.91	0.83	0.88	0.80	0.74	0.88
Beef and Veal Consumption	749–508	0.73	0.92	0.77	0.75	0.92	0.87	0.82	0.83	0.85	0.70	0.92	0.87	0.82	0.75–0.84
Sheep and Lambs, Receipts at Primary Markets	11,921–9,901	0.97	0.98	0.96	0.92	0.98	0.97	0.99	0.96	0.99	0.99	0.98	0.97	0.96	0.94–0.97
Lamb Production	360			0.88	0.48	0.66	0.82	0.44	0.59	0.81	0.81	0.61	0.73	0.82	0.69
Mutton and Lamb Consumption	883–302	0.83	0.81	0.70	0.76	0.78	0.75	0.71	0.63	0.76	0.71	0.58	0.83	0.84	0.73–0.71

TABLE XXXVI (CONTINUED)

Series	Sum of s^2	Coefficient of Correlation by Years													r for the Period
		1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1930-1	
Hogs, Receipts at Primary Markets	4,829–3,346	0.99	0.93	0.97	0.98	0.95	0.93	0.96	0.97	0.75	0.92	0.96	0.98	0.97	0.92–0.90
Pork Production	3,201			0.94	0.91	0.92	0.93	0.94	0.87	0.77	0.85	0.94	0.98	0.96	0.88
Pork Products, Apparent Consumption	615				0.83	0.87	0.78	0.96	0.84	0.79	0.65	0.86	0.86	0.87	0.83
Cotton Consumption	502[a]		0.03	0.14	0.45	0.92	0.82	0.84	0.81	0.63	0.81	0.75	0.93	0.72	0.77
Wool Consumption	340–449	0.02	0.54	0.74	0.12	0.60	0.81	0.82	0.84	0.73	0.71	0.83	0.63	—0.05	0.37–0.74
Hosiery Production	456						0.76	0.75	0.86	0.92	0.91	0.84	0.81	0.71	0.81
Shoe Production	735–1,803					0.84	0.96	0.94	0.84	0.99	0.94	0.96	0.94	0.83	0.89–0.93
Passenger Car Production	2,664–8,327		0.67	0.87	0.90	0.86	0.36	0.57	0.81	0.99	0.95	0.95	0.90	0.92	0.70–0.86
Inner Tubes Production	326–1,875				0.69	0.37	0.60	0.44	0.53	0.85	0.86	0.94	0.96	0.91	0.47–0.78
Steel Ingot Production	691–972			0.58	0.34	0.27	0.92	0.89	0.73	0.96	0.76	0.66	0.96	0.98	0.63–0.80
Contracts Awarded, Total.	4,836–2,415		0.87	0.89	0.98		0.82	0.88	0.75	0.96	0.94	0.80	0.75	0.92	0.91–0.80
Contracts Awarded, Residential	3,514–2,416		0.87	0.91	0.89		0.64	0.84	0.89	0.95	0.84	0.81	0.90	0.88	0.87–0.82

[a] Index for 1921-31 only.

stages of distribution, etc., but also the series that portray seasonal variations in consumers' demand due mainly to climatic conditions. In agricultural crops the exact month of harvest may not be the same every year. In retail trade the best example is afforded by the shift of the Easter holiday from March to April. Shifts in the exact date on which a new climatic season is really ushered in affect the sales of apparel, consumption of seasonal foods, sometimes even the beginning of construction operations or of water transportation.

The effect of these changes on the persistence of seasonal pattern from year to year can be measured, if only approximately, by the coefficient of second moment correlation between the percentage deviations of original data from the moving average and the deviations of the constant seasonal index from 100. If the coefficient is high year in and year out the inference may be drawn that the seasonal pattern is stable and that the non-seasonal changes, if present, are uncorrelated with the seasonal pattern. If the correlation is low, it is a definite indication of the importance of changes that are either non-seasonal in character, or if seasonal, different from the established constant seasonal pattern.

Table XXXVI presents these coefficients of correlation for twenty-two series relating to industrial activity. These coefficients are a by-product of the measurement of annual changes in seasonal amplitude, and the series were chosen so as to represent various groups and aspects of industrial activity. In addition to the measures that record the association for every calendar year, the table gives also the coefficient of correlation for the period as a whole (or for two periods, if two constant seasonal indexes were computed) and the sum of the squares of the deviations of the seasonal index from 100, a measure of seasonal amplitude.

Table XXXVI suggests the following observations:

(1) The coefficients of correlation run rather high. Those for the period as a whole range from 0.69 (considering the second period only) to 0.97. For single series the range is, of course, more appreciable; for some the coefficient in a single year falls close to 0 or even below it (cotton consumption in 1920 and 1921, wool consumption in 1930-31). But for several series the coefficients are uniformly high. Thus, for wheat marketing by farmers, receipts of cattle and calves, receipts

of sheep and lambs, the r's do not fall below 0.90; for wheat receipts at primary markets, wheat flour and shoe production, they do not fall below 0.80. These high values tend to indicate the importance of the average seasonal patterns as compared with other changes of a seasonal or non-seasonal character in the deviations of the original data from the moving average.

(2) As should have been expected, the magnitude of the correlation coefficients is closely associated with seasonal amplitude. For the more recent period the rank correlation between the column of Sum of s^2 and the r's (the latter taken for the period) is +0.77. For two selected years a similar index of rank correlation is +0.63 (for 1924) and +0.70 (for 1929). The indication is thus strong that, as in the case of the modifications in pattern from period to period, the absolute size of such modifications in pattern from year to year is unrelated to the magnitude of the seasonal swing. In series with conspicuous seasonal variations these disturbances in seasonal pattern are not sufficiently greater than in series with relatively mild seasonal swings to offset the difference in the amplitude of the constant seasonal variation.

(3) In view of the close association between seasonal amplitude and the measure of the persistence of the pattern, a more precisely specific measure of the latter could be established if we allowed for the differences in seasonal amplitude and proceeded to ascertain which series show a stability of pattern higher or lower as compared with the measure associated with amplitude. A simple if somewhat crude way of doing this is to rank the series by both amplitude and the r's and observe the difference in ranks. This is done in Table XXXVII using the r's for the entire period and for two selected years, 1924 and 1929.

This comparison reveals interesting differences among the series. Wheat flour production, receipts of cattle and calves, beef production, beef consumption, receipts of sheep and lambs, consumption of mutton and lamb, and production of hosiery and of shoes, all show a higher stability of pattern than that to be expected from the seasonal amplitude characterizing these series. Wheat receipts (and to a less extent, marketing by farmers), passenger car production, automobile tires and tubes, steel ingots and the two building con-

tract series, on the contrary, show a persistence of seasonal pattern considerably below that which might be expected from the large seasonal amplitudes characterizing these series. It seems evident that this division of series into those which are relatively stable seasonally from year to year and those which

TABLE XXXVII

COMPARISON OF RANKS BY SEASONAL AMPLITUDE AND BY STABILITY OF PATTERN

PRODUCTION, RECEIPTS AND CONSUMPTION

(ranks in increasing order for both variables)

	Difference between Ranks		
	r's for the Period	*r*'s for 1924	*r*'s for 1929
Wheat, Marketing by Farmers	+1	0	+9
Wheat, Receipts at Primary Markets	+3	+1	+3
Wheat Flour Production	−6	−7	−2
Wheat Flour Consumption	0	−5	+7
Cattle and Calves, Receipts at Primary Markets	−3	+1	−4
Beef and Veal Production	−6	−2	−3
Beef and Veal Consumption	−6	−5	−8
Sheep and Lambs, Receipts at Primary Markets	−2	−1	−2
Lamb Production	+1	−7	0
Mutton and Lamb Consumption	−1	−3	0
Hogs, Receipts at Primary Markets	+1	+4	−2
Pork Production	+1	+3	0
Pork Products, Apparent Consumption	−3	+2	−3
Cotton Consumption	+1	−3	0
Wool Consumption	0	−3	−5
Hosiery Production	−4	0	−5
Shoe Production	−7	−5	−7
Passenger Car Production	+6	+15	+2
Inner Tubes Production	+8	0	−2
Steel Ingot Production	+3	−3	+6
Contracts Awarded, Total	+7	+6	+8
Contracts Awarded, Residential	+6	+12	+8

are not agrees very well with the showing of the indexes of similarity between periods. The forces that are conducive to changes in seasonal pattern from period to period affect relative stability from year to year.

Similar results are obtained when the coefficients of correlation are observed for payrolls in eleven selected branches of manufacturing activity.

TABLE XXXVIII

CORRELATION YEAR BY YEAR BETWEEN AVERAGE SEASONAL INDEXES AND THE PERCENTAGE DEVIATIONS OF THE ORIGINAL DATA FROM THE MOVING AVERAGE

PAYROLLS IN SELECTED MANUFACTURING INDUSTRIES

Series	Sum of s^2	Coefficient of Correlation by Years								r for the Period
		1924	1925	1926	1927	1928	1929	1930	1930-1	
Flour Milling	175	0.93	0.85	0.98	0.85	0.92	0.93	0.84	0.97	0.88
Sugar Refining, Cane	262	0.87	0.82	0.72	0.88	0.39	0.77	0.78	0.79	0.73
Cotton Goods	232	0.93	0.89	0.97	0.75	0.76	0.86	0.96	0.74	0.83
Men's Clothing	533	0.94	0.95	0.94	0.98	0.95	0.92	0.85	0.70	0.91
Women's Clothing	2,950	0.98	0.96	0.90	0.94	0.98	0.98	0.96	0.94	0.95
Boots and Shoes	596	0.58	0.86	0.84	0.98	0.96	0.93	0.84	0.66	0.85
Passenger Cars	1,323	0.70	0.63	0.71	0.98	0.88	0.87	0.87	0.91	0.84
Auto Tires and Tubes	498	0.04	0.80	0.38	0.94	0.71	0.86	0.96	0.91	0.68
Furniture	357	0.82	0.88	0.97	1.00	0.98	0.83	0.74	0.73	0.87
Iron and Steel	262	0.85	0.69	0.66	0.92	0.90	0.34	0.86	0.90	0.70
Cement	763	0.93	0.92	0.95	0.98	0.96	0.99	0.94	0.93	0.91

Thus in Table XXXVIII also the coefficients run rather high, those for the period ranging from 0.68 to 0.95. Two of the series, cement and women's clothing, show coefficients that do not fall below 0.90 in any single year, and in one other, flour milling, the measures do not decline below 0.80. There is also a marked association between seasonal amplitudes and the coefficients of correlation, expressed by a coefficient of rank correlation for the period of +0.45.

The most significant correlation appears when the differences in rank are studied, with the series arrayed in the order of their seasonal amplitude and the magnitude of the r's. In such a comparison, flour milling, cotton goods, men's clothing, furniture and cement appear as a group whose stability of pattern is greater than expected; shoes, passenger cars, automobile tires and tubes, and iron and steel, as a group whose stability of pattern is less than expected. This division confirms, on the whole, the showing made in the larger number of series on production, receipts and consumption.