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Chapter Author: Arthur D. Gayer

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XII

SEASONAL VARIATION IN PUBLIC CONSTRUCTION [1]

Importance of the Seasonal Factor

The highly seasonal operation of the construction industries is of much importance in the study of the use of public works as a stabilizing influence. Even were other obstacles successfully surmounted, the seasonal element could in itself obstruct the expansion of public works at the moment when expansion on a large scale would be likely to prove most effective. To some extent this happened after the recession of 1929. The decline in industrial and commercial activity from its high level began in the summer of 1929, and the drastic liquidation following the stock market collapse set in towards the end of the year. The beginning of the winter of 1929–30 witnessed the onset of depression and the development of serious unemployment. Whatever its wisdom, the President's program of attempting to maintain a high level of business activity through increased public construction was launched at the most unpropitious season of the year.

[1] I am greatly indebted to Dr. Simon Kuznets, of the National Bureau of Economic Research, for his valuable critical advice throughout this chapter, and for making available to me several of the seasonal indexes computed by him in connection with his study of *Seasonal Variations in Industry and Trade* (National Bureau of Economic Research, 1933). The indexes of public construction were computed for the present study.

TABLE 92

INDEXES OF SEASONAL VARIATION IN CONSTRUCTION ACTIVITY, BY CLASSES

NUMBER	INDEX	J	F	M	A	M	J	J	A	S	O	N	D	A.D.	RANGE
1	Building permits	84	96	136	116	106	108	93	96	85	98	92	94	10.7	52
2a	Total contracts awarded, 1919–23	71	72	113	126	127	117	115	110	94	99	81	75	18.0	56
2b	Total contracts awarded, 1923–31	77	76	113	119	113	115	105	101	102	104	88	86	12.1	43
3	Index of volume of construction	71	65	68	86	102	117	121	124	127	119	115	87	20.7	62
4	Public contracts awarded (all)	60	66	107	115	128	122	123	115	106	98	78	77	19.8	68
5	Public contracts awarded (heavy)	74	64	88	116	123	128	105	124	122	106	75	76	20.6	64
6a	Residential contracts, 1919–23	72	72	114	129	128	103	95	99	100	101	95	92	12.5	57
6b	Residential contracts, 1923–31	75	78	115	126	114	105	95	97	95	109	97	94	11.5	51
7a	Industrial contracts, 1919–23	88	71	120	100	121	92	102	106	87	115	116	82	13.3	50
7b	Industrial contracts, 1923–31	80	89	110	100	101	104	93	98	99	112	112	102	6.8	32
8a	Commercial contracts, 1919–23	77	88	117	131	134	113	108	102	101	94	72	63	17.7	71
8b	Commercial contracts, 1923–31	96	91	124	108	112	113	104	98	95	90	82	87	10.2	42
9a	Educational contracts, 1919–23	54	54	108	137	121	129	152	134	95	100	55	61	30.2	98
9b	Educational contracts, 1923–31	57	68	110	105	118	133	134	106	104	94	86	83	18.5	77
10a	Public works and utilities, contracts, 1919–23	60	58	105	127	141	149	139	118	93	92	59	59	29.8	91
10b	Public works and utilities, contracts, 1923–31	72	64	111	135	114	124	120	109	103	104	70	74	20.0	71
11a	Public and semi-public, contracts, 1919–23	63	62	82	119	119	134	153	111	114	101	78	64	25.2	91
11b	Public and semi-public, contracts, 1923–31	67	76	108	116	111	119	106	117	115	98	80	85	15.5	52
12a	Total Federal contracts	96	78	93	130	95	93	155	93	109	125	68	65	19.8	90
12b	Total Federal contracts, smoothed	80	89	100	106	106	114	114	119	109	101	86	76	11.5	43
13	Hospitals and institutions, contracts	64	62	80	86	94	117	99	115	124	105	113	82	17.3	62
14	Waterfront developments, contracts	44	78	136	55	70	103	123	110	82	71	65	61	28.8	92
15	Sewer construction, contracts	48	51	95	96	143	110	140	114	98	84	70	84	23.4	95
16	Streets and roads, contracts	45	52	102	137	150	142	145	121	112	88	53	53	34.8	105
17	Federal-aid highways, miles under construction	94	93	94	96	100	103	106	107	108	106	100	96	4.81	15
18	Federal-aid highways, miles completed	74	63	42	51	76	123	80	98	140	164	151	140	36.2	122
19	Federal-aid highways, miles initiated	43	48	57	82	138	169	126	113	155	133	58	78	39.0	126
20a	Portland cement production, 1919–24	65	66	83	100	114	112	114	119	117	120	108	79	17.6	55
20b	Portland cement production, 1924–30	64	58	76	96	118	121	122	127	120	118	99	79	21.2	69
21a	Portland cement shipments, 1919–23	45	49	82	105	121	127	131	138	133	133	92	46	31.2	93
21b	Portland cement shipments, 1923–28	45	48	75	102	129	133	135	142	132	129	84	46	33.7	97

22 Asphalt production	70	68	83	98	115	122	123	125	121	122	87	66	21.3	59
23 Asphalt shipments	67	65	78	97	114	124	128	128	128	124	85	62	24.3	66

Sources of Original Data

1. Babson's series of permits issued, 1922–28
2, 6–11. Dodge data, 27 states, 1919–23; 36 states, 1923–31
3. Associated General Contractors of America, 1924–31 (published in *Survey of Current Business*)
4, 13–16. Dodge data, 37 states, 1926–30
5. *Engineering News-Record*, 1925–30
12. *Engineering News-Record;* 12b smoothed by 3-month moving average
17, 18. U. S. Department of Agriculture, Bureau of Public Roads (published in *Survey of Current Business*)
19. Derived from 17 and 18
20, 21, 22. U. S. Department of Commerce, Bureau of Mines (published in *Survey of Current Business*); period covered by 22, 1925–31
23. Figures derived from data on production and stocks; period covered, 1925–31

Total Construction

The first three indexes[2] of Table 92, permits, total contracts and volume of construction, reflect seasonal variations in the construction industry as a whole throughout the country.

The series on building permits covers twenty of the largest cities, the composition of the sample being identical throughout. The figures of contracts are the total contracts awarded for all types of construction published by the F. W. Dodge Corporation. The index of volume of total construction activity reflects actual current operations and not, as do the other two series, projected activity in the near future. It is a simple average of structural steel bookings, common brick bookings, Portland cement shipments, loadings of sand, gravel and stone, shipments of face brick and shipments of enameled sanitary ware. To allow for time-lag the index computed from these data for a particular month is shown as the construction index for the following month.

All these measures of general business activity disclose a clearly marked seasonal variation. In pattern the seasonal movements are not dissimilar, but in permits the peak occurs in March, in contracts awarded in April or May, in volume of construction activity in September; the high and low levels are distributed correspondingly. This is what we

[2] The procedure followed in computing the seasonal indexes in this chapter, except where otherwise indicated, is as follows: Twelve-month moving averages of the original items are calculated and centered at the seventh month by means of a two-month moving average; the ratio of the original item for each month to its moving average value is computed; the ratios for all the Januaries, Februaries, etc., respectively, are then arrayed, and arithmetic averages are taken for the central three, five, seven and nine items consecutively for each month. The averages are then readjusted so as to total 1200 for the year. The most stable set is selected as giving the index of seasonal variation. This method is in essentials that devised by Dr. F. R. Macaulay of the National Bureau of Economic Research and used extensively by the Federal Reserve Board.

should expect *a priori* from the nature of the respective series. Permit issues and contracts awarded, since both precede the beginning of actual construction and reflect probable future instead of current activity, naturally anticipate markedly in their movements a series in which construction activity is represented by actual installations. Again, as between contracts and permits, the latter, since their issue entails no obligation to build, are likely to precede the award of the contract, which represents a later stage in the building process, followed, either immediately or after only a short interval, by the beginning of construction operations.

Total and Public Construction Compared

The two series of public contracts, numbers 4 and 5, based on figures collected by the F. W. Dodge Corporation and the *Engineering News-Record* respectively, are the totals of contracts awarded for the different classes of public works which have been used throughout this study as showing the construction activities of governmental agencies. They thus differ from the Dodge Corporation's category of Public Works and Utilities by the exclusion of privately owned public utilities and the inclusion of hospitals, schools, public buildings and other similar structures.

As the figures in both represent contracts awarded, the most fitting comparison is with the similar series for total contracts awarded. The movements of the two Dodge series, total 1923–31 and public 1926–30, are sufficiently alike. The slightly later occurrence of the peak in public contracts—May as compared with April—is probably explained largely by a later occurrence of the peak in the most important of the thirteen heterogeneous series which compose this index, viz., streets and roads, which alone account for one-third of

CHART III

CONSTRUCTION SEASONALS

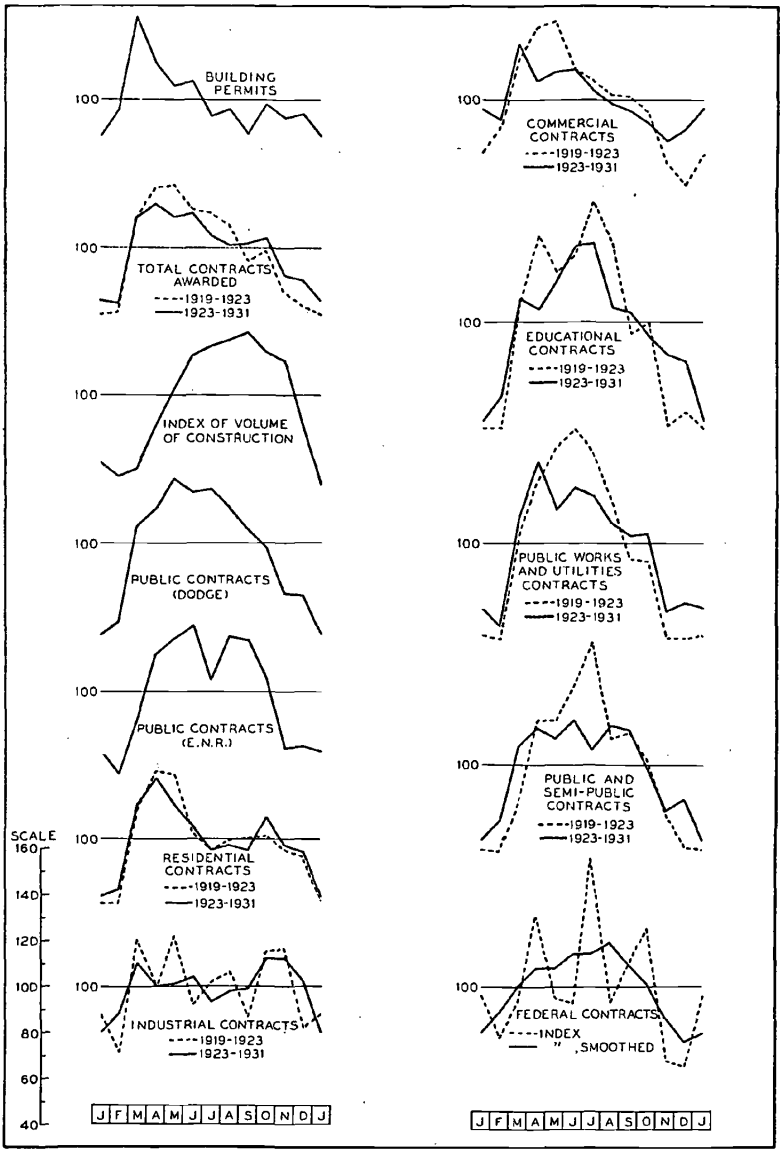
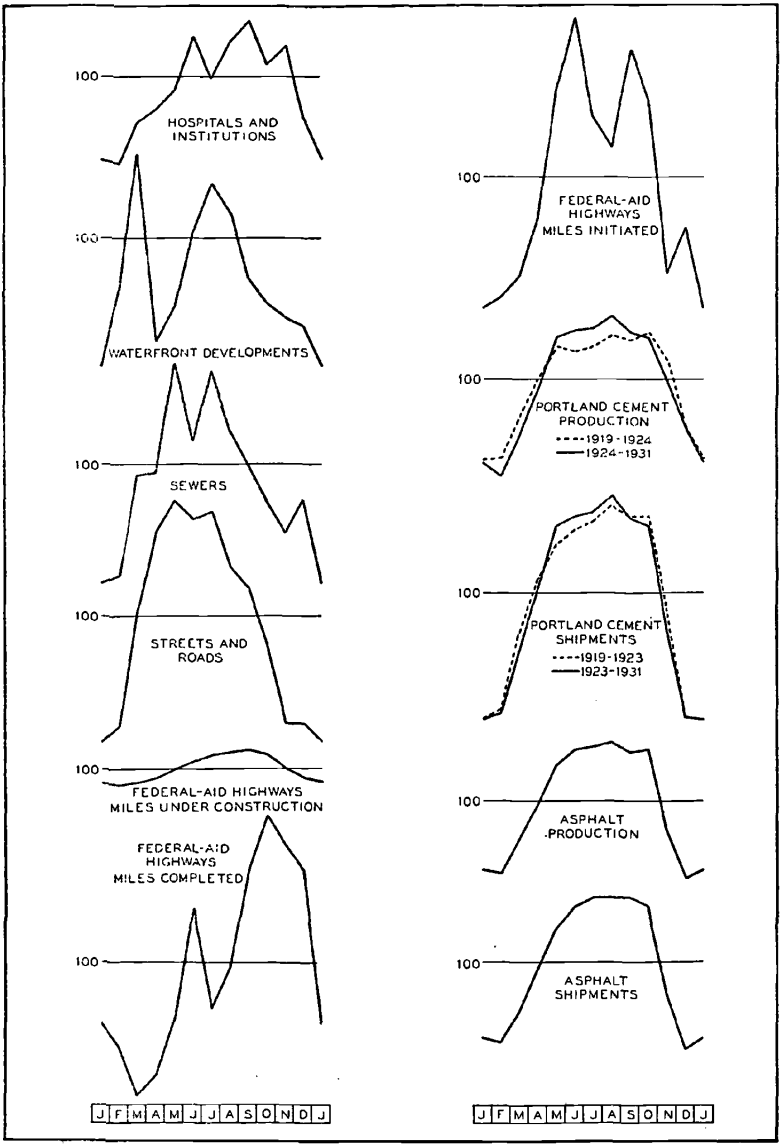


CHART III (CONT.)

CONSTRUCTION SEASONALS



the total valuation of public contracts awarded on an average over the period of years covered. Indeed, the general pattern of this index is largely determined by that of streets and roads. The most interesting feature, however, which emerges on a comparative examination of these two series is the more conspicuous amplitude of public works, the average deviation being 19.8 as compared with 12.1 for total construction, the range 68 as compared with 43. The second series representing public works, that of the *Engineering News-Record*, also displays a high seasonal variation, and one on the average reassuringly close to the Dodge figures: average deviation, 20.6; range, 64. Since this series excludes a very large volume of low-cost work, this might perhaps be interpreted as indicating that the seasonal element affects large and small projects in not greatly dissimilar fashion.

In the seasonal variation of residential, industrial and commercial building (indexes 6–8), as represented by contracts awarded, we are not directly interested. That the seasonal pattern of residential contracts should be quite similar to that of the total is not surprising, in view of the large percentage it constitutes of the latter: the same is true in less degree of commercial contracts, whose movement is also markedly similar to that of the total. Industrial contracts, on the other hand, exhibit no reliable seasonal at all. The most instructive feature, however, disclosed by these three classes of private construction is that the degree of variation, as measured by the average deviation, is in each case lower than that of the total. The less than average seasonal fluctuation shown by the three major classes of private contracts would indicate in public construction a degree of variation greater than the average; confirmation is found in the next three indexes (9–11).

Several interesting features emerge from inspection and

comparison of these indexes. All exhibit a high plateau from March or April to September or October, with relative inactivity indicated during the winter months. The least subject to seasonal variation is the group public and semi-public buildings. This is a miscellaneous category comprising hospitals and institutions, public buildings, religious and memorial buildings, and social and recreational buildings. All three indexes are characterized by a larger degree of amplitude than total contracts. The violence of the swing in educational buildings in both periods is pronouncedly greater than in the total. It is equally great in public works and utilities, a fact explained by the inclusion in this group of types of construction work peculiarly subject to weather conditions and hence to the seasonal element—waterfront developments, streets, roads and highways, sewers, etc. The great degree of seasonal variation in some of these subgroups, conspicuously highway construction, a most important component, may be seen in indexes 14–16.

When we compare the seasonal indexes computed for the two periods, 1919–23 and 1923–31, we find that the seasonal pattern tends to persist, but the seasonal swing shows an appreciable reduction in the later period, though it still remains markedly high. This reduction would seem to afford *prima facie* evidence of a diminution in the seasonal element in these three important classes of construction during the last decade: a condition which we shall see below to be by no means universally true of all types of public works.

From the series analyzed above it is clear that on the whole public works are subject to a decidedly greater degree of seasonal variation than are the various classes of private construction, though the periods of relative activity and quiescence are sufficiently similar. The comparison is made in the accompanying tabulation for 1923–31.

SERIES	AVERAGE DEVIATION	RANGE	PERIOD OF ACTIVITY	PERIOD OF QUIESCENCE
Total contracts	12.1	43	March-Oct.	Nov.-Feb.
All public (1926–30)	19.8	68	March-Sept.	Oct.-Feb.
Residential	11.5	51	March-June; Oct.	Nov.-Feb; July-Sept.
Industrial	6.8	32	March-June; Oct.-Dec.	Jan.-Feb; July-Sept.
Commercial	10.2	42	March-July	Aug.-Feb.
Educational	18.5	77	March-Sept.	Oct.-Feb.
Public works and utilities	20.0	71	March-Oct.	Nov.-Feb.
Public and semi-public	15.5	52	March-Sept.	Oct.-Feb.

Federal Construction

The seasonal index of Federal construction (No. 12), is computed from the weekly series (corrected to give comparable months) of contracts awarded by the Federal government published by the *Engineering News-Record.* Unlike the other figures of contracts awarded collected by this organization, this series does not omit projects below a certain minimum cost, but is claimed to be inclusive of all construction awards made by the Federal government throughout the country. It is therefore a valuable series, whose utility is enhanced by its availability in continuous form over a long period of years.

We should expect the general seasonal pattern exhibited to be not unlike those of the two series representing public works as a whole (Nos. 4 and 5). The movement of the monthly index is, however, highly erratic. In place of the peak in May and the high March-September plateau in the Dodge series for total public contracts, or the double peak in June and August and the general high elevation from October to April of the *Engineering News-Record* series for total public works, this series shows three distinct peaks sharply separated by deep troughs. Furthermore, the tallest of the peaks occurs in the very month when the *Engineering News-Record* series of total public contracts makes an unexpected dip. This, however, is of relatively slight importance, since on the average in recent normal years Federal contracts constituted less than 10 per cent of the *Engi-*

neering News-Record total for public works, and an even smaller percentage of the similar Dodge totals.

The average deviation for the series, curiously enough, works out at exactly the same figure as that of the Dodge total public series (19.8), though the range is much greater. Inspection of the seasonal variation of Federal contracts reveals a significant feature in their movement. It will be observed that a period of three months separates each of the three peaks (or rather four peaks, if the movement from November to January be included, as it should be). The monthly figures thus seem to reveal a discontinuity that is quite likely to be spurious in the sense that the activity represented may not properly be subject to a regular monthly fluctuation at all. Displaying as they do an interrupted flow of activity with regular peaks occurring at quarterly intervals they suggest monthly fluctuations superimposed upon a quarterly swing. If this analysis is correct the explanation may perhaps be found either in vagaries of reporting, or certain practices of the Federal government in the award of its contracts. However that may be, seasonal indexes of these data constructed on the assumption of regular concentration at quarterly intervals yield much more convincing results. Two such indexes were computed, the first by the standard method employed on all the series analyzed hitherto, on the basis, however, of quarterly instead of monthly original data; the other, which gives the most satisfactory results, through smoothing the monthly index by the simple process of passing through it a three-month moving average. This smoothed index is seen to exhibit a seasonal pattern quite similar to the two series of total public contracts, with a high plateau extending over almost exactly the same summer months, and with relative inactivity indicated during the winter. The main difference is in the shift of the peak months from May or June to August. The average deviation is of course markedly smaller than in any of the unsmoothed indexes.

Different Types of Public Construction

The next four indexes (13–16), for important classes of public works, should be examined in conjunction with those for educational buildings and total public contracts (9b and 4). All exhibit a high elevation in general during the summer months and indicate relative inactivity during the winter. Their seasonal patterns, however, show some marked differences. That of educational buildings is quite like the total for all public works. Hospitals and institutions exhibit some irregularity of movement during the high months. The dip in June in sewer contracts, and the conspicuously low values for April and May in waterfront developments are somewhat unexpected, but may in some way be related to possible effects produced on contract letting practices by the fact that fiscal years for many governmental bodies begin in the middle of the calendar year. Of greater interest, however, is the striking similarity between streets and roads and total public contracts. But since, as remarked above, contracts for roadbuilding in recent years have averaged one-third of all public contracts awarded, it is not surprising that their seasonal pattern should in large measure determine that of the latter.

It will be observed that of these five separate classes of public works, only one—hospitals and institutions—exhibits a seasonal variation, as measured by both the average deviation and range, smaller than the total for all classes of public works. The amplitude is higher than for any class of private buildings and higher also than for public and semi-public buildings, but it is lower than for educational buildings, probably owing to the seasonal character of school activities. The seasonal element in three of the four classes of public works other than hospitals and institutions is markedly

greater than in total public contracts. As compared with an average deviation for the latter of 19.8, it is 18.5 for educational buildings, but 23.4 for sewer construction, 28.8 for waterfront developments, and no less than 34.8 for road-building. It is, of course, not surprising that sewer, waterfront and road construction should be more subject, in this ascending order, to the influence of the alternating climatic seasons than are structures such as schools and hospitals.

When such important classes of public works as those analyzed above exhibit a greater seasonal variation than the average of all public construction represented by total public contracts, it is clear that the other categories of public construction must show a less than average amplitude in their seasonal indexes. The classes which offset those with high seasonal amplitude are not presented in Table 92 because no clearly marked seasonal variation could be detected in their movement. The accompanying tabulation presents the salient characteristics of the seasonal movements of the thirteen classes of public works that make up the total.

SERIES	AVERAGE DEVIATION	RANGE	PERIOD OF ACTIVITY	PERCENTAGE THAT CLASS FORMED OF TOTAL 1926–30
Total public works	19.8	68	March-Sept.	100.00
Streets and roads	34.8	105	March-Sept.	34.06
Waterfront developments	28.8	92	March, June-Aug.	3.51
Sewer systems	23.4	95	May-Aug.	6.44
Educational buildings	18.5	77	March-Sept.	22.11
Hospitals and institutions	17.3	62	June-Nov.	8.91
Bridges	No seasonal apparent			8.70
Public buildings	"	"	"	4.79
Subway construction	"	"	"	4.44
Water supply systems	"	"	"	4.13
Lighting systems	"	"	"	1.79
Military and naval buildings	"	"	"	.73
Incinerators	"	"	"	.21
Parks (public)	"	"	"	.18

Analysis of Roadbuilding Seasonals

The next three series (17–19), showing seasonals in Federal-aid highway construction, are computed from data collected and published by the Bureau of Public Roads. Such highways, which are constructed by the state governments but in part financed with Federal funds, constituted in 1925 about 25 per cent of the total mileage of roads improved by the forty-eight states of the Union. Only two of the three series, those showing number of miles under construction and mileage completed monthly, are published. The series of mileage initiated was derived, for purposes of this study, from the other two series, by adding to the first differences between successive monthly figures of number of miles under construction the new mileage completed at the end of each month.

The seasonal index of this last series, to the fuller discussion of which we shall presently return, is, of these three indexes, the one most comparable with the index of contracts awarded for streets and roads (No. 16), since the beginning of actual roadbuilding represents the stage in the construction process following the letting of contracts. It is interesting to observe that the seasonal amplitude of this series for roads initiated, as measured by the average deviation from 100, is markedly higher than that of contracts awarded—39.0 [3] as compared with 34.8—indicating, as would be expected, that contract letting is normally spread somewhat more evenly over the early summer in contrast to a higher degree of concentration in the starting of actual construction work. This is natural, in view of the anticipatory character of contracts awarded, and finds added confirmation

[3] This seasonal index was obtained from absolute deviations from the moving average.

in the earlier occurrence of the seasonal peak for contracts. The seasonal patterns of the two indexes are similar, but especially significant is the one feature of conspicuous divergence. The mild dip which the contract series exhibits in June is in marked contrast to the precipitous fall to be observed in the construction series in July and August. This reveals a very decided double seasonal peak only to a very slight degree reflected in the contract figures. The superiority of the mileage initiated series as an index of the movement of actual construction work would predispose one to suspect that it presents a better picture of the true seasonal element. An explanation of why this should be so is offered below.

PERIOD REQUIRED TO COMPLETE A ROAD

The seasonal pattern of completed mileage is conspicuous for its dissimilarity to the series of contracts awarded or miles initiated, since it shows only a minor peak in June, a very much higher peak in October and relatively low values during the first four or five months of the year. Now the occurrence of the major peak in the initiation of road construction in June and that of mileage completed in October seems to suggest that the period required to build a mile of road is either four or sixteen months. An examination of the seasonal index of mileage under construction indicates that the larger figure is correct. The mildness of the seasonal variation in this latter index is of course spurious, and arises because the original series is practically of a cumulative character, that is, the cumulative total of mileage begun. It is therefore merely the breadth of the base from which percentage variations are computed that makes the latter so mild. It is likewise this cumulative character of the series that probably accounts for the later occurrence of both the high and the low months of this index as compared with the series of miles initiated: if roadbuilding is begun in large volume in the early summer months, the total mileage under construction will

clearly remain large throughout the summer and have its peak late in that season.

The volume of mileage under construction is on the average over the period studied about sixteen times as great as the total mileage completed monthly. This explains why the average deviation of the former series is only 4.8, of the latter 36.2, and the range 15 and 122 respectively. But this ratio is also interesting as substantiating the inference drawn above that it has taken on the average in recent normal years about sixteen months to complete a mile of road. Further confirmation of this suggestion is afforded by a comparison of the double peaks of the indexes of mileage initiated and mileage completed respectively. Each index has a major and a minor peak, but in reverse time sequence. It will be readily observed that the time span between the major peaks is sixteen months—from June for miles initiated to October for mileage completed. The interval separating the two minor peaks, however, is twenty-one months. These two facts would seem to indicate that roads begun in early summer usually reach completion during the late autumn of the following year; but that roads that are not started until late summer are unlikely to be finished before the arrival of a second winter and are more often completed early in the succeeding summer. This inference has the merit of squaring with common sense expectations. In this connection it may also be noted that when the time span separating equivalent cumulative totals of mileage of roads initiated and of roads completed, respectively, monthly from 1922 to date, is determined, in order to show the number of months that the total volume of roads completed in any given month was under construction, the interval is found to vary from 22 to as low as 10, but averages about 16 months.

Production and Shipment of Construction Materials

The last four indexes (20–23) show the seasonal variation of two important construction materials. The Portland cement series in particular are of interest by reason of the considerable

use made of this material in road construction.[4] Their most interesting feature is the comparison between the earlier and the later period. In neither production nor shipments is there much change in the seasonal pattern. For both, in each index, the high plateau extends from May to October. The amplitude of the seasonal fluctuation, however, both in production and shipments, shows a noticeable increase in the later period. The markedly higher degree of seasonal variation exhibited by shipments as compared with production was to be expected.

Asphalt resembles Portland cement in its use for the construction of both roads and buildings.[5] The seasonal for shipments was derived by Dr. Kuznets from the series of production and one of stocks. The seasonal patterns of both series are obviously very similar to those of Portland cement: the high months extend from May to October, the low from November to April. As in the two Portland cement indexes the range of seasonal variation in shipments is greater than in production.[6]

[4] In 1926, it was estimated by the engineers of the Portland Cement Association that, of total consumption, 26 per cent went for public and commercial buildings, 33 per cent for paving, highways, sidewalks and driveways, and 18 per cent for small town and farm uses (quoted in *Mineral Resources of the United States for 1926*, II, 319).

[5] *Mineral Resources of the United States for 1927*, II, 73.

[6] Discussion of the seasonal element in the various types of construction by homogeneous climatic areas would occupy more space than is at our disposal. Regional differences in the seasonal variation of the construction industry as a whole are, however, discussed in the following studies: Joseph B. Hubbard, *An Analysis of Building Statistics for the United States* (Harvard Review of Economic Statistics, January 1924, Vol. VI, No. 1, pp. 32–62); *Seasonal Operation in the Construction Industries*, Report of a Committee of the President's Conference on Unemployment, 1924 (McGraw-Hill); and particularly, Simon Kuznets, *Seasonal Variations in Industry and Trade*.