Volume Title: Evidences of Long Swings in Aggregate Construction Since the Civil War

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Volume Publisher: NBER

Volume ISBN: 0-87014-404-9

Volume URL: http://www.nber.org/books/abra64-1

Publication Date: 1964

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Chapter URL: http://www.nber.org/chapters/c1806

Chapter pages in book: (p. 89 - 98)

7

Congruence of Long Swings in Major Branches of Construction

With the presentation of the chronologies of long swings in individual series, it was pointed out that the long waves roughly correspond to one another in the sense that their peaks and troughs occurred in nonoverlapping time bands. These bands, however, are sufficiently broad to permit a fair degree of disparate movement. Further, an extra cycle was identified in five series; and a number of series skipped one or more long-swing declines common to the rest, i.e., although growth did decelerate, there was insufficient evidence of a significant decline in the absolute level of the series.

In these circumstances, a more formal measure of the degree to which the movements of the various series regularly agreed with one another is in order. Such evidence of agreement or disagreement is interesting in its own right, for it bears on the question whether long swings in aggregate construction reflect movements only in one or two sectors or in many. At the same time, it provides evidence for or against the existence of long swings in aggregate construction activity. Since the estimates of aggregate construction are themselves weak, our confidence in the indications they provide about the occurrence of a succession of long swings may be bolstered by definite evidence that all or most of the major sectors participated in the indicated swings of the total. Such evidence would carry more weight because the series representing the different branches are drawn from several different sources, are expressed in different units—physical, current values, and constant values—and are formed into indexes by different methods.

The measures of agreement are the National Bureau's indexes of conformity. To obtain these measures, we first establish a "reference chronology" of peaks and troughs of long swings in aggregate construction activity and then measure the regularity with which the fluctuations in individual indexes of construction activity, either in the major branches or at various levels of aggregation, were associated with the long-swing expansions and contractions marked off in the reference chronology.

The reference chronology employed in measuring the conformity of individual series was established by study of the chronologies of long-swing peaks and troughs set forth in Table 4. Primary attention was given to the movements of the indexes of aggregate construction. When these did not agree, we tried to select a date which expressed the general consensus of the various series. And if the date so indicated differed from that suggested by large numbers of series representing the various sectors, weight was also given to the turning dates of the sectoral indexes. We felt freer to make such adjustments if the moviement of the aggregate in the neighborhood of a given peak or trough was relatively small, that is, if the exact turning dates in the aggregate were not sharply defined. Manifestly, the dates established by this procedure are, to some extent, arbitrary. They are, however, consistent with the run of the data. Moreover, the present purpose is merely to establish a temporal framework which, in conjunction with the National Bureau measure of conformity, will reveal the degree of regularity with which the long-swing movements of construction in various sectors are associated with each other and with measures of aggregate construction. For this purpose, a chronology may be misleading if it conceals substantial agreement which actually exists, but any reasonable chronological framework which reveals a large measure of agreement among the various sectors is unobjectionable. It brings out a real feature of construction activity, at least as this is recorded in the available statistics.

The reference chronology on which we settled runs as follows:

			Duration of Phase or Cycle			
Trough	*Peak*	*Trough*	Up-swing	Down-swing	Trough to Trough	Peak to Peak
			(years)			
1861	1871	1878	10	7	17	
1878	1892	1898	14	6	20	21
1898	1912	1918	14	6	20	20
1918	1927	1933	9	6	15	15
1933	1941	1944	8	3	11	14
1944	1959 (end of data)		15[a]			18[a]

[a]There is as yet (November 1961) no clear evidence that another long-swing decline in the absolute level of construction has begun, although rates of growth have fallen markedly.

This chronology provides another measure of the duration of long swings in construction since the Civil War. According to these dates, there were four swings measured from trough to trough from 1861 to 1933, respectively, seventeen, twenty, twenty, and fifteen years in duration. In the same period, there were three swings measured from peak to peak, respectively, twenty-one, twenty, and fifteen years long. The course of development since the Great Depression is radically bent by the impact of World War II. The upswing which began in 1933 was cut short by World War II; and the peak in 1941 and the trough in 1944 are strictly wartime, rather than long-swing, turning points. The upswing beginning in 1944, starting with backlogs created by the war and still remaining from the Depression, has not yet reached a clearly defined terminus. The date we have inserted, 1959, represents only the last year for which we have compiled figures. We use it in order to include the post-World War II experience in these measures. Finally, even in the period before World War II, the record reveals the influence of wars in the dating of the troughs of 1861 and 1918.

Having established a reference chronology, we then proceeded to compute indexes expressing the degree of conformity of the fluctuation of individual series to the reference expansions and contractions which the chronology defines. Three such indexes were computed for each series: an index of conformity to long-swing expansions, an index of conformity to long-swing contractions, and an index of conformity to full long swings.

The computation of the indexes of conformity to reference expansions is a simple matter. For any given series, we merely ask whether at any given peak of the reference chronology the standing of the individual series was higher or lower than it was at the preceding long-swing reference trough. If it was higher this comparison is scored +100; if lower, –100; if there was no change, zero. The scores for all the reference expansions covered by the series are then added, and the total is divided by the number of expansions. The resulting figure is the index of conformity to expansion. The index may vary from +100, indicating perfect positive association, to –100, indicating perfect inverse association. If a series fell as many times during the expansions of aggregate activity as it rose, its index would be zero. One may think of the level of the index, therefore, as representing the percentage difference between the actual association of fluctuations in a series with those in aggregate construction activity and that which might be expected by chance alone.

The index of conformity to reference contraction is computed in an analogous way. The standing of a series in the years in which the reference chronology stands at long-swing peak levels is compared with its standing in the next succeeding years in which the reference chronology denotes a long-swing trough. If the standing at a reference peak is higher than it is at the compared trough, the series is scored +100; if lower, –100, etc. And again the individual scores are averaged to obtain the index of conformity to contraction. Thus, a score of +100 means that a given series fell during each interval of reference contraction; zero means it rose as often as it fell; and –100 means that it rose without exception during intervals in which aggregate construction was experiencing a long-swing contraction.

The index of conformity to full long swings is designed to take care of the cases in which the association of a given series with the movements of aggregate construction expresses itself not in a rise (or fall) in its absolute level during reference expansions followed by a fall (or rise) in the absolute level during reference contractions, but rather by retardation (or acceleration) in growth during reference contractions compared with expansions. To determine the index, the average changes per annum of a series are computed between years marked in our chronology as peaks and the succeeding reference troughs (these are called "rates of change" during reference contractions), and the average changes per annum are computed between years marked in our chronology as reference troughs and succeeding reference peaks (these are called "rates of change" during reference expansions). Then the rate of change during each reference contraction is compared first with the rate of change during the preceding reference expansion and then with the rate of change during the following reference expansion.[1] For

[1]To ensure comparability, the absolute changes per annum during the reference expansion and contraction being compared are expressed as percentages of the average standing of the series during the years covered by the given reference expansion and contraction. For a detailed description of the exactly analogous measure computed by the National Bureau for business-cycle movements, see Burns and Mitchell, *Measuring Business Cycles* (8), pp. 176-184.

each such comparison, the series is scored +100 if the rate of change during contraction is algebraically lower than in expansion; −100 if it is algebraically higher; zero if the rates are equal. Then the scores are averaged. Thus, a series which invariably rises more slowly during reference contractions than during neighboring reference expansions will have an index of +100; if the reverse, −100; if it speeds up during contractions as often as it slows down, its index will be zero.

Table 13 gives the results of the foregoing calculations. The indexes of conformity to long-cycle expansions display the virtually perfect record one might expect in series most of which have rising long-term trends. The great majority of all series—twenty-nine out of thirty-eight—also declined in each reference downswing. Here, however, there are scores lower than +100 in several important series. For the most part, these reflect the skipped cycles already noted in Table 4. There were, however, a few additional cases of divergence from conformity to reference contraction. Kuznets' estimate of aggregate construction in current prices rose on net balance between 1871 and 1878 and again between 1912 and 1918. The latter divergence was presumably due to the price inflation of World War I, for it does not appear in Kuznets' constant price series. Hence, so far as physical-quantity measures of aggregate construction are concerned, the only evidence of divergence from positive conformity refers to the 1870's, and that evidence is subject to the qualifications already noted for Kuznets' estimates. Price inflation during World War I also helps explain one of the instances of divergence in the Colean-Newcomb index of the value of urban building in current prices. In some instances, however, no long downswing was recognized by the tests employed in establishing the chronologies of Table 4; nevertheless, a series declined on net balance between the long-swing reference dates. This behavior suggests that the sectors in question contributed something to the postulated decline in aggregate construction. Such was the case with Long's index of the value of urban building permits in the downswing 1892-98; with the same index as adjusted by Colean and Newcomb, and with Long's index of the value of nonresidential permits, in the same period.

When one turns to full-cycle indexes—that is, to measures based on comparisons of rates of change—the scores are almost uniformly perfect. Indeed, only three series had full-cycle indexes lower than +100. Two of these—the Colean-Newcomb index of the value of new

TABLE 13

MEASURES OF CONFORMITY TO REFERENCE LONG SWINGS IN CONSTRUCTION, 1861-1959

Series	Period	No. of Reference Long Swings	Index of Conformity: Upswings	Index of Conformity: Downswings	Index of Conformity: Full Swings
A. Aggregate Construction					
1. Gross new construction in current prices, Kuznets	1871-1959	5	+100	+20	+100
2. Gross new construction in 1929 prices, Kuznets	1871-1959	5	+100	+60	+100
3. Index of the value of construction in current prices, NBER	1871-1918	2.5	+100	+100	+100
4. Index of the value of construction in constant prices, NBER	1871-1918	2.5	+100	+100	+100
5. Index of the physical volume of construction, NBER	1861-1918	3	+100	+100	+100
6. Total construction in current prices, Commerce-Labor	1919-1956	2.5	+100	+100	+100
7. New construction in current prices, Commerce-Labor	1918-1959	2.5	+100	+100	+100
8. New construction in 1947-49 prices, Commerce-Labor	1918-1959	2.5	+100	+100	+100
B. Total Urban Building					
9. Riggleman's value of permits per capita in current prices	1861-1933	4	+100	+100	+100
10. Riggleman's index adjusted for trend	1861-1933	4	+100	+100	+100
11. Riggleman-Isard index of value of permits	1861-1933	4	+100	+100	+100
12. Long's index of the value of all permits	1871-1933	3.5	+100	+100	+100
13. Long's index of the number of all permits	1861-1933	4	+100	+100	+100
14. Long's index of the value of all permits, as adjusted by Colean and Newcomb	1871-1933	3.5	+100	+100	+100

(continued)

TABLE 13 (continued)

Series	Period	No. of Reference Long Swings	Index of Conformity: Upswings	Index of Conformity: Downswings	Index of Conformity: Full Swings
B. Total Urban Building (continued)					
15. Colean-Newcomb index of the value of new building in current prices	1861-1944	5	+100	+20	+78
16. Colean-Newcomb index of the value of new building in constant prices	1861-1933	4	+100	+50	+100
C. Nonfarm Residential Building					
17. Long's index of the value of residential permits	1871-1933	3.5	+100	+100	+100
18. Long's index of the number of residential permits	1861-1933	4	+100	+100	+100
19. Expenditures for new dwelling units in current prices, Blank	1892-1959	4	+100	+100	+100
20. Expenditures for new dwelling units in 1929 prices, Blank	1892-1959	4	+100	+100	+100
21. Number of dwelling units started, Blank	1892-1959	4	+100	+100	+100
21a. Production of housekeeping dwelling units, Gottlieb	1861-1933	4	+100	+100	+100
D. Private Nonresidential Building					
22. Long's index of the value of nonresidential permits	1871-1933	3.5	+100	+100	+100
23. Long's index of the number of nonresidential permits	1861-1933	4	+100	+50	+100
24. New private nonresidential construction in current prices, Commerce-Labor	1918-1959	2.5	+100	+100	+100
25. New private nonresidential construction in 1947-49 prices, Commerce-Labor	1918-1959	2.5	+100	+100	+100

(continued)

TABLE 13 (concluded)

Series	Period	No. of Reference Long Swings	Index of Conformity		
			Upswings	Downswings	Full Swings
E. Farm Construction					
26. New farm construction in 1947-49 prices, Commerce-Labor	1918-1959	2.5	+33	+100	+100
F. Transportation and Other Public Utilities Construction					
27. Rail consumption	1861-1941	4.5	+100	+50	+100
28. Increase in wire mileage, Western Union Telegraph Co.	1871-1941	4	+100	0	+43
29. Increase in wire mileage, all telephone systems	1892-1944	3.5	+100	+50	+100
30. Gross capital expenditures in 1929 prices, all regulated industries, Ulmer	1871-1944	4.5	+100	+100	+100
31. Gross capital expenditures in current prices, all regulated industries, Ulmer	1871-1944	4.5	+100	+100	+100
32. New private public utilities construction in 1947-49 prices, Commerce-Labor	1918-1959	2.5	+100	+100	+100
33. New private public utilities construction in current prices, Commerce-Labor	1918-1959	2.5	+100	+100	+100
G. Shipbuilding					
34. Tonnage of merchant vessels built in the U.S.	1861-1944	5	+20	+20	+11
H. Public Construction					
35. Long's index of the value of public building permits	1871-1935	3.5	+100	+100	+100
36. New public construction in current prices, Commerce-Labor	1918-1959	2.5	+100	+100	+100
37. New public construction in 1947-49 prices, Commerce-Labor	1918-1959	2.5	+33	+100	+100

building in current prices (Series 15) and Western Union Telegraph Company's increase in wire mileage (Series 28)—had relatively high indexes, indicating one divergence from positive conformity in nine and two in seven comparisons, respectively. The only low score in the table refers to merchant shipbuilding.

The measures in Table 13 are to be interpreted as supporting the conclusion that there was very wide participation in the postulated long swings of aggregate construction. Indeed, it appears that every sector except shipbuilding participated regularly.[2] For the most part, that participation took the form of net rises during periods of long-swing reference expansion and of net declines during the long reference downswings. There were, however, occasional exceptions to this rule. The two most important were in one or the other measure of private nonresidential building—with reflections in some of the series representing total urban building—and in railroad construction as measured by rail consumption.[3] Even in these sectors, the exceptions refer to a minority of the long declines (one out of four or five); and even in the exceptional episodes, the series displayed retardation in growth during the postulated declines in aggregate construction activity.

The conformity measures do not speak only for the diffusion of long swings in construction through all the major sectors. They make

[2]This exception is, of course, interesting, and some special study of the United States shipbuilding industry is doubtless in order. Its relatively independent pattern of movement may possibly reflect the exceptional impact of wars on the industry or some special sensitivity to international influences which operate out of phase with domestic construction.

[3]The apparent failure of railroad construction to decline on balance between 1912 and 1918 is almost certainly due to the inadequacies of rail consumption as a measure of construction during the war period. Ulmer's estimate of gross capital expenditures of steam railroads in 1929 dollars declines, with but minor year-to-year reversals from $1,067 million in 1912 to $483 million in 1918. (See Ulmer, *Capital in Transportation, Communications and Public Utilities* (42), Table C-1.) These figures include expenditures for equipment as well as for road and structures, but there is little doubt that a decline in construction was a major part of the total decline in real capital formation by railroads. While total gross capital expenditures, according to Ulmer, fell 55 per cent between 1912 and 1918, the number of freight cars produced fell only 14 per cent, the number of passenger cars fell 45 per cent, and the number of locomotives produced *increased* 32 per cent.

somewhat more plausible the inference that the long swings in aggregate construction took the form of protracted upsurges in construction activity followed by protracted declines in the absolute level of construction work and not merely by retardation. The degree of support that conformity indexes can lend to this inference, however, is limited. For they do not take account of the amplitudes of decline and, as has been shown, on some occasions this amplitude was narrow. Having regard to the inadequacies of the statistics, it would be inappropriate to assert with assurance that there was a succession of long-swing declines in the absolute level of aggregate construction, although the conformity indexes tend to support such a presumption.