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Chapter 4

Total Inventories during Business Cycles

This chapter and the next two are devoted to the cyclical behavior of manufacturers' inventories in the aggregate. The data are derived from accounting records and are dollar values. In the case of one important block of data, current (book) values are corrected for the influence of changes in prices to yield indexes of physical volume. This chapter deals first with inventories in current prices, then with their volume as indicated by values in constant prices.

1 *Inventories in Current Prices*

The materials used in this chapter are described fully in Appendix A. Brief notes will suffice here.

THE DATA

Kuznets' estimates

Kuznets' estimates show the book value of inventories held on December 31 of each year 1918-41.[1] For 1926-41 the basic figures are drawn from the balance sheets filed with the United States Treasury Department by manufacturing corporations and published in *Statistics of Income*. A small adjustment sufficed to allow for corporations that did not file balance sheets and somewhat larger adjustments for inventories held by unincorporated firms. From 1918 to 1925 the estimates are derived by applying inventory-sales ratios for samples of corporations in each manufacturing group to the

[1] Kuznets' estimates for 1918-33 were published in *Commodity Flow and Capital Formation*, Part VII. He generously put his figures for 1934-38 at my disposal. In making estimates for later years, I used the same sources and methods.

gross income of all corporations from *Statistics of Income*.[2] Adjustments were then made for unincorporated firms. While Kuznets' estimates constitute the most useful and extensive body of dollar value materials, other data supplement, extend and, to a certain extent, check them.

Dun and Bradstreet wartime estimates

Dun and Bradstreet compiled the accounts of 106 large manufacturing corporations that publish year end balance sheets 1913-22,[3] constituting 20-25 percent of all manufacturing activity. To construct a general index for manufacturing as a whole, data for individual companies were aggregated to yield indexes of inventories in 15 industry groups. The industry indexes were then combined in both weighted and unweighted averages.[4] The two types of average yield indexes for all manufacturing that are remarkably similar; in no year does the difference exceed 2 percent.

The Schmidt-Young estimates

In connection with their studies in business financing C. H. Schmidt and R. A. Young gathered reports of 81 large manufacturing corporations, 1914-22, holding about 18 percent of total manufacturing inventories.[5] The industrial coverage is not comprehensive.

Terborgh's estimates

George Terborgh prepared composite indexes for 8 durable and 11 nondurable goods industries for each year end, 1915-23, weighted

[2] The level of the data was corrected by computing inventory-sales ratios from sample data for 1926 and using the sample ratios for 1926 and earlier years as an index to extend inventory-gross income ratios for 1926 from *Statistics of Income* to earlier years. Minor adjustments sufficed to bring the level of the estimates into line with data from capital stock tax returns for 1923 and 1924.

[3] *Dun's Review*, Feb. 1940. A few concerns engaged in mining are included. In manufacturing apparently no leather tanning firms are included and the sample seems especially weak in lumber and textiles.

[4] The weights were based on the 1937 Census inventory figures adjusted for differences in the rates of growth of the various industries since the period to which the index applies.

[5] The Effect of War on Business Financing: Manufacturing and Trade, World War I, NBER *Occasional Paper 10*, Nov. 1943, pp. 31 ff., and App. A.

largely by Kuznets' estimates of inventory holdings by industry in 1923.[6] Stocks held by unincorporated firms are allowed for. The estimates of total inventories and of inventories in the durable and nondurable goods groups are expressed both as indexes on a 1915 base and in dollars.

The sample on which the estimate is based for each year, 1916-23 "covers nearly all of the manufacturing concerns for which both the opening and closing inventories are reported in Moody's Manuals."[7] The sample companies are estimated to have held about 25 percent of total manufacturing inventories in 1916 and about 40 percent in 1923.

Currie's estimates

Lauchlin Currie compiled balance sheet information for a still larger sample of manufacturers for year ends, 1922-28.[8] In 1928 they held more than 35 percent of total manufacturers' inventories. Mr. Currie's comment upon his results is significant:

"Although care was taken to include the available reports of all the smaller companies and also of companies in depressed industries, the series as a whole is mainly representative of the larger and more successful companies, owing to the greater availability of their financial statements."

The Dun and Bradstreet, Schmidt-Young, Terborgh, and Currie estimates all serve to check Kuznets' figures for the years before 1926 when the latter are based on small samples of corporations. Kuznets' estimates before 1926 are based on corporation samples that differ in size and composition from those used by the other four estimators, which also differ among themselves. But the latter estimated inventories directly while Kuznets estimated total stocks by constructing indexes of inventory-sales ratios in ten industry groups. From these indexes he extrapolated the inventory-sales ratios for all corporations in these groups in 1926 and applied the resulting ratios to comprehensive sales figures for all corporations.

[6] Manufacturing Inventories During and After the World War, *Federal Reserve Bulletin*, July 1941, pp. 613-7.

[7] Ibid., p. 613.

[8] The Decline of the Commercial Loan, *Quarterly Journal of Economics*, Aug. 1931, p. 699.

National Industrial Conference Board indexes

The National Industrial Conference Board presents estimates by months since January 1929 for a sample of large and small firms. Coverage was small in the earlier years of the period, but by 1940 about one-sixth of all manufacturing activity was represented. The index is so constructed that the growth of the sample does not affect the trend of the data. Companies manufacturing food products, tobacco, liquors, petroleum, and certain lumber products are not included "because these industries are so closely tied up with agriculture or with the extractive industries" and "do not represent the more active sector of industry in which the individual decisions of industrial management have greatest effect on business activity".[9]

Department of Commerce indexes

A far more extensive sample reporting by months has been organized by the Department of Commerce, giving figures since December 1938.[10] The reporting firms now number more than 1,200, representing nearly 40 percent of total manufacturing. Nevertheless, in some industries the sample is still quite inadequate (e.g., only 16 apparel manufacturers were reporting in June 1940). Moreover, the sample of companies having total assets of less than $500,000 was purposely kept small in order to lighten the task of handling the large number of reports required to cover this group properly. The Department of Commerce notes, however, that these companies hold only 12.5 percent of all manufacturing inventories. In constructing the index, data were aggregated by industries and combined by weighting inventory relatives by the value of inventories held by the various industries at the end of 1938 as indicated by the Census of Manufactures. Adjustments were made for groups not covered or incompletely covered by the census.

CONFORMITY AND TIMING

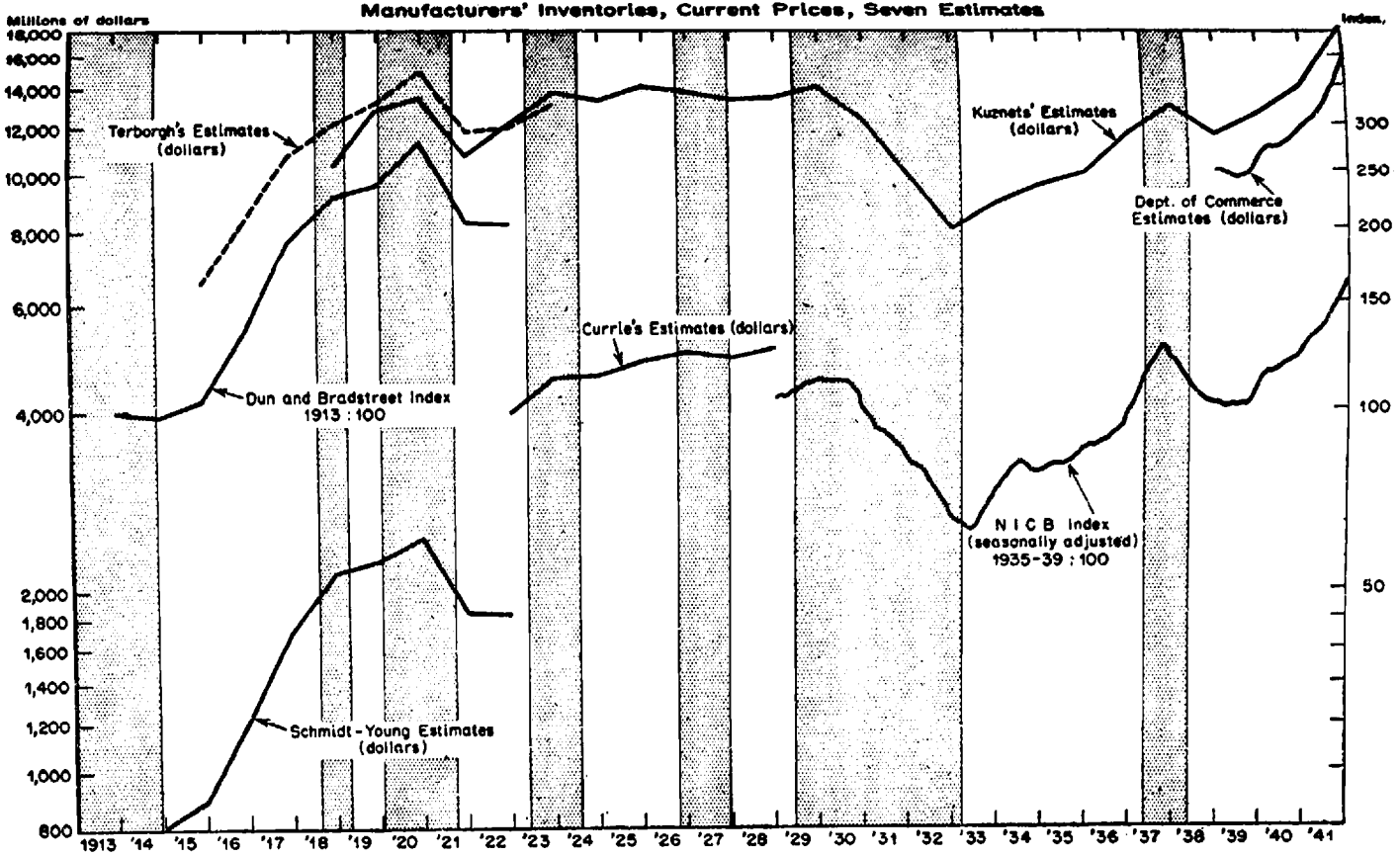
Chart 3 shows these seven series plotted in a fashion that distin-

[9] *Economic Record,* II, Supplement, Dec. 26, 1940: Inventories, Shipments and Orders, 1929-1940, p. 2.

[10] Monthly Industry Survey, *Survey of Current Business,* Sept. 1940, pp. 7 ff.

Chart 3

Manufacturers' Inventories, Current Prices, Seven Estimates



Contractions (shaded) and expansions (unshaded) are marked off by the monthly reference chronology.
All series are end of year, except the N I C B and Department of Commerce series which are end of month.

Logarithmic scales

guishes their behavior during expansions and contractions of business at large, marked off according to the National Bureau standard monthly chronology. The vigorous expansion accompanying the boom of World War I and its aftermath, the liquidation of 1920-21, and the subsequent recovery all appear clearly in the inventory records. Equally marked are the big slump after 1929, the 1933-37 recovery, and the succeeding depression and recovery merging into the intense activity of World War II.

A somewhat more systematic impression of the conformity of total holdings to business cycles can be gained from the chart. If we ignore the fact that the series (except the NICB and Department of Commerce data) show the standing of stocks only once a year, and if we treat the lines drawn from one December 31 to the next as though they represented continuous series, several interesting observations can be made. First, stocks are higher at every peak of general business than at the preceding trough.[11] Further, they decline during 3 of the 6 contractions covered (1920-21, 1926-27, and 1929-33). In still another contraction, May 1937 to May 1938, they decline if we take the evidence of the NICB monthly series although in Kuznets' annual data they rise. Moreover, in all 3 contractions in which the annual data rise (1918-19, 1923-24, and 1937-38) the rate is lower than in the preceding expansions. The suggestion of positive conformity with movements of general business, therefore, is strong.

The graphs suggest also that stocks lag behind changes in general business. During the period general business had 7 troughs and 6 peaks—13 turns in all. A turning point in stocks is found in the vicinity of 6 troughs and 5 peaks, since the September 1918-April 1919 contraction does not appear in the annual data on which we have to depend. Of the 11 turns at which we can make comparisons,[12] stocks apparently turn later than general business 7 times. On 2 occasions, December 1914 and 1927, they reach their trough at the end of the same month as general business does.

[11] Terborgh's series, however, appears to fall between the trough in September 1921 and the peak in May 1923, although Kuznets' series rises.

[12] Currie's sample skips the 1923-24 contraction, apparently because it represents the inventories of large corporations only. It thus has a pronounced upward trend in this period which does not affect all manufacturing business to the same degree.

The evidence at the other 2 turns is mixed. At the trough in March 1933 Kuznets' annual series appears to lead, but the NICB monthly series lags. The 2 series are sufficiently similar in their movements to suggest that the lag in the latter would appear also in Kuznets' series were it available by months. At the business cycle peak of October 1926, however, the evidence suggests that stocks turned before business at large. Kuznets' series reaches a peak on December 31, 1925, the year end preceding the business cycle peak. Currie's series reaches a peak on December 31, 1926, the year end following the monthly peak in business. The apparent lag of Currie's series may, however, reflect only its upward trend, a feature consistent with the fact that his sample is supposed to represent fully only large corporations.

Inspection of a chart is suggestive, but the need for more systematic measurement of the relation between stocks and business cycles is obvious. For this purpose we use the measures of conformity and timing described in Chapter 3.[18] For both we adapt National Bureau methods to the peculiarities of year end series and apply them to Kuznets' estimates for total manufacturing and for his ten component industry groups.

Table 20 presents the timing measures. It tells whether stocks tend to lead or lag at the turns of general business as determined by the National Bureau monthly chronology. The table was prepared by calculating the number of months by which the December 31 turns of stocks preceded or followed the monthly reference dates. The average lead or lag is the simple mean of the individual comparisons. All inventory series were treated positively, that is, peaks in stocks were compared with corresponding peaks in business, and troughs in stocks with corresponding troughs in business.

These systematic timing comparisons reveal a pronounced tendency for inventories in book values to lag behind general business. The series representing the aggregate holdings of manufacturers lags in 8 comparisons out of 10. Of the 77 comparisons that could

[18] Conformity measures were not computed for the shorter annual series or for the monthly NICB data depicted in Chart 3. None was long enough to make such measures meaningful. As far as they go, however, their behavior is fully consistent with the calculations made from Kuznets' series, which are longer.

be made for the ten industry groups, 58 were lags, 19 leads. If we add a few comparisons suggested by marked changes in trend,[14] the count becomes 64 lags and 19 leads in 83 comparisons. Roughly speaking, 3 out of 4 comparisons were lags. Leads outnumbered lags in only one of the ten industry groups, textiles, and then only by 5 to 3. The total and nine of the ten component groups yielded average lags; only one group, again textiles, appeared to lead on the average.

TABLE 20

Manufacturers' Inventories, Current Prices
Timing at Business Cycle Turns, 1918-1938

	NUMBER OF		AV. LEAD (−) OR LAG (+), MO.	
	Leads	Lags	Actual turns	Actual & indicated turns[b]
(1)	(2)	(3)	(4)	(5)
Total manufacturing	2	8	+3.8	
Food, beverages & tobacco	2	4	+3.7	
Textiles & textile products	5	3	−2.2	
Leather & leather products	3	3(2)[a]	+4.0	+4.4
Rubber & related products	1	7(2)[a]	+5.4	+6.2
Lumber & wood products	1	3	+3.8	
Paper, printing & publishing	3	7	+5.0	
Chemicals & allied products	1	9	+5.0	
Stone, clay & glass products[c]	0	8(2)[a]	+12.1	+11.2
Metals & metal products	2	6	+6.1	
Miscellaneous	1	8	+6.1	
Sum of 10 groups	19	58(6)[a]		
Av. of 10 groups weighted by no. of turns			+5.0	+5.2

[a] Figures in parentheses are the number of additional comparisons suggested by marked acceleration or deceleration of trend.

[b] Includes turns suggested by a marked change in trend.

[c] Averages include a peak in 1930 and a trough in 1922. The standing of the series, however, was the same in 1929 as in 1930 and virtually the same in 1921 as in 1922. Substituting these earlier dates changes column 4 to +9.1; column 5, to +8.8.

Concerning the length of the lag, one must speak more warily. Timing comparisons made from annual data cannot be very accurate, and it is better to think in terms of a range than of a single figure. On the average, the aggregate holdings of manufacturers

[14] That is, the point of pronounced reduction in an upward trend (or acceleration of a downward trend) is counted as a peak; the point of pronounced acceleration of an upward trend (or reduction of a downward trend) is counted as a trough.

appeared to lag 3.8 months behind the turns of general business. Eight of the ten industry groups yielded average lags of 3.7 to 6.1 months. There was one longer lag and one shorter lead. If we think of inventories in current prices as tending to lag 3-6 months behind business in general, we shall probably not be far wrong.

This conclusion should be applied to manufacturers' inventories as a whole, not to individual industries or commodities. In Chapter 3 I argued that timing measures made from annual data are unlikely to be reliable unless the series is very long. Our own series are shorter than the standard there laid down. I use them because I can bring to bear the evidence not of one but of ten indicators of manufacturers' stocks. It is important, however, to use the results to get a general impression about manufacturers' holdings in the aggregate and not to seek more detailed results for members of the group.

To say that stocks tend to lag 3-6 months at reference turns implies a certain regularity in their behavior. This can be tested by measures of conformity. For this purpose we adapt the National Bureau standard measure to the peculiarities of annual single-date, year end series. The reader will recall that to establish a chronology of business expansions and contractions for synchronous series we determined the December 31's when business successively reached peak and trough levels. If a series tends to lag 3 months we predate our year end stocks 3 months and use a September 30 business chronology. If a series tends to lag 6 months, we predate year end stocks 6 months and use a June 30 chronology, and so on. We choose the timing category in which a series belongs by consulting our regular timing comparisons (in this case Table 20), then round the average lead or lag to the nearest 3-month interval. We measure conformity on other than a synchronous basis only if average timing is based on at least seven comparisons and we never assume a lead or lag longer than 12 months. Seven comparisons are hardly enough to give reliable results for individual series, although this is a fairly strict standard for series that extend through only five business cycles. Once again, therefore, we apply our findings only to manufacturers' stocks as a whole and avoid conclusions about individual series.

As to the meaning of the indexes, it is only necessary to remem-

ber that in order to score +100 in conformity to expansion, a series must stand higher at the end than at the beginning of every business expansion. A score of +50 means that the series rose in three out of four expansions; +33 means it did so in two out of three (or four out of six) times, and so on. Conformity to contraction is measured in the same way, except that +100 means that the series declines in every contraction. There is one complication. A series with a rising trend is likely to have a high score in expansions and a low score in contractions. Hence our measure of conformity to full cycles is based on a comparison of the rates of growth during both contraction and expansion. Thus a series can score +100 in conformity to full cycles if it either rises in every business expansion and falls in every contraction or if it simply rises more rapidly in each expansion than in adjacent contractions. Of course if a series tends to decline in expansions and rise in contractions our indexes will have negative signs, and if a series does so invariably it will score −100. Our results for inventories in current prices are summarized in Table 21.

The lesson to which the table as a whole points is clear. Allow-

TABLE 21

Manufacturers' Inventories, Current Prices
Conformity to Business Cycles, 1918-1938

(1)	LEAD (−) OR LAG (+) ASSUMED[a] (MO.) (2)	NO. OF PHASES[b] (3)	INDEX OF CONFORMITY TO BUSINESS CYCLE Exp. (4)	Contr. (5)	Cycle (6)
Total manufacturing	+3	10	+100	+100	+100
Food, beverages & tobacco	0[c]	10	+60	−20	+56
Textiles & textile products	−3	10	+20	−20	+33
Leather & leather products	+3	10	+20	+60	+56
Rubber & related products	+6	11	+60	+67	+60
Lumber & wood products	0[c]	10	+20	−20	−33
Paper, printing & publishing	+6	11	+20	0	+20
Chemicals & allied products	+6	11	+100	+67	+100
Stone, clay & glass products	+12	11	+100	+33	+100
Metals & metal products	+6	11	+60	+33	+80
Miscellaneous	+6	10	+60	+60	+78

[a] From Table 20, col. 4 and 5. Results are rounded to the nearest 3-month interval.

[b] That is, expansions plus contractions. The number of phases varies slightly from series to series because the business chronology of certain timing categories brings an extra phase within the period covered by our series.

[c] Inventories are matched synchronously with business cycles because timing comparisons were too few to furnish a sound basis for any other procedure.

ing for timing differences, the degree of conformity is high—strikingly so for annual data. Seven of the ten industry groups yield conformity indexes for full cycles that are higher than 50; all except one are positive. The indexes for total manufacturing indicate perfect conformity to expansions and contractions as well. Manufacturers' aggregate holdings rose in each of five expansions, fell in each of five contractions. Even the one defection from positive behavior, lumber, is a doubtful case. Conformity was measured on a synchronous basis because only four comparisons were available to establish a typical lead or lag. If we relax our rule and allow for a 3-month lag as suggested by the average timing of this series, its conformity indexes would run +60, +20, +100.

The expansion and contraction indexes point a lesson of their own. True, manufacturers' aggregate holdings conformed perfectly to individual phases, but the expansion indexes of the individual groups run somewhat lower than the full cycle indexes, and the contraction indexes are much lower, sometimes negative. Consequently, a considerable portion of the regular positive conformity evidenced by the full cycle measures must reflect the impact of business cycles on the trend of the growth of stocks rather than on the direction of their movement. Stocks often do not fall in contractions, but they almost always grow more slowly. This qualification, however, is probably less serious than our measures indicate. An annual series with a rising trend will skip more contractions than will a monthly series. We can be fairly sure that if we had monthly data, both the expansion and the contraction indexes would be higher. Subject to these qualifications, one can say: inventories in current prices tend to conform positively to business cycles if we allow for a 3-6 month lag. Judged by the interwar record, this is a regular feature of business cycles.

All these lessons can be confirmed and more learned by close inspection of Chart 4. These graphs were drawn in a way that helps bring out the regular association between inventory movements and business cycles. The years covered by expansion and contraction are not the same in all graphs because the same business chronology is not appropriate to all timing categories. The eye, therefore, can get a rough impression of the regularity with which inventories respond to the changing phases of the business cycle.

Chart 4

Manufacturers' Inventories, Current Prices Total and Ten Groups

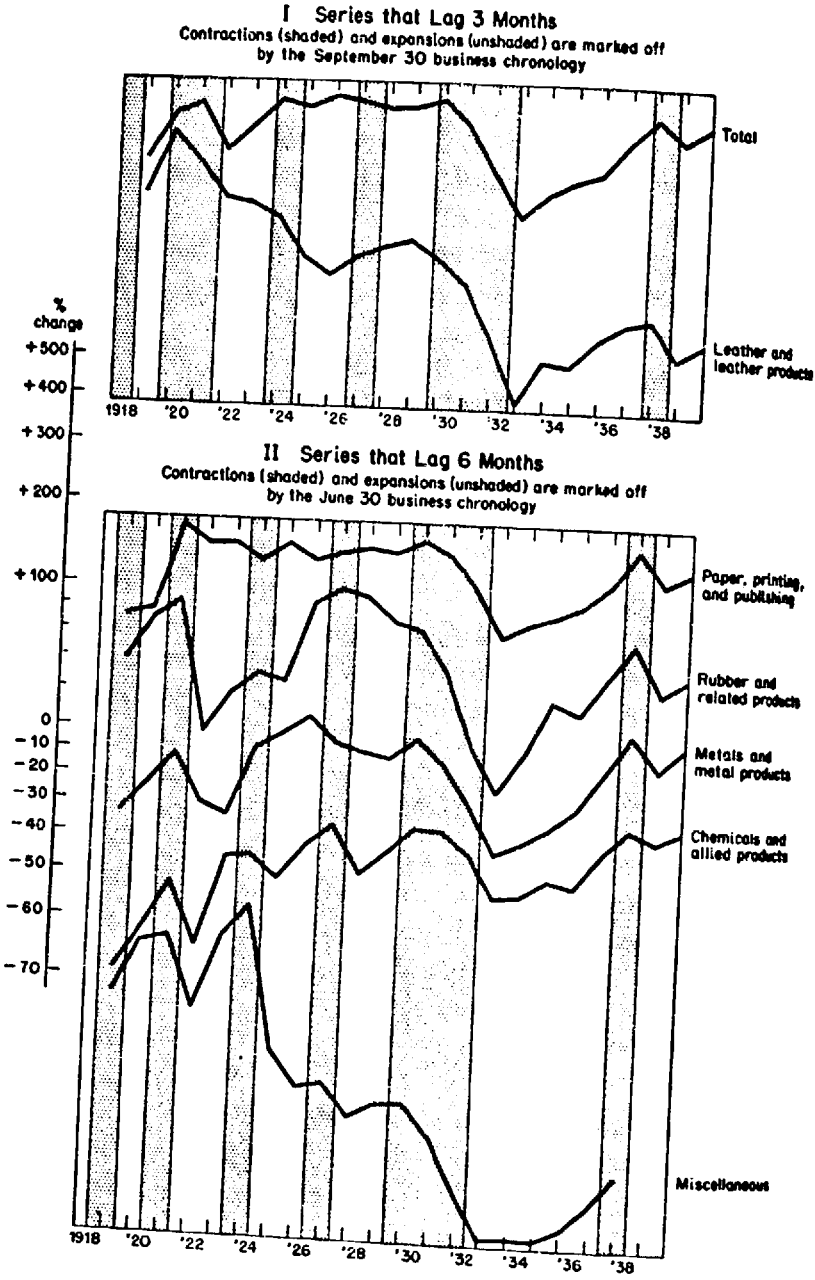
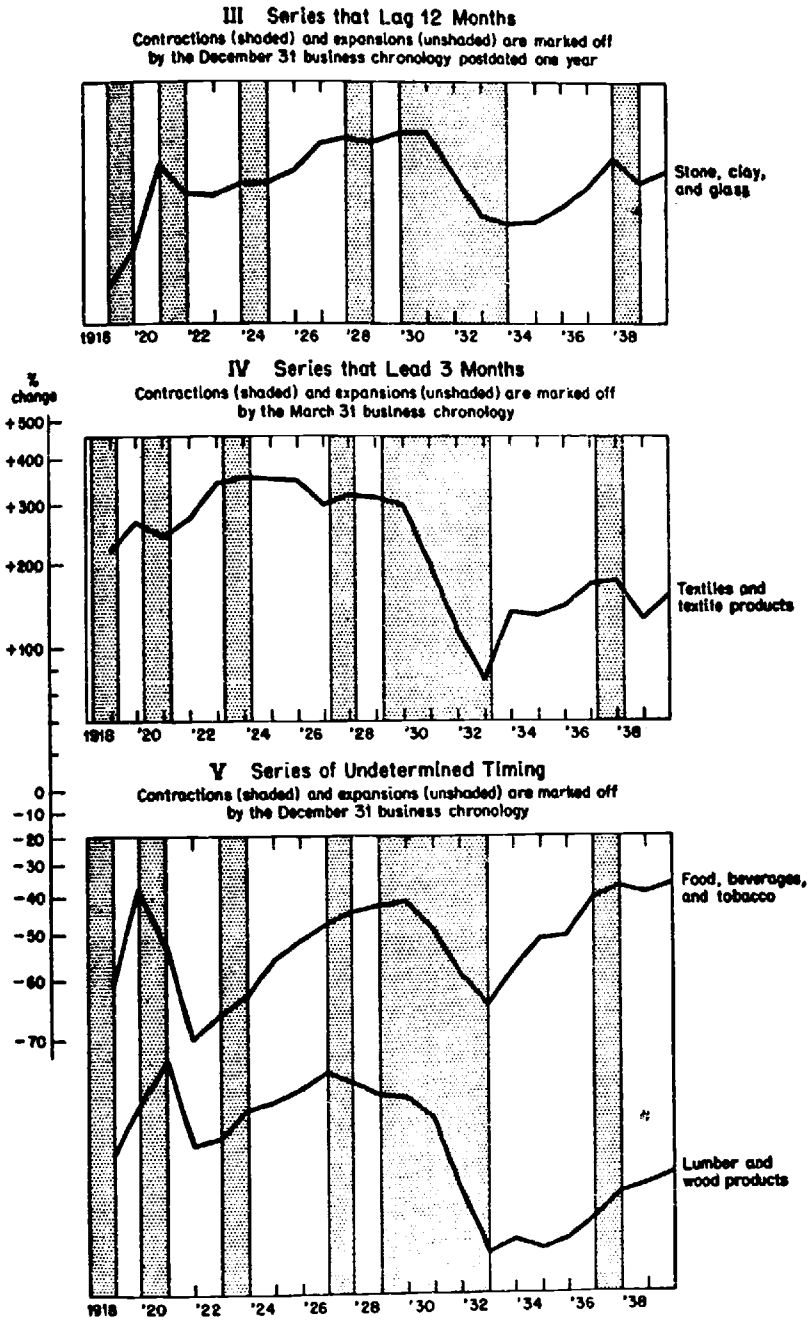


Chart 4 (concl.)



A striking feature is the difference in the response of inventories to the milder and more violent episodes of the period. The 1920-21 deflation, the great depression after 1929, and the marked recovery beginning in 1933 are all reflected in large inventory movements. On the other hand, mild business cycles in the middle 'twenties are matched by equally mild changes in inventories.

Consonant with this is the fact that most of the defections from conformity come in this short period of relative calm, 1923-29. The series that represent the ten industry groups extend, in the aggregate, over 95 business cycles, measured both from trough to trough and from peak to peak. Of these 95 cycles the inventories series do not conform on 21 occasions. But 13 of the 21 defections occurred during 1923-29 which included only 30 cycles.[15] This concentration appears to be due chiefly to the impact of changes in prices on inventory values. Later in this chapter, when inventories corrected for changes in prices are considered, it will be found that the physical volume of inventories behaved no less regularly during the mild cycles of the 'twenties than during the rest of the interwar period.

2 *Inventories in Constant Prices*

Inventories in current prices show the behavior of stocks as businessmen see it on their account books. Book values are relevant to business decisions as far as they tell businessmen how much of their assets are committed in this form. They are useful also because they are a first approximation to estimates of the physical volume of manufacturers' stocks, which are far more important from the viewpoint of business cycle analysis. For businessmen usually judge whether their stocks are deficient or redundant on the basis of the number of physical units they hold relative to expected sales, output, price movements, etc., not on the basis of the value of the goods. In this section we study the physical volume of manufacturers' stocks more directly.

[15] If allowance is made in the lumber and wood products series for a 3-month lag, defections number only 15, of which 11 occur between 1923 and 1929.

METHODS OF ESTIMATION

We can construct an index of quantities of stocks from book values provided they can be corrected for changes in prices. This is not easy, and we cannot expect to obtain anything more than crude approximations. Nevertheless, such corrections were carried through for Kuznets' estimates of inventories in his ten manufacturing groups.[16] The estimates for the individual industry groups were then aggregated to yield an estimate of manufacturers' holdings. We have at hand also Terborgh's figures corrected for changes in prices. The procedures by which the influence of changes in prices on Kuznets' estimates was eliminated are described fully in Appendix A, Part 2. Here we indicate only the major difficulties—difficulties that could not be wholly overcome.

Manufacturers usually value their inventories at cost except that they mark them down at the end of the year when replacement costs are lower than original costs. Of this more below. Valuation at cost means that a substantial portion of manufacturers' stocks—goods in process and finished goods—enter the inventory accounts at unit values made up of the purchase price of raw materials consumed plus allowances for labor costs per unit, for other direct costs, and for overhead. This in turn means that the behavior of unit values of goods in process and of finished goods cannot be represented accurately by the movements of commercial prices of purchased materials for which there are public records. We can allow for labor costs in a few cases but in no industry were we able to allow for changes in overhead costs per unit.

As a consequence, the indexes of purchased material prices that enter into the indexes used to correct inventory values for changes in prices were inevitably overweighted. I estimate that labor and overhead costs should have borne a weight of not less than 18 percent. They may have constituted as much as 30 percent of the cost of inventories though it is highly unlikely that they were so large.

[16] For 1918-25 the price indexes used in all groups were devised by Kuznets and his staff and published in *Commodity Flow and Capital Formation*, Part VII. The same is true of the indexes used in later years for metal and metal products; stone, clay and glass; and miscellaneous manufacturing. For the other seven groups, revised indexes for the years after 1925 were prepared by me with the assistance of Fred Lynn and David Rolbein.

A second element of crudity inheres in the fact that the commodity price series in our indexes are far outnumbered by the commodities included in inventories. In addition, the price series represent goods at early stages of fabrication more adequately than they do goods at later stages.

These defects in the price indexes have an identifiable bias. While different classes of prices tend to turn at about the same time, the prices of highly fabricated goods have a somewhat smaller cyclical amplitude than the prices of less highly fabricated goods, which are given undue weight in our indexes. Similarly, commodity prices probably have a larger cyclical amplitude than labor costs per unit, which are inadequately represented. In general, therefore, because of the price deflators we use, the amplitude of inventories in constant prices is probably understated to some degree.[17] Moreover, the turning points of inventories in constant prices are probably shifted somewhat in a fashion discussed below.

Finally, we must remember that while most manufacturing companies mark down inventory values at the end of the year when replacement costs are lower than original costs, not all do so. Since I could not discover the exact proportion of deviations from the common practice I assumed that all manufacturers follow the rule of 'cost or market, whichever is lower'. I do not believe, however, that this particular difficulty can cast serious doubt on my findings. The maximum degree of error that could be engendered was tested by comparing our figures with those based on the assumption that only half the manufacturers in each industry follow the cost or market rule (see App. A, Part 2).

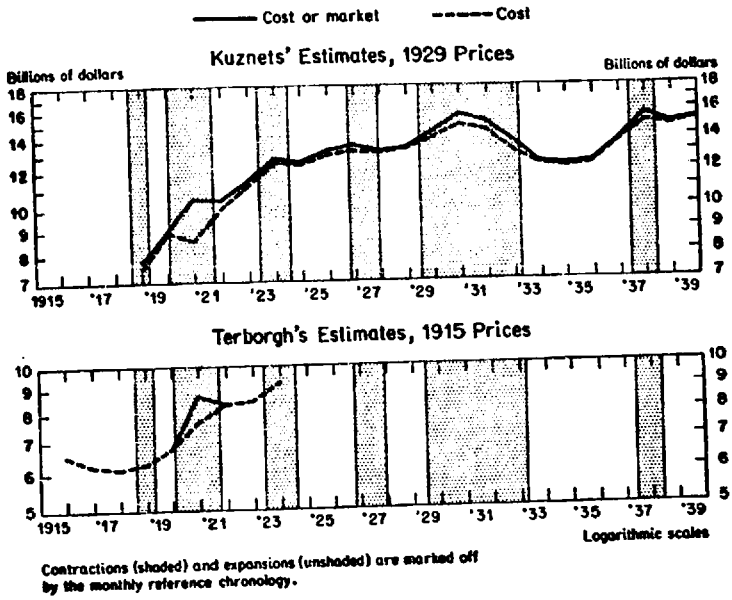
Since the estimates of inventories in constant prices must obviously be subject to serious error I do not rely upon the detailed results for individual industries, but merely seek to determine what general characteristics are strongly supported by the bulk of the evidence for all industries. Even with this restriction, the data yield useful information.

[17] Indirect evidence that this is so is presented by Harold Barger in *Outlay and Income in the United States, 1921-1938* (NBER, 1942), App. C.

CONFORMITY AND TIMING

Chart 5 shows Kuznets' and Terborgh's estimates of manufacturers' total inventories in constant prices arranged so as to distinguish their behavior during business expansions and contractions. For purposes of comparison, Kuznets' estimates appear in two forms: one based on the assumption that all manufacturers value inventories at the lower of cost or market, the other on the assumption that all value inventories at cost. Once more a simple inspection of the chart yields some useful preliminary findings about the relation between inventories and business cycles.

Chart 5
Total Manufacturers' Inventories, Constant Prices



Contractions (shaded) and expansions (unshaded) are marked off by the monthly reference chronology.

We note first the close similarity between the two forms of Kuznets' estimates. Both move in the same direction and at nearly the same rate in every year of the period except two, 1919-20 and 1920-21. The big drop in prices at the end of 1920 produces a high corrected value for inventories at the end of that year when we assume that markdowns were universal but a low value when we assume that they were nonexistent. Since most stocks are probably valued at the lower of cost or market, and since both series

move in substantially the same way except in the two years noted, we feel justified in confining attention to the former, though the truth must lie between them.

Perhaps the most striking feature of the graph is the regularity with which the peak and trough values of inventories lag behind the monthly reference dates. Beginning with the reference peak in 1920, a peak in inventories follows every peak in business and a trough in inventories every trough in business. This regularity is broken only in the expansion of World War I and in the subsequent short contraction. As represented by Terborgh's estimates, inventories shrank between the end of 1915 and the end of 1917 and expanded during the contraction of 1918-19. Whether this behavior is an accurate picture of events during the war is difficult to say.[18] After World War I, inventory cycles regularly lag behind the corresponding cycles of business. The mild business cycles of the middle and late 'twenties are matched by mild inventory cycles. The deep depression in business between the peaks of 1929 and 1937 is equally marked in manufacturers' stocks. As they stand, however, the estimates suggest that manufacturers were able to reduce their holdings but little during the violent business contraction and price deflation of 1920-21.[19] The recovery from the depression of 1921, in contrast, is well reflected. The volume of manufacturers' stocks conforms positively to business cycles with an even more pronounced and regular lag than that exhibited by book values. This visual impression can be checked and reduced to quantitative terms by measuring the timing and conformity for total manufacturing and the ten industry groups.

The timing measures in Table 22 for inventories in constant prices, made on the same plan as those in Table 20 for inventories in current prices, strongly support our preliminary observations.

[18] Terborgh got his estimates in constant prices by computing separate price indexes for each of the 19 component industries that make up his total. He assumes that all inventories were valued at cost, except at the end of 1920 when he assumes that they were marked down if replacement costs were lower than original costs.

[19] This is only a suggestion. Price correction is especially likely to err in such an excited period of inflation and deflation, and our year end figures may well, in this case, misrepresent the true height of the peak of stocks and the true depth of their trough.

TABLE 22

Manufacturers' Inventories, Constant Prices
Timing at Business Cycle Turns, 1918-1938

	NUMBER OF		AV. LEAD (−) OR LAG (+), MO.	
	Leads[a]	Lags[a]	Actual turns	Actual & indicated turns[b]
(1)	(2)	(3)	(4)	(5)
Total manufacturing[c]	0	10	+8.6	
Food, beverages & tobacco[d]	1	4	+5.5	
Textiles & textile products	2	6	+6.0	
Leather & leather products	0	10	+9.9	
Rubber & related products[d]	0	5 (2)	+11.9	+8.9
Lumber & wood products[e]	0	7	+16.4	
Paper, printing & publishing[d]	0	1	+9.5	
Chemicals & allied products[d]	0 (2)	4	+4.0	+1.2
Stone, clay & glass products	0	8	+13.6	
Metals & metal products	2	6	+7.6	
Miscellaneous	0	8	+8.8	
Sum of 10 groups	5 (2)	59 (2)		
Av. of 10 groups weighted by no. of turns			+10.4	+9.3

[a] See Table 20, note a.

[b] See Table 20, note b.

[c] The average in col. 4 includes a turn of stocks at the end of 1934. From 1933 to 1934 stocks declined only 1 percent. Had we assumed that stocks turned at the end of 1933, the average lag would be only 7.4 months.

[d] One or more lags in 4 series were disregarded because they exceeded 24.5 months.

	DATE OF TURN	LAG (MONTHS)
Food, beverages & tobacco	1932	+42.5
Rubber & related products	1931	+30.5
	1936	+45.5
Paper, printing & publishing	1931	+30.5
Chemicals & allied products	1931	+30.5
	1935	+33.5

[e] The average in col. 4 includes a turn of stocks at the end of 1934. The standing at the end of 1933 was virtually the same as at the end of 1934. Had we assumed that stocks turned at the end of 1933, the average lag would be 14.6 months.

Based on ten comparisons, all of which are lags, manufacturers' total holdings turned on the average 8.6 months later than business. The ten industry groups also lagged consistently. Of the 64 comparisons between reference dates and turns in the inventories held by individual industry groups, inventories lagged in 59 and led at only 5.

There is evidence here of a strong tendency for inventories to lag behind business by a considerable number of months. It is not easy, however, to determine the length of the lag. Total manufacturing lagged 8.6 months. An average of all 64 comparisons yielded by the ten groups suggests a lag of 10.4 months.[20] But the dispersion about these figures is great. The average lag for the ten groups ranges from about 3 to over 16 months. In view of the deviations to be expected of measurements on annual data from the true average lag, it does not seem safe to say more than that the average lag of the physical volume of stocks behind general business is probably more than 6 and less than 12 months.

This implies that the lag of stocks in constant prices tends to be longer than that of stocks in current prices. The record clearly supports this implication. First, in the measures for the ten industry groups, inventories in current prices led the reference turns in nearly 25 percent of the comparisons. For inventories in constant prices, the leads were only some 8 percent of the comparisons. The average for all comparisons between reference dates and the turns of the ten industry groups (including the few judged from marked changes in trend) yielded a 5.2 month lag for inventories in current prices and a 9.3 month lag for inventories in constant prices. In current prices, manufacturers' total holdings lagged 3.8 months on the average; in constant prices, 8.6 months.

This characteristic difference between the timing of inventories in book values and in constant prices is easily explained in terms of the cyclical behavior of prices. We have concluded that manufacturers' inventories in constant prices tend to turn 6-12 months later than general business. If prices were actually constant near business peaks and troughs the movements of stocks in current prices would parallel the movements of stocks in constant prices at cyclical turns. But if prices begin to decline before business reaches a peak or if they lag less than stocks, the rise of stocks in current prices will be impeded, and they will tend to reach a peak and decline before stocks in constant prices. Again, stocks in current prices will tend to lead stocks in constant prices at business troughs if prices begin to rise before business reaches a trough or

[20] The average would be 9.3 months if we included the four turns indicated by the marked changes in trend.

if they lag by a shorter interval than do stocks in constant prices.

The actual behavior of prices is consistent with this explanation. Of the 11 turns of general business between April 1919 and May 1938, the period for which we have inventory data also, the Bureau of Labor Statistics wholesale price index led the National Bureau reference dates at 8. Only one of the three lags exceeded 4 months. Raw materials, moreover, have more weight in determining inventory values than do wholesale prices in general. The BLS index of prices of raw materials turned before general business on 9 of 10 occasions between 1919 and 1938.[21]

These observations help to bolster our conclusions about the timing of the physical volume of inventories. It is not clear, however, that the difference between the timing of inventories in current and constant prices is as large as our figures seem to indicate. Since the amplitude of fluctuations in the indexes used to correct inventory values for changes in prices is probably too large, the timing of inventories in constant prices is affected. If our deflators overstate the movements of the unit value of inventories immediately after the peak in business, the turning points of inventories in constant prices will tend to be postponed, relative to those of inventories in current prices. If, therefore, the data indicate that inventories in constant prices turn 6-12 months later than business activity, the true lag is probably closer to 6 than to 12 months.

Table 23, summarizing our measures of the regularity with which manufacturers' stocks respond to business cycles, is drawn up on the same plan as Table 21. In measuring conformity, the lag of stocks behind business is allowed for. The lags indicated in Table 22 were used after rounding to the nearest 3-month interval. Three

[21] The BLS index, however, is made up exclusively of unfabricated goods whereas the raw materials used by many manufacturers include partly fabricated goods purchased from other manufacturers.

The cyclical timing of prices was different before World War I. Between 1857 and 1914, peaks in the index of wholesale prices lagged behind those of business cycles on 9 of 13 occasions. On the average, prices lagged 1.5 months. At troughs prices lagged at 8 of 13 turns; the average lag was 4.5 months. These measures are based on the Warren-Pearson index before 1890 and on the BLS index since that date.

This tendency for prices to lag behind business cycle peaks and troughs before 1914 suggests that the relation between inventories in constant prices and in book values may not have been the same as that since 1919.

groups, food, paper, and chemicals, were treated on a synchronous basis because their average timing measures rested on too few comparisons to do otherwise.

TABLE 23

Manufacturers' Inventories, Constant Prices
Conformity to Business Cycles, 1918-1938

(1)	LEAD (−) OR LAG (+) ASSUMED[a] (MO.) (2)	NO. OF PHASES[b] (3)	INDEX OF CONFORMITY TO BUSINESS CYCLE Exp. (4)	Contr. (5)	Full Cycle (6)
Total manufacturing	+9	11	+100	+33	+100
Food, beverages & tobacco	0[c]	10	+20	−20	−11
Textiles & textile products	+6	11	+60	+33	+40
Leather & leather products	+9	11	+20	+67	+80
Rubber & related products	+9	11	+100	0	+40
Lumber & wood products	+12	11	+60	+33	+60
Paper, printing & publishing	0[c]	10	+100	−60	+11
Chemicals & allied products	0[c]	10	+20	−60	+33
Stone, clay & glass products	+12	11	+100	0	+60
Metals & metal products	+9	11	+100	0	+80
Miscellaneous	+9	10	+60	+20	+33

[a] From Table 22, col. 4 and 5. Results are rounded to the nearest 3-month interval.

[b] See Table 21, note b.

[c] See Table 21, note c.

The indexes for full cycles confirm our impression that inventories conform positively to business cycles. The expansion and full cycle indexes for total manufacturing are +100. Six of the ten groups have full cycle indexes of +40 or better. The full cycle indexes of the groups are, on the whole, lower than those for inventories in current prices, but since annual data usually yield lower indexes than monthly series a fairly high degree of regularity of behavior is indicated.

The response of the volume of inventories to business cycles took the form of a variation in trend rather than of actual cycles in level even more often than did the response of inventories in current prices. The trend was strongly upward, as is evidenced by the high expansion indexes. The contraction indexes, in contrast, are low, sometimes negative, indicating a net tendency in at least some groups for inventories to continue rising during contractions. As shown by the full cycle indexes, however, the rate of rise during contractions even in these groups was generally lower than in ex-

pansions. Allowing for the long lag already indicated, inventories conformed positively during full cycles.

Chart 6 shows the stocks held by the ten industry groups as well as by all manufacturers. Again the light and dark areas differ from frame to frame according to the timing category of each series. The graphs will help the reader form his own impression of the sensitivity of inventories to general waves of prosperity and depression.

One prominent feature of inventories in current prices is not repeated when the values are corrected for changes in prices. In the former case we found that a high proportion of all defections from conformity to business cycles came in the short period of mild business cycles between 1923 and 1929. The volume of inventories, in contrast, responds as regularly, though, of course, not as vigorously, to mild as to severe fluctuations in business. The ten industry group series representing inventories in constant prices extend, in the aggregate, over 96 business cycles measured both from trough to trough and from peak to peak. Inventories did not conform in 27 cycles. Only 10 defections come between 1923 and 1929, when the ten series together extended over 30 cycles.

3 *Inventories Held by Other Industrial Divisions*

Though this study is devoted to manufacturers' inventories, it is interesting to compare their cyclical behavior with inventories held in other major divisions of the economy. Estimates we consider sufficiently reliable for this purpose are available in both current and constant prices for four divisions: trade, transportation and other public utilities, mining, and agriculture. They were first compiled by Simon Kuznets;[22] minor revisions and extensions were carried through by me. The four groups together with manufacturing hold about 95 percent of total inventories (Table 3).

Charts 7 and 8, depicting the movements of the five series from 1918 through 1938 or 1939, are arranged so as to distinguish behavior during business expansions and contractions marked off

[22] Kuznets presented the estimates in their original form in *Commodity Flow and Capital Formation*, Part VII, for year ends 1918-33. Subsequently he extended the estimates to later years and used results derived from them in Commodity Flow and Capital Formation in the Recent Recovery and Decline, 1932-1938, NBER, *Bulletin 74*, June 1938, and *National Product since 1869*.

Chart 6

Manufacturers' Inventories, Constant Prices
Total and Ten Groups

I Series that Lag 9 Months

Contractions (shaded) and expansions (unshaded) are marked off by the March 31 business chronology

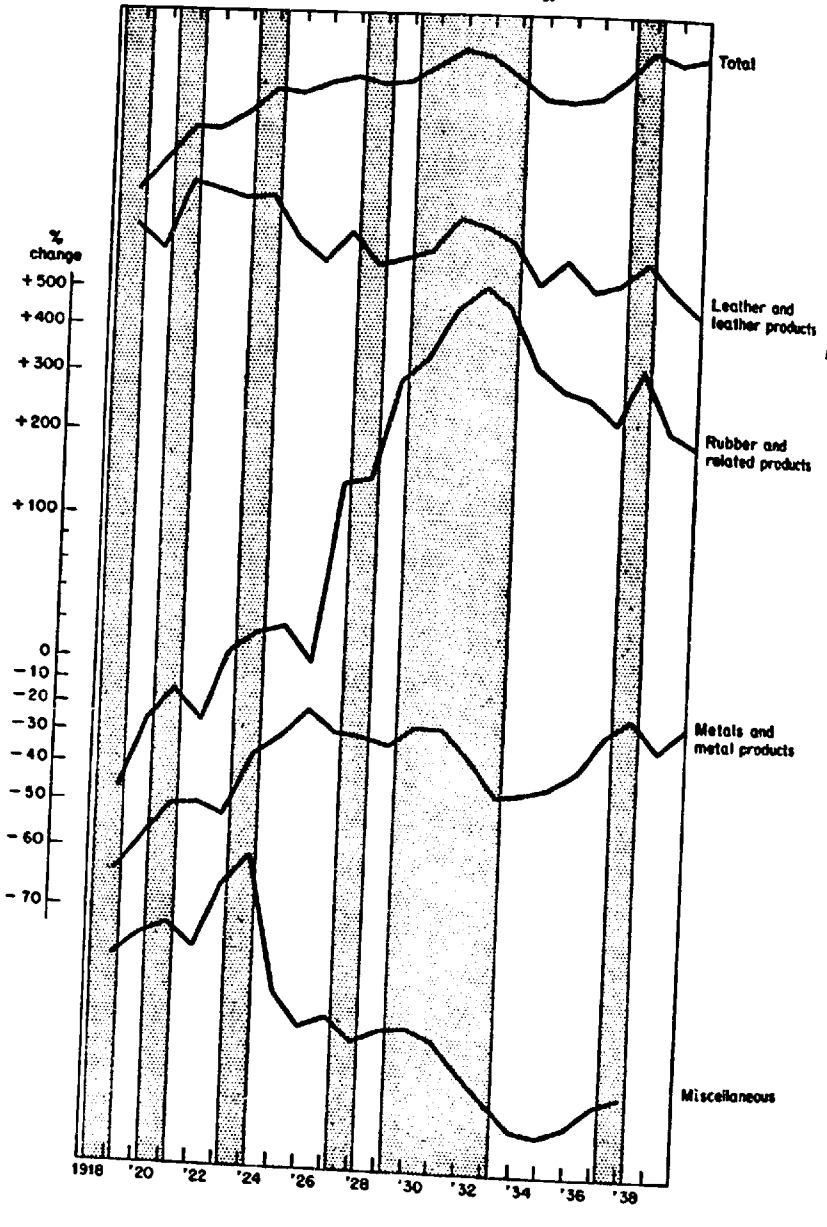
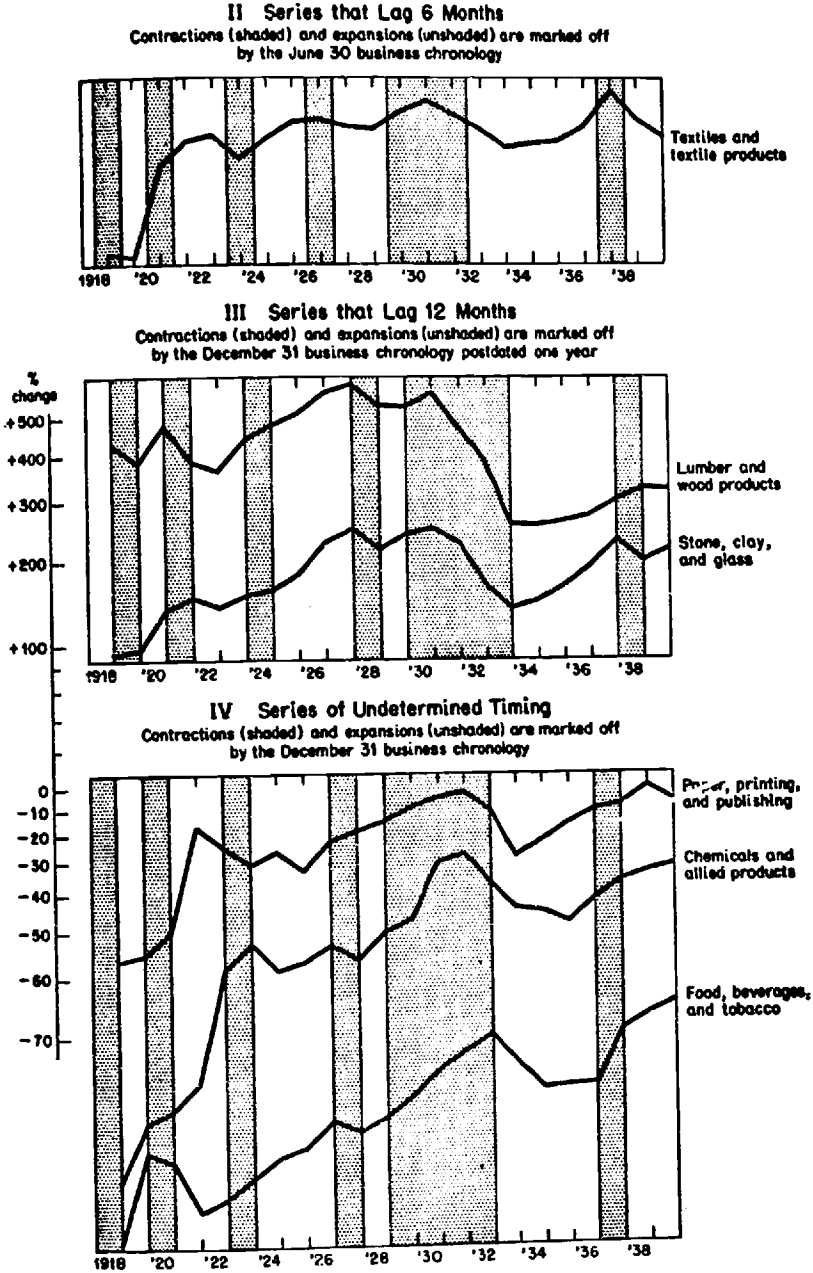
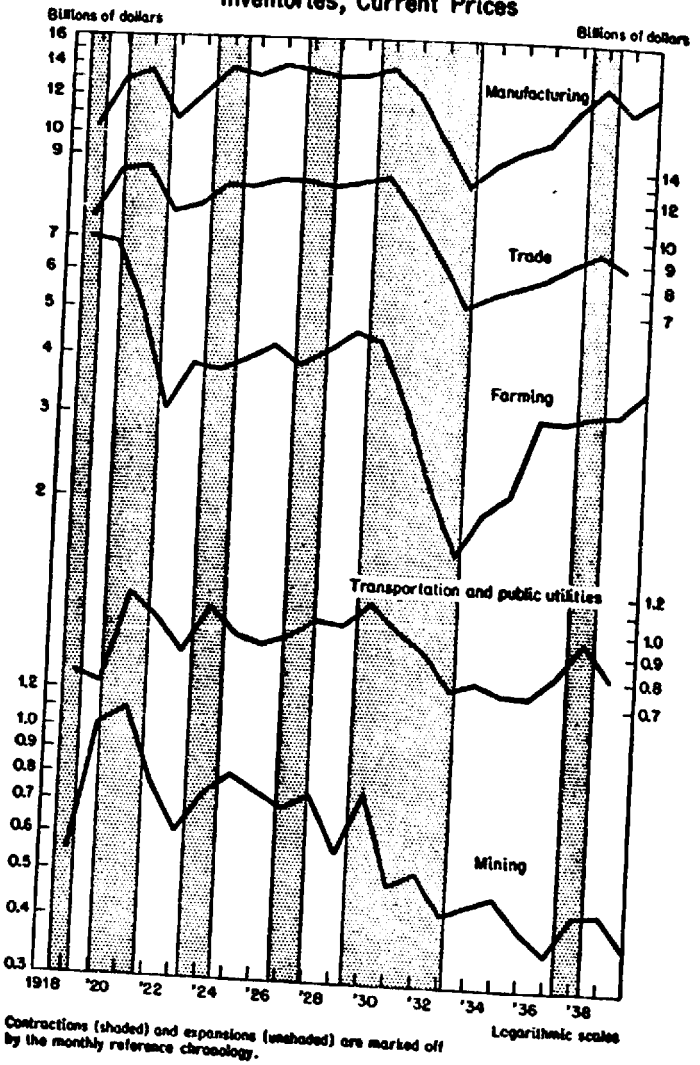


Chart 6 (concl.)



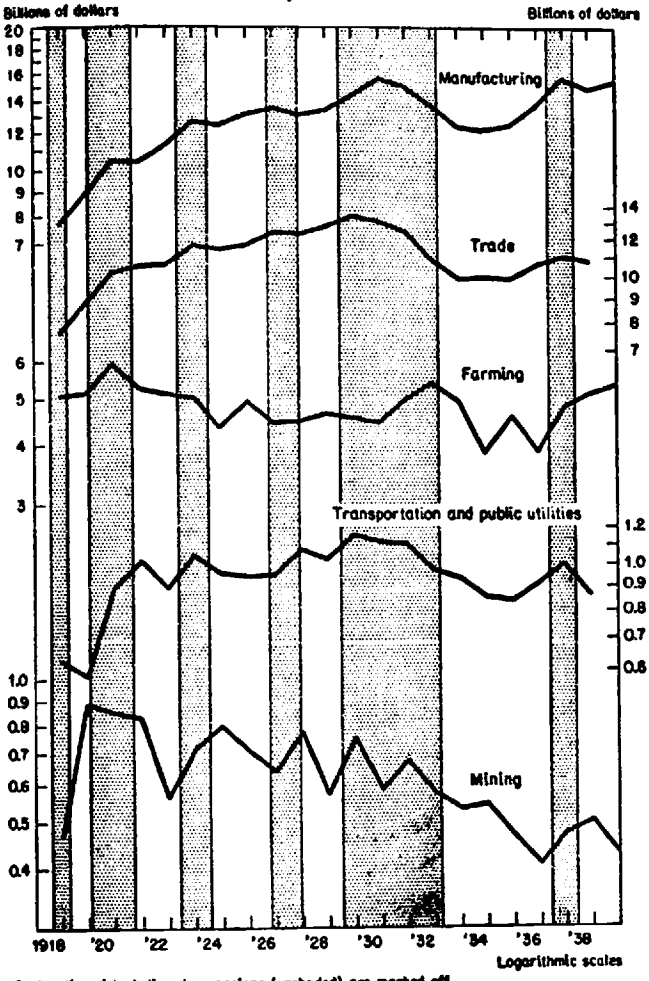
Influence of changes in price eliminated on the assumption that inventories are valued at the lower of cost or market.

Chart 7
Five Major Industrial Divisions
Inventories, Current Prices



uniformly according to the standard monthly chronology. A striking feature of the estimates in both current and constant prices is the similarity between manufacturing and trade as far as their behavior can be judged from annual data. In current prices the two series have cycles that correspond perfectly and that reach peak and trough values at the same year ends. The estimates of

Chart 8
Five Major Industrial Divisions
Inventories, Constant Prices



Contractions (shaded) and expansions (unshaded) are marked off by the monthly reference chronology.

physical volume, as shown by the series in constant prices, correspond almost as well. Trade skips the contraction of 1920-21, but its growth is markedly retarded. Thereafter, its peaks and troughs are synchronous with those of manufacturers' stocks until the peak of 1929, when the latter turn down a year later. Both series reach troughs in 1932, remain low until the end of 1934,

then sweep upward to a peak at the end of 1937. As in manufacturing then, the stocks held by wholesalers and retailers conform positively to business cycles with a lag that is longer for estimates of physical volume than for those in current prices.

This similarity between the inventories of the two major industrial divisions extends to transportation and other public utilities. In it, however, the lags characteristic of the two major divisions are even more pronounced.

When we turn to mining and agriculture the resemblance disappears. The peaks and troughs of the mining series are more easily matched with those of business cycles on an inverted basis, and the conformity measures indicate inverted association. These results would stand out more clearly in the charts had the big price declines of 1920-29 and 1929-32 not depressed mining inventories in current prices and the great depression after 1929 left its mark on even the volume of stocks.

The positive pattern of farm stocks in current prices is due to the violent swings in agricultural prices between prosperity and depression. The estimate in constant prices is a less regular series which appears to move inversely if there is any regular association at all with business cycles.

Table 24, which summarizes the timing comparisons, and Table 25, which presents measures of conformity, give these impressions

TABLE 24

Inventories, Five Major Industrial Divisions
Timing at Business Cycle Turns, 1918-1938

	INVENTORIES, CURRENT PRICES			INVENTORIES, 1929 PRICES[a]		
	NUMBER OF		AV. LEAD (−) OR LAG (+),	NUMBER OF		AV. LEAD (−) OR LAG (+),
(1)	Leads (2)	Lags (3)	MO. (4)	Leads (5)	Lags (6)	MO. (7)
Manufacturing	2	8	+3.8	0	10	+8.6
Trade	2	8	+3.8	0	8	+5.9
Transp. & other pub. ut.	1	10	+9.7	0	10[c]	+12.1[c]
Agriculture	6	1	−5.2	3	2	−1.9
Mining & quarrying[b]	4	4	−0.9	4	4	−0.2

[a] Except for agriculture, inventories are corrected for changes in price on the assumption that they are valued at the lower of cost or market. Estimates for agriculture are derived from physical quantities multiplied by end of year prices in 1929.

[b] Timing measured invertedly; see Ch. 3, note 5.

[c] One lag omitted because it exceeded 24 months.

TABLE 25

Inventories, Five Major Industrial Divisions
Conformity to Business Cycles, 1918-1938

(1)	LEAD (−) OR LAG (+) ASSUMED[a] (MO.) (2)	NO. OF PHASES[b] (3)	INDEX OF CONFORMITY TO BUSINESS Exp. (4)	Contr. (5)	Cycle (6)
INVENTORIES, CURRENT PRICES					
Manufacturing	+3	10	+100	+100	+100
Trade	+3	10	+100	+100	+100
Transp. & other pub. ut.	+9	11	+100	+100	+100
Agriculture	−6	10	+20	+60	+78
Mining and quarrying	0	10	−60	−60	−56
INVENTORIES, 1929 PRICES					
Manufacturing	+9	11	+100	+33	+100
Trade	+6	11	+100	+33	+100
Transp. & other pub. ut.	+12	11	+100	+67	+80
Agriculture	0[c]	10	−20	−60	−78
Mining & quarrying	0	10	−60	−60	−78

[a] From Table 24, col. 4 and 7. Results are rounded to nearest 3-month interval.
[b] See Table 21, note b. [c] See Table 21, note c.

objective form. The lags of inventories in manufacturing, trade, and public utilities are more consistent and longer for estimates in constant than in current prices. The transportation and public utilities series is the most serious laggard of the three, but it is doubtful that the apparent difference between trade and manufacturing (in 1929 prices) is significant. It arises partly because in these annual data trade skips the 1920-21 contraction and partly because its trough at the end of the great depression is placed at the end of 1933 instead of at the end of 1934 as is done for manufacturing. For both series the change between the two year ends is very small.

The mining and agriculture series also bear out the impression gained from the charts. The cycles in the former correspond easily to business cycles on an inverted basis and indicate an approximately synchronous association. The latter appear to lead when estimates in current prices are matched positively with business cycles. But the comparisons are fewer than for the other divisions and the irregular association is especially pronounced for estimates in constant prices.

Trade and transportation, like manufacturing, conform regularly and positively to business cycles, allowing for the indicated lag of stocks. Mining conforms inversely with fair regularity. Stocks on farms conform positively under the influence of changes in prices but inversely with fair regularity when the effect of changing prices has been eliminated.

Both the similarities and differences in inventory cycles these tables reveal are illuminating. For example, as we shall see later, the relation between business cycles and manufacturers' stocks is a composite of divers behavior traits characteristic of various categories of manufacturers' stocks. In particular we shall find that inverted behavior, or long lags verging on inverted movement, is characteristic of stocks of certain classes of staple finished goods. For such commodities, manufacturers can safely risk a certain delay in adjusting the pace of their operations fully and promptly to cycles in their sales. Inverted behavior is characteristic also of situations in which manufacturers cannot easily control the size of their stocks of purchased materials, either because they must buy them long in advance or because the conditions under which the raw materials are supplied force the rate of fabrication to adjust itself to the rate of supply rather than to the rate of demand. In the light of these findings it is significant that the stocks of both farmers and mine operators consist mainly of staple goods that are 'finished' from the standpoint of these industries; farmers, of course, cannot quickly adjust their output to demand. These facts raise the interesting possibility that the apparently different behavior of stocks in the various industrial divisions may be found to be rather readily susceptible to rationalization in terms of a single consistent hypothesis. But this is a suggestion for future investigation rather than a problem for this study.

Whether or not this possibility of reconciling differences in the action of the various divisions of the economy turns out to be a valid lead,[23] we should still notice the impressive degree to which

[23] Even if it should prove possible to organize support for this theory, it seems likely that the degree of (inverted) association between business cycles and stocks on farms will turn out to be weak. For the output of crops and livestock, though subject to pronounced cycles, is either unrelated or only tenuously related to business cycles. Geoffrey H. Moore will treat this question in his forthcoming study of Harvest Cycles.

the formula earlier established for manufacturers' stocks is repeated in trade and transportation. The positive and lagged conformity of these three divisions, which together account for about 80 percent of all commodity stocks, serves to enhance the importance of the next section and of other portions of this study which appraise our findings about manufacturers' stocks.

4 *Significance of the Findings*

We have concluded from the interwar record that manufacturers' aggregate stocks vary positively with business cycles, lagging more than 6 but less than 12 months. It is well to realize exactly what such long lags mean. To make our ideas quite definite, assume that the true average lag is 9 months.[24] During the 21 business cycles since 1854 the National Bureau has identified, expansions lasted on the average slightly more than 26 months, contractions only 21.5 months. A 9-month lag, therefore, means that aggregate physical inventories of manufacturers would decline for slightly more than one-third of an average expansion and would continue to increase for over 40 percent of an average contraction. Moreover, 5 of the 21 expansions and 13 of the 21 contractions lasted 18 months or less. In such short phases manufacturers' inventories would move counter to business for half the phase or more. This assumes, of course, that the lag of inventories behind general business is not correlated with the length of cyclical phases.

If these observations are valid, they serve both to correct and to give precision to the suggestions put forward by earlier writers. The juxtaposition of my findings about the timing of stocks with the Bureau's measures of expansions and contractions makes it easier to see Blodgett's results in fair perspective. He concluded that manufacturers' inventories move inversely to business. In the light of my findings, this appears to be true only of the shorter movements (18 months or less) which have constituted a majority of business contractions in the United States but only a small minority of expansions. As already stated, however, Blodgett discerned a tendency for series that normally behave inversely to move with business in "long and severe" contractions. Blodgett's

[24] This figure, however, may exaggerate the true lag somewhat; see Section 2 above.

findings and our own, therefore, are more nearly consistent than may appear at first glance.

The results of this chapter are less easily reconciled with the views of other writers. My observations are at odds with at least one reading of Hawtrey's theory—that cycles of stocks of finished goods offset those of stocks of goods in process. Some such offsetting there may be during some stages of the business cycle. The offsetting action of the two groups of stocks, as far as it exists, however, is either not continuous or incomplete. A definite cycle of inventories related to business cycles does manifest itself. Of course, Hawtrey's theory of the trade cycle, as already stated, depends upon a virtual cycle in the *demand* for stocks, not upon an actual cycle of inventories physically acquired. The broad lines of his explanation of business cycles are, therefore, untouched by my observations. On the other hand, the invisible cycle in the demand for stocks, which Hawtrey stresses, is closely related to the visible fluctuations in the amount of goods held. If businessmen desire to hold larger inventories in the early months of expansion, their orders and their planned output may be affected by the fact that their stocks are shrinking in those months instead of expanding.

Both Mitchell and Keynes suggest that aggregate inventories generally move with business, but neither appeared to expect such a long lag as I find.[25] True, Keynes asserts that liquid stocks increase for some time after the peak of business and decline after its trough, but he contends that their action will be outweighed by the movements of working capital, which are (roughly) synchronous with business. If Keynes is right about the behavior patterns of working and liquid capital, however, the fluctuations of the latter must, in fact, be large enough to dominate the total during the early part of business expansions and contractions. Otherwise, we would not find the lag that appears.

Keynes' hypothesis about the interaction of fluctuations in working and in liquid capital led him to put forward a theory about the behavior of inventory investment. He suggested that the rate of investment is low but positive in the early months of expansion when the increase of working capital is being offset by a decline in

[25] The same is true of Hawtrey as far as he expects to find an actual cycle in stocks.

liquid capital and that it rises as liquid capital ceases to fall and begins to increase. Similarly, he suggests that after the peak of business, stocks will be declining but that the rate will be low as long as liquid and working capital are moving in opposite directions. When liquid capital too begins to be reduced, the rate of disinvestment accelerates. The typical cycle pattern of inventories, however, is somewhat different. Total stocks do not merely grow slowly in the early months of expansion; they actually decline. They do not merely decline slowly after the peak of business; they actually increase for some months. This suggests that the pattern of inventory investment during business cycles is unlikely to accord well with the model implicit in Keynes' views.

The above observations indicate also that the principle of acceleration as applied to inventories requires modification. This theory of inventory investment, in its simple form, holds that inventories vary directly and proportionately with output. Assuming, for the time being, that output and business at large move together, the observation that inventories lag many months behind business requires explanation. J. M. Clark, who first advanced the hypothesis, never supposed that what I have described as the theory "in its simple form" was an adequate description of reality. He stressed, from the beginning, that business decisions about investment are likely to lag behind the changes in output or sales that call for them, and that still more time is required to execute investment decisions once they are made. Both qualifications are consistent with the observed lag of inventories behind output, and I shall argue that both are involved in a complete account of inventory behavior. But other factors will also be found to be important. Moreover, the principle may have direct and simple application to some parts of total inventories.

Having found so much awry in the theories of inventory behavior even with respect to aggregate stocks, it is pleasant to end this chapter with a glance at Metzler's suggestion. His model of an inventory cycle involves the sound notion that inventories lag behind business. Whether he would expect as long as lag as I have found cannot be said, but in a broad way his theory of the dynamics of inventory cycles is consistent with the lag of inventories at cyclical turns.