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Volume Author/Editor: Thomas M. Stanback, Jr.

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Goods-in-Process Inventories and Inventory Investment

For his study of goods-in-process behavior, Abramovitz once again divided the category into its major components and sought to determine the typical behavior of each. In the present chapter, a discussion of Abramovitz' system of classification and the theory which he developed is followed by an observation of the behavior of goods-in-process stocks and investment as revealed in Department of Commerce data. A third section develops possible reasons for observed differences in actual and hypothesized behavior and presents a revised theory.

Amplitude of movements in purchased materials, goods-in-process, and finished-goods investment are compared in chapter 7. As noted in this chapter, however, significant movements in goods-in-process investment are found only in the durables series. Nondurables in-process investment moves erratically and with little amplitude.

Abramovitz' Theory of Goods-in-Process Behavior [1]

Abramovitz classified these stocks under two heads, those held within and those held between stages of manufacture. On the basis of an analysis of production processes, and from information in a special Federal Trade Commission survey for 1939, relating to size of goods-in-process stocks held by specific industries, he estimated that 37.7 percent of goods-in-process stocks were held by continuous process industries which characteristically hold them within stages; 36.1 percent by discontinuous process industries with large holdings of in-process stocks between stages; and2 6.2 percent by industries with a mixture of continuous and discontinuous processes. He pointed out that if inventories in the mixed industries were about equally divided between stocks held within and stocks held between stages, roughly half of all goods in process would be held in each.

Goods-in-process behavior in the continuous process industries was determined by several hypothetical models which showed that the timing of turns in these stocks is dependent upon the timing pattern of inputs and the length of the production period. On the basis of this analysis Abramovitz concludes that: "In such industries stocks of goods in process cannot lag behind production. On the contrary, they are likely to lead. The lead, however, cannot exceed an interval equal to a production period; that is, it cannot exceed the time elapsing between the moment work is begun upon a prospective unit of output in a manufacturing establishment and the time it is ready for delivery." [2]

Regarding the goods in process held by discontinuous and mixed industries, he points out that "In other [than continuous] manu-

[1] The following account is based upon Abramovitz, "Inventories and Business Cycles, with Special Reference to Manufacturers Inventories," New York, NBER, 1950, pp. 160–177, 380–388.

[2] Ibid., p. 380. Abramovitz estimates the average length of the production period in American industry to be 25 days, pp. 171–174.

facturing industries, the relation need not be rigid; yet even here there is a bias in favor of a positive relation between production and goods in process. For only surplus stocks between stages can move inversely to output. The stocks within the various stages of discontinuous industries must still move together with activity in their respective stages. Since activity in these stages is closely bound together, so must output and goods in process within the various stages. Finally, it must be remembered that surplus stocks between stages need not move inversely to output; they only may do so.

"* * * there is, in fact, a very powerful set of forces impelling (all) goods in process as here defined, to move together with output in manufacturing as a whole." [3]

The analysis of goods-in-process investment follows along similar lines. Emphasis is given to the behavior of in-process stocks within stages. For these goods Abramovitz finds that investment will not lag behind the rate of increase in output and is likely to lead, but not by more than one production period.[4] He holds that goods "between stages" in discontinouous industries may or may not act in the same fashion, "when they do not, the effect is probably to cause goods in process in the aggregate to respond to changes in activity somewhat more tardily than they otherwise would. Hence investment in goods in process as a whole is likely to lead the rate of growth of production by less than investment in continuous industries does. It may even lag by a short interval. It seems best, therefore, to say merely that investment in goods in process and the rate of growth of output turn at nearly the same time." [5]

Goods-in-Process Inventories

Before examining the Department of Commerce data on goods-in-process inventories, it should be noted that the problems of deflation here are much greater than those encountered with purchased-materials and finished-goods data. Goods in process are not bought and sold and there is no market price for them. Their value for accounting purposes is determined by cost-accounting techniques which estimate the value of labor and overhead applied to the purchased materials. For the inventory data there are, therefore, no price indexes from which deflators can be constructed, nor any clues to the composition of goods in process (i.e., the proportions which are are in early, middle, and late stages of production) which would permit assumptions as to the value added.

These restrictions reduce the effectiveness of the analysis, but do not preclude learning from the data. Crude deflators can be devised which will permit us to observe whether or not cyclical characteristics found in the undeflated series are sufficiently well stamped upon the data to remain apparent after making an arbitrary allowance for possible price effect. Furthermore, the undeflated data may be examined and, where there are a large number of observations, generalizations may be made concerning well-established characteristics.

[3] Ibid., p. 165.
[4] Ibid., p. 387.
[5] Ibid., p. 387.

Comprehensive goods in process series were deflated by using an average of the purchased-materials and finished-goods deflators. It was not deemed worthwhile to prepare deflators for the individual industry series, but timing and conformity measures of the undeflated series were prepared, as well as a summary of the timing sequence of their turns when related to turns in undeflated purchased materials and finished goods.

MAJOR PATTERNS OF MOVEMENT IN STOCKS

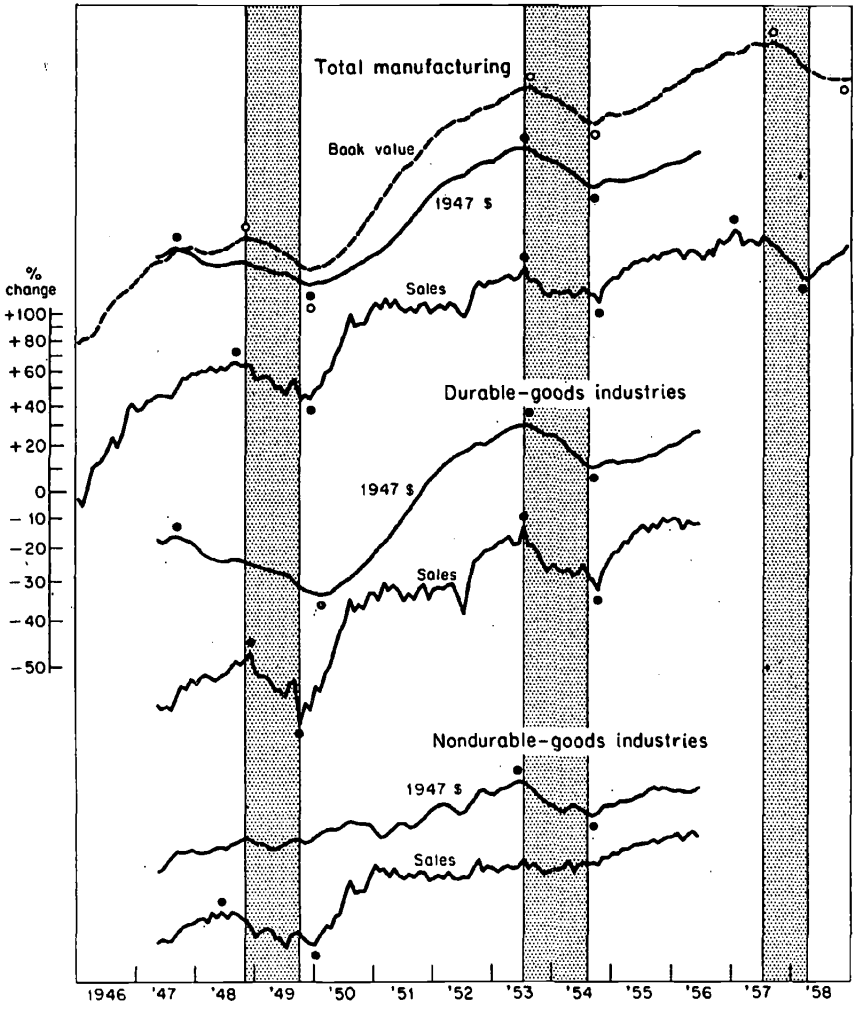
The undeflated goods-in-process inventory series for total manufacturing shows three well-marked cyclical movements from 1945 to 1958 (chart 14). There is, however, no movement in the series which would indicate conformity to the cyclical forces accompanying the Korean period.

Deflation alters the total manufacturing series significantly in only one phase. The timing of the first cycle peak occurs 14 months earlier in the deflated than in the corresponding undeflated series (table 29). The undeflated-durables series which has the same pattern of movement as total manufacturing is affected in the same way.

In the undeflated nondurables series the cyclical patterns are less clearly defined. The pattern of the first cycle is approximately the same as that of the undeflated total manufacturing series, but movements are smaller. From June 1951 to the second peak in June 1953 a series of irregular movements occurs, and the contraction which follows is of very small amplitude. When the nondurables data are deflated, the resulting series moves so irregularly, prior to mid-1953, that no cycle turns can be marked. The contraction of 1953–54 remains, however, with timing approximately the same as in the undeflated series.

CHART 14

GOODS-IN-PROCESS INVENTORIES AND SALES: TOTAL MANUFACTURING, DURABLE- AND NONDURABLE-GOODS INDUSTRIES, 1946–58



Shaded areas represent business contractions; unshaded areas, expansions.
Dots identify peaks and troughs of deflated inventory cycles; circles, of undeflated cycles. All sales data are undeflated.

Source: Department of Commerce. Data deflated by the author.

TABLE 29.—*Timing and conformity of manufacturers' goods-in-process inventories at output and sales turns*

A. TIMING MEASURES

Industry	Lead (−) or lag (+), in months, in zones associated with reference turns							
	1948 peak	1949 trough	Korean war: 1951 peak	Korean war: 1952 trough	1953 peak	1954 trough	1957 peak	1958 trough
	Timing of inventories to output turns							
Deflated inventory data:								
Total manufacturing	−10	+1	(1)	(1)	0	+5	------	--------
Durable-goods industries, total	−10	+4	(1)	(1)	+1	+5	------	--------
Nondurable-goods industries, total	(2)	(2)	(2)	(2)	−1	+9	------	--------
Undeflated inventory data:								
Total manufacturing	+4	+1	(1)	(1)	+1	+5	+1	+7
Durable-goods industries, total	+5	+4	(1)	(1)	+1	+5	0	+7
Nondurable-goods industries, total	+5	+6	(2)	(2)	−1	+9	+5	+7
Industry series (undeflated):								
Primary metals	+4	+7	(3)	(3)	+4	0	------	--------
Machinery (including electrical)	−1	+7	(1)	(1)	−8	+10	------	--------
Transportation equipment (including motor vehicles)	−6	+2	(1)	(1)	0	0	------	--------
Stone, clay, and glass	+3	+9	(2)	(2)	+2	+16	------	--------
Food and beverages	(1)	(1)	(1)	(1)	(1)	(1)	------	--------
Paper	+6	+4	+8	+13	(3)	(3)	------	--------
Chemical	−13	+9	−8	−10	+1	+7	------	--------
Petroleum and coal	+5	+7	(3)	(3)	(3)	(3)	------	--------
Rubber	(4)	+7	+20	(2)	(2)	0	------	--------
	Timing of inventories to sales turns							
Deflated inventory data:								
Total manufacturing	−12	0	(1)	(1)	0	−1	------	--------
Durable-goods industries, total	−15	+4	(1)	(1)	+1	−1	------	--------
Nondurable-goods industries, total	(2)	(2)	(1)	(1)	(3)	(2)	------	--------
Undeflated inventory data:								
Total manufacturing	+2	0	(1)	(1)	+1	−1	+8	+8
Durable-goods industries, total	0	+3	(1)	(1)	+1	−1	+7	+7
Nondurable-goods industries, total	+5	−2	(1)	(1)	(3)	(2)	+12	+7
Industry series:								
Primary metals	+2	+7	(2)	(2)	+2	−1	------	--------
Machinery (including electrical)	−12	+1	(1)	(1)	−6	+5	------	--------
Transportation equipment (including motor vehicles)	−5	+2	(1)	(1)	0	−2	------	--------
Stone, clay, and glass	+3	+3	(2)	(2)	+3	+16	------	--------
Food and beverages	(2)	(2)	(1)	(1)	(2)	(2)	------	--------
Paper	+6	+2	+8	+7	(3)	(3)	------	--------
Chemical	+6	+9	−5	−11	+2	+7	------	--------
Petroleum and coal	+5	+4	(3)	(3)	(2)	(2)	------	--------
Rubber	(4)	+3	+8	(1)	(2)	−3	------	--------

B. SUMMARY OF CONFORMITY TO OUTPUT

	9 industry series		4 durable-goods industries		5 nondurable-goods industries	
	All turns	All turns except Korean	All turns	All turns except Korean	All turns	All turns except Korean
Number of comparisons	39	29	20	16	19	13
Matching inventory turns	31	26	16	16	15	10
Percentage of matching turns	79	90	80	100	79	77

[1] No turn occurs in either activity or inventories.
[2] Activity turn occurs, but no matching inventory turn.
[3] Inventory turn occurs, but there is no activity turn.
[4] Not available.

Source: Based on material from Department of Commerce.

TIMING AND CONFORMITY OF STOCKS: COMPARISON WITH OUTPUT AND SALES TURNS

In table 29 timing and conformity measures are presented for the undeflated and deflated comprehensive series and for the undeflated industry series. Timing comparisons were made with turns in output as well as sales to facilitate subsequent discussion of the relations between stocks and the rate of output.

The movements described above conform to all movements in output and sales for the total manufacturing and durables comprehensive series. Timing is virtually coincident for all turns in the undeflated series prior to the revival in 1958. Deflation alters the timing no more than 1 month, except for the 1948 peak when the turn in stocks occurs slightly over a year earlier.

In the nondurables undeflated comprehensive series the turns conform to the output and sales turns associated with the business cycle, but not to those associated with the Korean cycle. For the two turns which remain in the nondurables series after deflation, the timing is approximately the same.

Among the undeflated industry series, 29 of the 39 turns in output have matching stock turns, but timing is irregular. There appears to be a tendency for stocks to lag behind output, but a number of leads are noted. On the whole the durables conform better and show more consistent timing.[6]

TIMING OF STOCKS DURING BUSINESS CYCLES

In table 30 timing of both the deflated and undeflated comprehensive series is compared with reference turns. With the exception of the first peak the deflated total manufacturing and durable stocks series turn roughly coincidently with business cycle (reference) turning points. The deflated nondurables series, of course, conforms only to the 1953–54 business cycle turns.

Since the undeflated goods-in-process industry series may not be relied upon to give an accurate picture of timing of cyclical movements, the sequence of turns in these series has been related to comparable turns in the purchased-materials and finished-goods series. The cyclical behavior of these last two types of stocks has already been described, and it is assumed that the patterns of sequence observed in the undeflated series, if well established, will provide an acceptable approximation of those which would be found to obtain if deflation of all the series could be properly carried out.[7]

[6] There is a tendency for the durables series to show earlier turns relative to output and sales peaks than they do at troughs. The characteristic does not appear, however, in the nondurables comprehensive series.

[7] This assumption is, of course, open to the criticism that price effects (upward during expansion, downward during contraction) may tend to find their way into inventory values in a time sequence in which purchased materials show the effect first, followed by goods in process and finished goods. I have not noticed such a tendency in deflating the purchased-materials and finished-goods series, however.

TABLE 30.—*Timing of manufacturers' goods-in-process inventories at reference turns* [1]

Industry	Lead (−) or lag (+) in months					
	Business cycle		Business cycles			
	Peak, November 1948	Trough, October 1949	Peak, July 1953	Trough, August 1954	Peak, July 1957	Trough, April 1958
Deflated inventory data:						
Total manufacturing	−14	+2	0	+1	----------	----------
Durable-goods industries, total	−14	+4	+1	+1	----------	----------
Nondurable-goods industries, total	(2)	(2)	−1	+1	----------	----------
Undeflated inventory data:						
Total manufacturing	0	+2	+1	+1	+2	+7
Durable-goods industries, total	+1	+4	+1	+1	+1	+7
Nondurable-goods industries, total	0	+1	−1	+1	+6	+6

[1] There were no turns conforming to "Korean" cycle reference dates.
[2] No matching turn in inventories.

Source: Based on material from Department of Commerce.

Accordingly, turns in the individual industry goods-in-process series have been compared first with turns in purchased materials and then with those in finished goods.

Comparisons with purchased-materials turns

	Number	Percent
Total comparisons of goods in process	34	100
Leads, 4 or more months	11	32
Rough coincidences	18	53
Leads, less than 4 months	(11)	(33)
Coincidences	(2)	(6)
Lags, less than 4 months	(5)	(14)
Lags, 4 or more months	5	15

Comparisons with finished-goods turns

	Number	Percent
Total comparisons of goods in process	24	100
Leads, 4 or more months	15	62
Rough coincidences	5	21
Leads, less than 4 months	(2)	(9)
Coincidences	(2)	(8)
Lags, less than 4 months	(1)	(4)
Lags, 4 or more months	4	17

The typical relationships are apparent. Goods-in-process stocks turn at approximately the same time as purchased materials in over half the observations; but there is a tendency to lead. This is firmly established in relation to finished-goods turns, with leads noted in 71 percent of the comparisons—4 months or more in 62 percent.

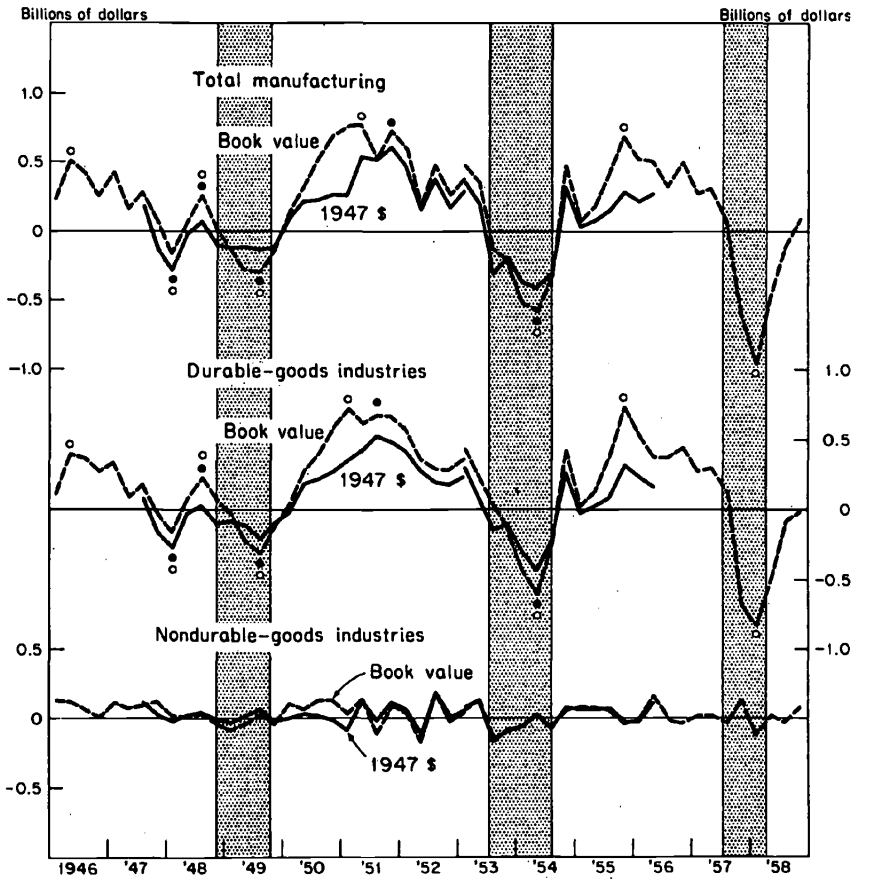
These findings are consistent with the comparisons of timing in the deflated comprehensive series. To the extent that we may generalize from these postwar observations, goods in process may be expected to lead or coincide with business cycle peaks and to coincide or lag by a short interval at troughs.

Goods-in-Process Inventory Investment

The overall behavior of total manufacturers' inventory investment in goods in process (chart 15) resembles in several respects that of purchased-materials investment (chart 16). During the period 1945–49 the patterns of movements in the two undeflated series are similar. Investment moves sharply upward until mid 1946, declines, and rises to a second and lesser peak in the first half of 1948. Thereafter each series declines to a trough in 1949. Following this last trough, goods-in-process behavior differs from that observed in the purchased-materials series. There is a major upward movement in goods-in-process investment lasting until the second quarter of 1951, following which there occurs an erratic, generally declining movement until the second quarter of 1953, and then a sharp drop to the trough in 1954.[8]

Chart 15

Goods-in-Process Inventory Investment: Total Manufacturing, Durable- and Nondurable-Goods Industries, 1946–58



Shaded areas represent business contractions; unshaded areas, expansions.
Dots identify peaks and troughs of deflated cycles; circles, of undeflated cycles.

Source: Department of Commerce. Data deflated by the author.

[8] The pattern of movement in the deflated series is essentially the same except that the peak in 1948 becomes "submerged" and the peak in 1951 occurs 6 months later.

The purchased-materials series during this last period shows a very sensitive reaction to cyclical forces in the economy in 1951–52, declining sharply to a well marked trough in the second quarter of 1952.

The durables goods-in-process series (undeflated and deflated) show the same general pattern as total manufacturing, except that there are no irregular movements in 1952–53 (chart 16). The nondurables series, on the other hand, show a much less well-defined pattern, being especially choppy from the beginning of 1951 to the second quarter of 1953, so that peaks and troughs cannot be marked with confidence.

TIMING AND CONFORMITY OF INVESTMENT: COMPARISON WITH OUTPUT, SALES, AND REFERENCE TURNS

The movements described for total manufacturing and durable-goods investment are reflected in the timing measures shown in table 31. Among the industry series most of the output turns may be matched by those in inventory investment, but the timing is irregular.

TABLE 31.—*Timing and conformity of manufacturers' goods-in-process inventory investment at output and sales turns*

A. TIMING MEASURES

Industry	Lead (−) or lag (+) in months, in zones associated with reference turns							
	1948 peak	1949 trough	Korean War		1953 peak	1954 trough	1957 peak	1958 trough
			1951 peak	1952 trough				
	Timing of investment to output turns							
Deflated data:								
Total manufacturing	+1	−3	(1)	(2)	(3)	+1	-------	-------
Durable-goods industries, total	+1	−2	(1)	(2)	(3)	+1	-------	-------
Nondurable-goods industries, total	(4)	(4)	(4)	(4)	(4)	(4)	-------	-------
Undeflated data:								
Total manufacturing	+1	−3	(1)	(2)	(3)	+1	−21	−2
Durable-goods industries, total	+1	−2	(1)	(2)	(3)	+1	−21	−2
Nondurable-goods industries, total	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Primary metals	−2	−2	+8	+4	−3	−5	-------	-------
Machinery (including electrical)	+10	−1	(1)	(2)	(3)	−3	-------	-------
Transportation equipment (including motor vehicles)	−13	−4	(1)	(2)	(3)	−9	-------	-------
Stone, clay, and glass	−11	+2	−6	(2)	(3)	+7	-------	-------
Food and beverages	(4)	(4)	(4)	(4)	(4)	(4)	-------	-------
Paper	−13	0	0	+8	(1)	(1)	-------	-------
Chemical	−22	+4	+5	+9	−2	−2	-------	-------
Petroleum and coal	−4	+4	(1)	(1)	−3	(1)	-------	-------
Rubber	(1)	−4	+10	−2	−3	−11	-------	-------
	Timing of investment to sales turns							
Deflated data:								
Total manufacturing	−1	−4	(1)	(2)	(3)	−5	-------	-------
Durable-goods industries, total	−4	−2	(1)	(2)	(3)	−5	-------	-------
Nondurable-goods industries, total	(4)	(4)	(4)	(4)	(4)	(4)	-------	-------
Undeflated data:								
Total manufacturing	−1	−4	(1)	(2)	(3)	−5	−14	−1
Durable-goods industries, total	−4	−2	(1)	(2)	(3)	−5	−14	−2
Nondurable-goods industries, total	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Primary metals	−4	−2	+8	+5	−5	−6	-------	-------
Machinery (including electrical)	−1	−7	(1)	(2)	(3)	−8	-------	-------
Transportation equipment (including motor vehicles)	−10	−4	(1)	(2)	(3)	−11	-------	-------
Stone, clay, and glass	−11	−4	−6	(2)	(3)	+7	-------	-------
Food and beverages	(4)	(4)	(4)	(4)	(4)	(4)	-------	-------
Paper	−13	−2	(4)	+2	(1)	(1)	-------	-------
Chemical	−18	+4	+8	+8	−3	−2	-------	-------
Petroleum and coal	−4	+1	(2)	(2)	−2	(1)	-------	-------
Rubber	+1	−8	(2)	(2)	−5	−14	-------	-------

TABLE 31.—*Timing and conformity of manufacturers' goods-in-process inventory investment at output and sales turns*—Continued

B. SUMMARY OF CONFORMITY TO OUTPUT

	9 industry series		4 durable-goods industries		5 nondurable-goods industries	
	All turns	All turns except Korean	All turns	All turns except Korean	All turns	All turns except Korean
Number of comparisons	38	28	20	16	18	12
Matching inventory turns	34	25	16	13	18	12
Percentage of matching turns	90	90	80	81	100	100

[1] Inventory investment turn occurs, but there is no activity turn.
[2] No turn occurs in either activity or inventory investment.
[3] Activity turn occurs but no matching inventory investment turn.
[4] Not available.

Source: Based on material from Department of Commerce.

Timing comparisons of the comprehensive series and reference turns are shown in table 32. The total manufacturing and durables series (both deflated and undeflated) lead at all business cycle turns.

TABLE 32.—*Timing of manufacturers' goods-in-process inventory investment at reference turns*

Industry	Lead (−) or lag (+) in months							
	Business cycle		Korean cycle		Business cycles			
	Peak November 1948	Trough October 1949	Peak February 1951	Trough June 1952	Peak July 1953	Trough August 1954	Peak July 1957	Trough April 1958
Deflated data:								
Total manufacturing	−3	−2	+9	(1)	(1)	−3	-------	-------
Durable-goods industries, total	−3	−2	+6	(1)	(1)	−3	-------	-------
Nondurable-goods industries, total	(1)	(1)	(1)	(1)	(1)	(1)	-------	-------
Undeflated data:								
Total manufacturing	−3	−2	+3	(1)	(1)	−3	−20	−2
Durable-good industries, total	−3	−2	0	(1)	(1)	−3	−20	−2
Nondurable-goods industries, total	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)

[1] No turn in inventory investment.

Source: Based on material from Department of Commerce.

For the individual industry series, turn sequences are summarized below.

Comparisons with purchased materials investment turns

	Number	Percent
Total comparisons:		
Goods-in-process investment	35	100
Leads, 4 or more months	4	11
Rough coincidences	25	72
Leads, less than 4 months	(10)	(29)
Coincidences	(9)	(26)
Lags, less than 4 months	(6)	(17)
Lags, 4 or more months	6	17

Comparisons with finished goods investment turns

	Number	Percent
Total comparisons: Goods-in-process investment	37	100
Leads, 4 or more months	15	40
Rough coincidences	19	52
Leads, less than 3 months	(12)	(33)
Coincidences	(4)	(11)
Lags, less than 3 months	(3)	(8)
Lags, 4 or more months	3	8

A clear timing tendency is revealed: turns in goods-in-process investment occur roughly coincidently with turns in purchased-materials investment, but lead turns in finished-goods investment.

These findings are sufficiently in agreement with the measures for the other comprehensive series presented in table 35 (ch. 7) to permit a generalization as to postwar timing. Goods-in-process investment, like purchased-materials investment, will tend to lead business cycle turns. The lead may be of considerable duration.

Analysis and Revision of Abramovitz' Theory

If one attempts to pass judgment on Abramovitz' theory in the light of the observed behavior of the data, the results are ambiguous. The general tendency for goods in process to roughly coincide with turns in output is consistent with Abramovitz' explanation. On the other hand, there is nothing in the theory that would lead one to expect the several very long leads and lags that occur in the industry series, or the failure of such goods in process as total nondurables and certain of the industry series to conform to the Korean cycle.

The behavior of inventory investment is even less consistent with the theory. In a comparison of investment turns in the undeflated industry series with turns in rates of change in comparable output series, of the 36 turns in the latter, timing was as follows: 6 leads (3 of which 6 or more months); 9 coincidences; 21 lags (17 of which, 6 or more months).

The leads and lags of 6 months and more would appear to be well outside the range of possible timing according to Abramovitz' theory. Especially difficult to explain is the behavior of investment in the total manufacturing and durable series after 1949. The great upward movement in inventory investment observed in these series in chart 15 lasted until the latter half of 1951, the peak occurring roughly coincidently with the trough in the rate of change in output.

I can suggest four possible explanations for this disagreement between Abramovitz' theoretical statement and the behavior of the data: (1) Errors in the data due to price movements; (2) definitional difficulties leading to a reporting of stocks other than goods in process; (3) changes in composition of goods-in-process stocks since World War II; and (4) theoretical omissions.

Little need be said regarding the first point; it has already been shown that formidable obstacles to deflation exist. While we can be confident of neither the undeflated nor the deflated data, the differences noted between the timing in the series and the timing postulated by Abramovitz cannot be attributed principally to this

difficulty. Experience with the purchased-materials and finished-goods series, for which deflation is more reliable, indicate that only in a small minority of cases does deflation significantly alter the essential pattern of movements in stocks and inventory investment.

It is quite possible that in the current data goods in process are not identical with those defined by Abramovitz. We do not know for instance how much of these goods are fully fabricated items held by plants in vertically integrated organizations, goods which are in process only in the sense that they will enter into further production in another division of the organization. In a nonintegrated firm such stocks would be reported as finished goods. Although there is no way to determine the extent to which this is true, its significance is doubtful. It is only reasonable to expect integrated corporation reports to be composed of consolidated accounting records kept by member plants or divisions. Since the cost records of individual plants or divisions contain separate statements of inventories held at each stage of fabrication the consolidated report should not provide a different figure from that which would have been reported had the production units been individual firms.

The third possible reason for differences between theory and observed behavior appears to be of greater importance. Abramovitz' analysis rested on the assumption that continuous process operations were the most important in American industry, and that the behavior of goods in process within stages dominated the cyclical pattern of total goods in process. This assumption was based on his estimates of the relative amount of goods in process held by continuous, mixed, and discontinuous industries in 1939.

As shown previously, there has been a marked change in the structure of American industry since 1939; the durables, especially transportation equipment and machinery, having assumed a more prominent place. It is precisely these industries that have discontinuous production processes.[9]

Approximately 50 percent of total stocks were held by durables manufacturers at the close of 1939. Comparable figures for December 31, 1953, show durables with 58 percent of total stocks.[10] The dis-

	Value of total stocks by production process of minor industries		
	Continuous	Discontinuous	Mixed
Nondurable goods manfacturing:			
Food and tobacco products	88	12	----
Textiles and textile products	36	2	62
Leather and leather products	57	43	----
Rubber products	100	----	----
Paper and allied products	73	----	27
Chemicals	100	----	----
Petroleum and coal products	100	----	----
Durable goods manufacturing:			
Lumber and wood products	20	43	37
Stone, clay, and glass	15	38	47
Ferrous and nonferrous metals and their products (excluding machinery)	45	30	25
Machinery (including electrical)	5	62	33
Transportation equipment (including auto)	17	83	----

[9] This is clearly seen in Abramovitz' estimates of the value of total stocks held by production processes on Dec. 31, 1939 (compiled from table 105, with dollar figures converted to percentages, ibid., p. 560).

[10] I derived the 1939 figure from ibid., table 105, p. 560, omitting the miscellaneous category and classifying the industries as durable or nondurable. The 1953 figure was obtained similarly using the 1953 Annual Survey of Manufactures data.

parity between the amounts of goods-in-process stocks held by the durables and nondurables categories on the two dates is even greater because the discontinuous processes, so important to the durables industries, carry a higher proportion of total stocks as goods in process than do the mixed or continuous processes. Using Abramovitz' assumptions, it is estimated that durable manufactures held 57 percent of all goods in process in 1939 and 65 percent in 1953.[11] But the latter figure, although comparable with Abramovitz', is too low. According to the census estimates (Annual Survey of Manufactures), goods in process held in 1953 by these same industries amounted to 81 percent of the total.[12]

The effect of this increased role of durables is, of course, to increase the proportion of total goods in process held by discontinuous process industrial activities. Using Abramovitz' assumptions and method, comparable estimates for 1939 and 1953 are as follows:

	1939	1953
Continuous	37.7	32
Discontinuous	36.1	46
Mixed	26.2	22

An estimate made directly from the postwar census goods-in-process data, rather than the Abramovitz method, results in a slightly higher proportion of goods-in-process stocks held by industries engaging in discontinuous processes, roughly 50 percent. The significance of this finding is clear. The increased importance of that type of goods in process most loosely tied to the rate of production could account, in part, for the disparity noted between the behavior hypothesized and that observed in the data.

Finally, it appears that Abramovitz in his theoretical discussion omitted some possible types of behavior which may be of importance. The first omission concerns the behavior of goods in process between stages. As pointed out previously, Abramovitz' treatment of the behavior of these stocks was somewhat sketchy; only surplus stocks could move in an inverted fashion, but they need not. In the main, he holds, these between-stage stocks may be expected to move fairly closely with output. I suggest that when these goods in process are standardized component parts they need not behave either in an inverted fashion or move with the rate of output, but may be treated in a manner similar to purchased materials; that is, increased in advance of actual utilization on the basis of orders received. Further, as in the case of purchased materials, it may be desirable for the manufacturer to allow these goods in process to accumulate when there is a rapidly rising backlog of orders or when a large order backlog is not being significantly reduced. Such a hypothesis is particularly helpful in explaining the long expansion in durables goods-in-process investment from 1949 to 1951.

The second omission concerns goods in process held within stages of production. Abramovitz assumes that these will be effected by

[11] In preparing this estimate I made use of Abramovitz' estimates of the value of each industry's total stocks held in continuous, discontinuous, and mixed type operations and converted these by using his average ratios of goods in process to total stocks for the 3 types of processes. See ibid., p. 164, for these ratios.

[12] Excluding the miscellaneous category. See footnote 10 above.

changes in the rate of output. I suggest that this need not be the case if output is varied simply by working more or fewer days per week or more or fewer shifts per day, without increasing or decreasing the number of machines used. Under such conditions the amount of material in process at any time need not be altered. This practice is quite important in some industries (e.g., in the cotton broad-woven goods industry, varying the number of days worked per week is the principal device for varying output). Further, it is a well-established fact that the length of the workweek in manufacturing varies with the business cycle. To the extent that output is varied in this fashion, fluctuations in the level of goods in process within stages will tend to be muted, and the type of movement visualized by Abramovitz will play a lesser role.

If these previously omitted cases are added to the theoretical description of goods-in-process inventory behavior and due account is taken of the changed composition of these stocks, the composite picture is altered substantially. The movements of within-stage stocks become less important in determining the overall pattern because these stocks are smaller and because they are not so completely tied to movements in the rate of change in output as was formerly supposed. The movements of between-stage stocks, on the other hand, become more important, for they are much larger than in prewar years. Moreover, they are no longer so closely tied to output movements under the revised theory, but are related in a larger measure to the volume of incoming orders and to the levels of unfilled orders.

These revisions do not leave us with a very precise theory, but certain conclusions may be drawn as to expected behavior. Goods-in-process stocks may be expected to conform closely to cyclical movements. Expected timing of these movements is somewhat indeterminate, except that there would seem to be little reason to anticipate the development of inverted tendencies. Goods-in-process investment movements would be expected to resemble those of purchased-materials investment, moving with a lead at both peak and trough and thereby contributing to the early set of forces which brings about the end of the expansion and of the contraction phases.

Such a theory goes far toward explaining the difference in behavior of durable and nondurable goods-in-process investment. Investment series for durables manufacturers' goods-in-process inventories, which contain a large proportion of between-process stocks, are relatively sensitive to business cycles; those for nondurables, which contain a small proportion of such stocks, are relatively insensitive.

Summary

Although problems of deflation render conclusions regarding goods-in-process behavior less dependable than those for purchased materials and finished goods, certain characteristics may be noted. The inventory series conformed to business cycles with virtually coincident timing at four of the six reference cycle turns, and inventory investment led all business cycle turns. Analysis of sequence of timing among the industry series indicates that, for both inventory and investment, goods in process lead or turn coincidently with purchased materials and lead finished-goods series.

Although these findings are generally consistent with Abramovitz' theory among the individual industry investment series, irregularities in timing appear which cannot be explained by his analysis. Three factors appear to contribute to this behavior:

(1) The composition of postwar goods in process is different from that observed by Abramovitz. Owing to the increased role of durables, there is a much larger proportion of these stocks held by industries engaging in discontinuous processes, roughly 50 percent compared with his estimate of 36 percent.

(2) Goods-in-process stocks in discontinuous-process industries are likely to be held in substantial quantities between stages. These stocks may be expected to rise and fall in a manner similar to that of purchased materials.

(3) Goods held within stages need not fluctuate in as close conformity to changes in output as Abramovitz maintained.