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Chapter 17

Investment in Raw Materials Stocks

The essential features of my tentative account of the cyclical behavior of raw materials stocks can be stated briefly. There are two main categories of stocks of raw materials. One consists of goods moving through the pipeline between the point of delivery to the consuming manufacturer and the point at which fabrication in his plant begins. For some supplies this requires transportation, and for all goods it involves processes incident to receipt and issue: unpacking, checking, storage, and hauling to the processing shops. Another part consists of a reserve to ensure continuity of operations against irregularities in delivery of materials and to cover any likely expansion of sales in the near future. The size of both the pipeline stock and the reserve must, of course, be consonant with the rate of output, that is, with the rate at which materials are being consumed.

Were manufacturers able to control the size of their stock perfectly, they would increase it when output rose and reduce it when output fell. The cyclical peaks and troughs of stocks would coincide with those of output. Whether manufacturers would like to maintain a constant ratio between their stock of raw materials and their output we do not know. Of course, one would not expect a constant ratio to be maintained during periods of excited price speculation. But even during more typical cycles, when price speculation plays a minor role, the point is obscure. When output is high, it seems likely that there will be relatively few dead, or moribund, elements in the stock. There will be a call for a larger portion of the full line of each manufacturer, and a larger portion of all the kinds of materials carried will, therefore, be moving smoothly into production. On the other hand, when output is high there are more

likely to be fears that deliveries may be delayed or that prices may rise, hopes for further expansion of production are likely to be relatively bright, and businessmen are likely to be more venturesome in meeting these contingencies. Neither the statistical record nor general reasoning provides persuasive grounds for either accepting or rejecting the hypothesis that, if manufacturers could control their stocks of raw materials perfectly, they would typically try to maintain a roughly constant ratio between stocks and output.

Whatever a manufacturer might do if his control over inventories were perfect, however, his control is far from complete. The reason is that an interval, more or less long, necessarily elapses between the time materials are ordered and the time they are delivered. Unless a businessman has second sight, a decline in output will not immediately be followed by a decline in deliveries of materials. Moreover, since stocks may be presumed to be increasing during the later stages of an expansion, raw materials will continue to rise for some time after output begins to decline. The length of this lag depends, first of all, upon the interval between order and delivery; but the lag will be extended by whatever time is required for a decline in output to be reflected in a decline in orders for materials. It will be still further extended if the initial cut in orders is insufficient to bring deliveries below the level to which consumption of materials may have fallen by the time deliveries start at the reduced rate. As suggested in preceding chapters, the lag of total stocks of raw materials at cycle turns is three or four months, and very much longer in the case of commodities whose rate of delivery the purchasing manufacturers find it difficult to control.

This information about cycles in the level of raw materials inventories is of some limited use in connection with the present problem: the cyclical behavior of the rate of change in inventories. If raw materials stocks tend to reach their cyclical turning points three or four months after manufacturing output, we can infer that inventory investment (or disinvestment) will turn somewhat earlier. For it seems very unlikely, although it is not impossible, that stocks will continue to increase at an accelerating pace until the very moment they begin to fall. It seems more likely that the rate of accumulation will slacken some time before it becomes zero and finally negative. If this surmise is valid, the rate of inventory

accumulation cannot reach its cyclical peak much later than manufacturing output does, that is, in close proximity to the peak of business. And the same would be true of the timing of the maximum rate of disinvestment at the trough of business.

Useful as they are, these inferences do not take us very far. For while they enable us to fix extreme limits after which it is improbable that the maximum rates of investment and disinvestment in stocks of raw materials will occur, they do not tell us how much earlier in expansions and contractions these maxima may be reached. The crucial question is whether the peak rate of investment in raw materials coincides with, or perhaps occurs even slightly later than, the peak of business or whether it typically precedes the peak and so helps to explain the downturn. Similarly, at troughs the question is whether the rate of disinvestment in stocks drops off before the trough of business is reached.

For this purpose, it would be highly convenient if we could assume some constant relation between movements in output and stocks of raw materials during expansions and contractions. If the relation were constant, the times when the rates of change in stocks reached peaks and troughs could be gauged by studying the rates of change in output, as was done in the preceding chapter for investment in goods in process.

No such convenient assumption, unfortunately, is valid. For the raw materials required in any given month must be purchased in advance, and the period by which manufacturers must anticipate requirements may be a few days or several months. As a result, the degree of similarity between the movements in stocks of raw materials and in output from one month to the next depends upon the accuracy with which manufacturers forecast changes in their rate of operations. The accuracy of forecasts is, of course, limited and it must be expected that individual manufacturers will usually either over- or underestimate the changes in the rate at which they will consume raw materials in the months to come. In consequence, changes in their stocks will be larger or smaller than expected, and in subsequent months efforts must be made to fill up deficits or dispose of surpluses. These efforts may take the form of a more or less rapid change in stocks than in output, though both are moving in the same direction, or even of a temporary rise in stocks when output is falling or a reduction in stocks when output is rising.

For individual manufacturers, then, it seems reasonable to suppose that the relation between the size of the month to month movements in stocks and in output is very loose. On the whole, as already indicated, their stocks will be rising when output is increasing and falling when output is declining. Even small errors in forecasting, however, can make the size of stock changes in any short period quite different from that of output changes. And subsequent efforts at correction will have the same effect.

The mistakes of individuals may, of course, largely offset one another in figures that combine the records of all the members of an industry. The probability is even greater when all industries are combined. In that event some constant relation between changes in stocks and in output would probably emerge. No doubt such offsetting sometimes happens; indeed, it may happen typically, but its incidence cannot be determined by pure speculation. If the mistakes of most individuals are large, they are seldom likely to balance out even roughly. Moreover, manufacturers' forecasts may often be biased in one way or another so that most are either overoptimistic or overpessimistic at the same time.

The cyclical behavior of the rate of investment in stocks of raw materials, therefore, remains to be determined. Maximum investment is not likely to follow the peak of business but it may precede it, and maximum disinvestment is not likely to follow the trough of business but it may precede it. The rate at which stocks of raw materials are accumulated and liquidated may, because of errors in forecasting and subsequent attempts at correction, be quite irregular. This seems likely for individual concerns, and it may be true even for the mass of stocks. Finally, if investments in stocks of raw materials held by individual industries and by manufacturing at large behave in regular fashion, their timing and their relation to the behavior of the rates of change in manufacturing production are still in doubt.

These questions can be settled only by direct study of records. Although our sample is far from adequate, it is worth examination, partly for what it suggests about the pattern of aggregate investment in stocks of raw materials and partly for what it reveals about differences between commodities of diverse types.

1 *The Showing of the Records*

As indicated in Chapters 9 and 10, the series on manufacturers' stocks of raw materials are few and, in many ways, unrepresentative. For only 8 commodities can we analyze monthly or quarterly data. Of these, cotton, silk, and hides alone appear to be supplied to manufacturers under conditions that afford the degree of responsiveness of supply to changes in demand that characterizes most raw materials purchased by manufacturers—not, indeed, because they are supplied by other manufacturers, as most raw materials are, but because their fabricators can draw upon buffer stocks held by dealers.

The other commodities are supplied under conditions that characterize only minor fractions of the raw materials consumed by manufacturers. In some cases receipts of raw materials respond to needs so tardily that stocks either lag behind manufacturing activity by longer intervals than are typical or even move inversely; for example, lead at warehouses, because it must be imported; publishers' stocks of newsprint, because adjustments are hampered by long-term contracts; and manufacturers' stocks of crude rubber, because rubber output cannot quickly be expanded or contracted. The production of still other commodities has fluctuated haphazardly during business cycles with the result that manufacturers' stocks have moved irregularly; for example, refiners' stocks of raw sugar and of petroleum.

In analyzing fluctuations in inventories, as distinct from their rate of change, I tried to overcome the problems raised by the paucity of data by studying closely the various commodities for which statistics are available. For each commodity I tried to explain the cyclical pattern of stocks by the conditions affecting its supply and consumption. In this way, I was able to describe several characteristic situations, estimate the importance of each, and construct a general theory about the behavior of raw materials in the aggregate.

Whatever its difficulties, this was easy in comparison with the present task. Suppose that an industry's stock of raw materials rises and falls with the rate at which materials are consumed but lags behind consumption at the cyclical turns. To account for this behavior one need only explain why manufacturers desire raw ma-

terials stocks to vary directly with activity and why they cannot reduce the rate at which they receive raw materials below the rate at which they consume them until a few months after the peak of production. To account for the behavior of the rate of investment in stocks is far more difficult. One must explain not only why receipts exceed consumption at certain times, and vice versa, but why the difference between receipts and consumption rises to a maximum at one stage of the cycle and falls to a minimum at another. An explanation of the size of these differences is, I believe, beyond the reach of case studies confined to a few commodities. To yield reliable results empirical generalizations must be based on a large collection of materials; only then can an explanation be attempted. For this reason the observations drawn from our small sample should be regarded simply as a survey of the data that are now available rather than as a firm basis for generalization.

The measures of rates of change shown below are calculated on the same plan as those presented in Chapter 16, Section 3, with one exception. Cycles are marked off by the peaks and troughs in manufacturing activity in the industry holding the stocks rather than by the turning points in general business. For while manufacturing activity as a whole conforms closely to business cycles, activity in any particular industry during a few cycles may exhibit a significant degree of independence. If stocks of raw materials are strongly influenced by the rate of manufacturing activity, as apparently they are, individual stocks are likely to exhibit a fairly close relation to activity in the industry holding them, but their behavior during business cycles will depend upon the degree to which output in the industry conforms to business cycles in the period for which observations are available. In these circumstances, as stated, it seems better to observe the behavior of the few available series during cycles of manufacturing activity in the industries holding the stocks. One can then form a judgment about the typical behavior of the class during business cycles by considering these observations in conjunction with the fact that manufacturing activity as a whole moves in close conformity with business cycles.

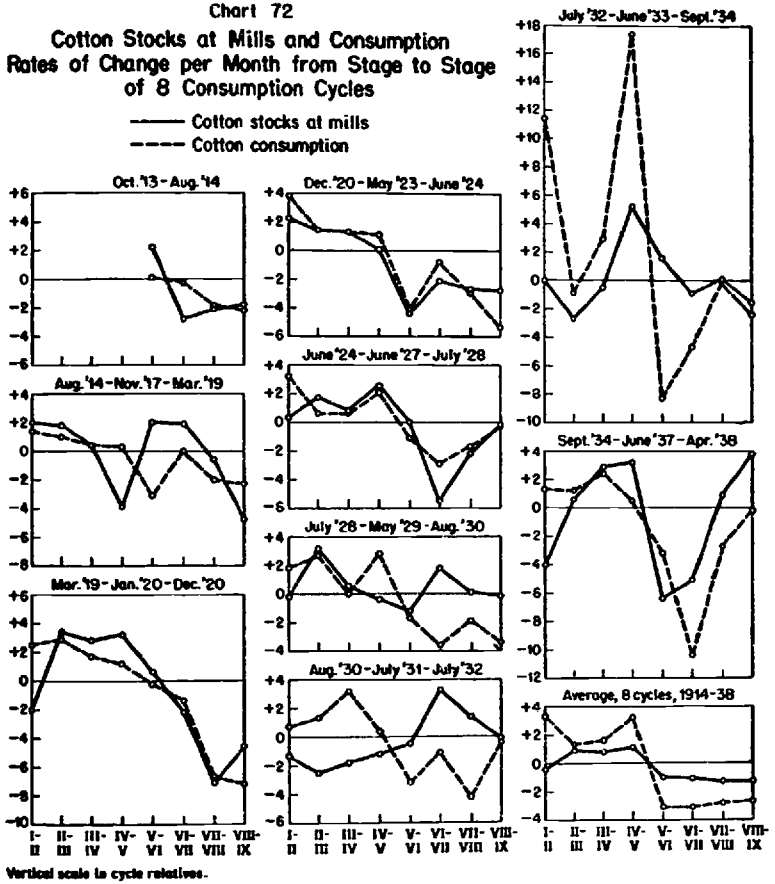
In consonance with this view, the measures used in this chapter represent the rate of change in stocks per month from stage to

stage of cycles marked off by turning points in indicators of the rate of manufacturing activity in the industries holding the stocks. As in preceding chapters, these indicators measure the consumption of the raw materials in question or are closely related to such consumption.

I begin with manufacturers' stocks of three commodities—cotton, silk, and hides—whose supplies can be adjusted rapidly to manufacturers' requirements. Charts 72-4 show the patterns of the rates of change in stocks and in raw material consumption of these commodities during individual cycles of consumption.[1] Despite

Chart 72

Cotton Stocks at Mills and Consumption
Rates of Change per Month from Stage to Stage
of 8 Consumption Cycles

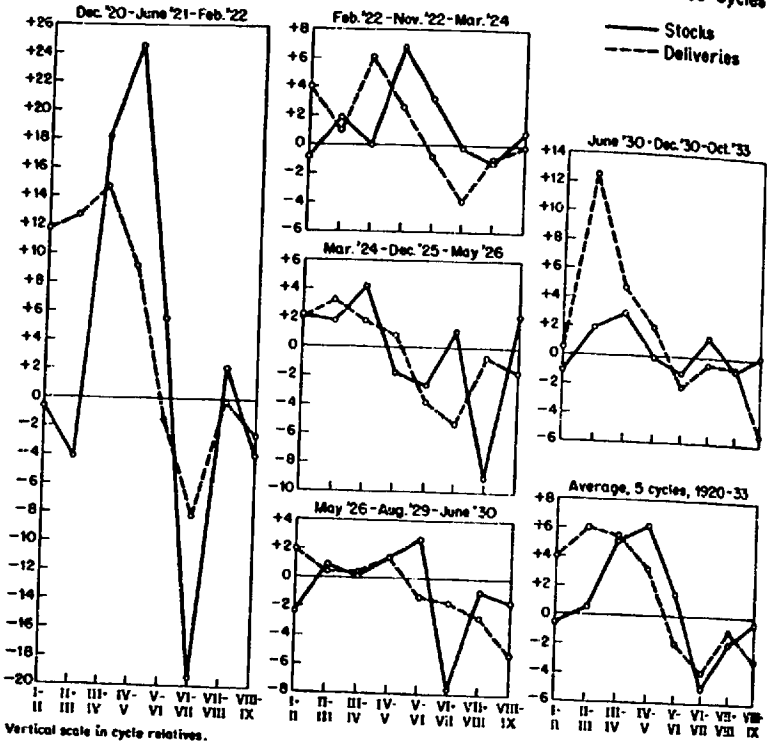


Vertical scale is cycle relatives.

[1] In the case of raw silk, consumption is represented by deliveries of silk to mills.

Chart 73

Raw Silk Stocks at Manufacturers and Deliveries to Mills
Rates of Change per Month from Stage to Stage of 5 Deliveries Cycles

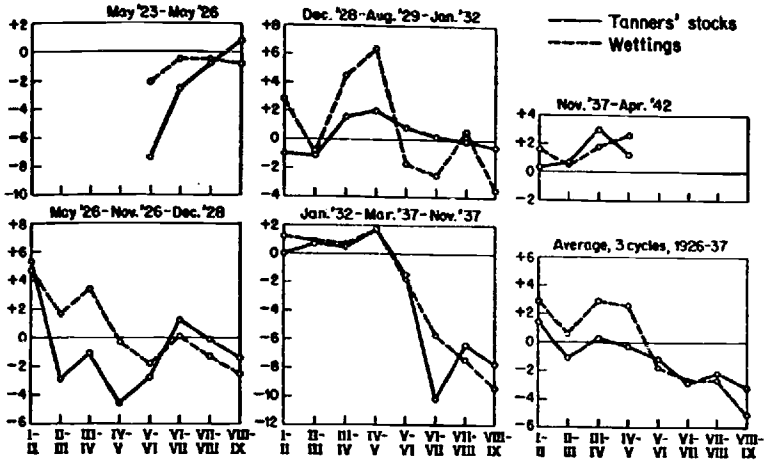


considerable independence of movement, fluctuations in the rates of change in stocks of these three commodities have been remarkably similar to those in the rates of change in manufacturing activity. This visual impression may be confirmed by counting the number of instances in which the two variables changed in the same and opposite directions (Table 76). Two commodities show a clear preponderance of agreements over disagreements: in cotton the ratio is somewhat better than 2 : 1; in hides it is somewhat better than 3 : 1. In silk, however, agreements hardly exceed disagreements.[2] For the three series together the ratio of agreements to disagreements is almost exactly 2 : 1.

[2] This negative result may be due to the fact that the comparisons were made on a synchronous basis. But that inventory cycles lag behind activity cycles, as argued in Chapter 10, suggests that the rates of change in the two series may stand in a similar time relation. This view is supported by silk. If we post-

Chart 74

Cattle Hide Stocks at Tanners and Wettings
Rates of Change per Month from Stage to Stage of 3 Wettings Cycles



Vertical scale in cycle relatives.

These measures are consistent with the idea that investment in raw materials inventories tends to conform to cycles in the rate of change in manufacturing activity. The many disagreements between the changes in the two processes presumably reflect the mistakes of individual manufacturers in forecasting short-term fluctuations in production. The preponderance of agreements reflects the degree to which errors compensate when sufficiently large aggregates are studied. If this hypothesis is valid, we should expect the relation between total investment in raw materials by all manufacturers and the rate of change in activity to be closer than it is in individual industries. In that event, the patterns of the rates of change in manufacturing output identified in Chapter 15 could be used as guides to the cyclical timing of investments in stocks of raw

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date the changes in activity by one stage interval, the direction of movement in the rates of change in the two series agree 27 times, disagree 10 times. The suggestion of a lag is not confirmed, however, by the behavior of cotton and hides. Part of the difficulty may be due to the fact that the cycle stage is an awkward interval for measuring leads or lags if these tend to be uniform for a given commodity in terms of some small number of months. Because of the inadequate data, it was not worth while to recalculate our measures to meet this difficulty.

TABLE 76

Cotton, Silk, and Hides Stocks and Manufacturing Activity
Number of Agreements and Disagreements in Direction of Movement of Rates of Change per Month during Activity Cycles

	COTTON 8 Cycles *1914-38*	SILK 5 Cycles *1920-33*	HIDES 3 Cycles *1926-37*	ALL 3 COMMODITIES
Agreements	45	21	23	89
Disagreements	20	17	7	44
Interstage intervals when the rate of change in stocks or activity remained constant	2	1	1	4
Total no. of comparisons	67	39	31	137

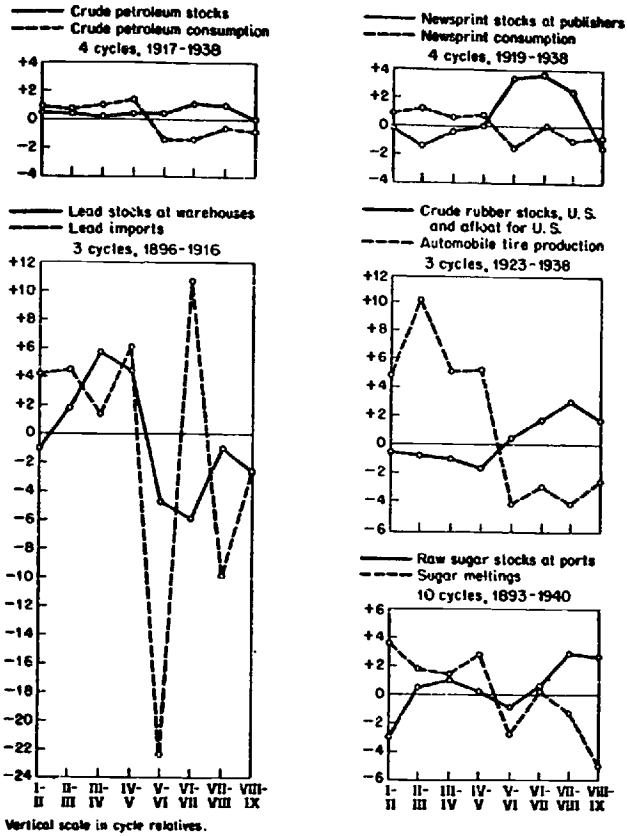
materials as they were for investments in stocks of goods in process. Even so, there are good reasons for thinking that the timing of investment in raw materials would not coincide with investment in goods in process. One reason is that the mistakes of individual manufacturers may not consist entirely of chance errors randomly distributed throughout all industries. Some may be typical mistakes characteristic of all or most manufacturers. In the analysis of cycles in stocks (Ch. 9) it was argued that manufacturers typically fail to foresee cyclical turns in their production. Since they are therefore unable to adjust orders of raw materials soon enough, their stocks continue to rise for a few months after the peak of business and to fall for some months after the trough. It is reasonable to suppose that something similar is true of the relation between investment in raw materials and the rate of change in activity.

Another reason to think that investment in raw materials may lag behind the rate of change in activity is that not all commodities share with cotton, silk, and hides the characteristic that their rate of supply to manufacturers can be altered rapidly. We have already seen what striking contrasts in the cyclical behavior of stocks can be caused by differences in the capacity of manufacturers to change the rate at which raw materials are received (Ch. 10). The cyclical behavior of the rate of investment in raw materials affords similar contrasts (Chart 75).

In cotton, silk, and hides the peak rate of investment typically occurs either in the last stage of expansion or earlier; the trough of

Chart 75

Five Examples of Stocks of Raw Materials and Associated Indicators of Manufacturing Activity, Average Rates of Change per Month from Stage to Stage of Manufacturing Activity Cycles



Vertical scale is cycle relatives.

investment (or highest rate of disinvestment), in the last stage of contraction or earlier. The five patterns in Chart 75 represent commodities whose rates of supply to manufacturers are less easily adjusted than are those of cotton, silk, or hides. The rates of change in lead stocks at warehouses alone display a cyclical pattern similar to those of cotton, silk, and hides. As explained in Chapter 10, lead may resemble the cotton-silk-hides group because warehouse stocks consist in part of metal being refined in bond for re-export. They are, therefore, more closely tied to the current rate of proc-

essing than are inventories that consist only of raw materials as defined here.[3]

Investment in stocks of crude rubber and in newsprint stocks at publishers follows a roughly opposite course. Accumulation is at a peak after the rate of activity begins to fall off, that is, during the contraction in consumption; liquidation is most rapid after activity has turned up, that is, during the expansion in consumption. Rubber stocks are liquidated most rapidly, indeed, near the peak of crude rubber consumption.

The lag of inventory investment in newsprint and crude rubber reflects the same conditions that make cycles in their stocks move inversely to the rate of consumption of materials. In the case of newsprint, the lag is due to the long-term contracts governing the purchase of this commodity, which prevent publishers from quickly adjusting their receipts to requirements. In rubber the lag is due to a combination of causes: (a) output tends to be stable in the short term, being insensitive to demand and largely unaffected by weather; (b) climate makes it impracticable to keep more than pipeline stocks in the Far East; (c) the big manufacturers are such large factors in the market that they must themselves hold a large proportion of the stock. These conditions cause the receipts of rubber by United States manufacturers to remain fairly steady in the short run. As a result, their stocks rise soon after their rate of fabrication falls off and fall soon after activity starts to recover.

These considerations do not, indeed, suffice to explain why inventory investment turns just when it does. But they do explain why the peak rate of accumulation is reached after the peak of fabrication and the peak of liquidation after the trough of fabrication. And as stated above, this lag of investment behind the turning points in manufacturing activity contrasts sharply with that observed when supply can be rapidly adjusted to requirements.

Crude petroleum is another commodity whose supply responds only sluggishly to short-term changes in demand. The pattern of inventory investment in crude oil stocks resembles those of newsprint and rubber, although the amplitude of the swings is very

[3] In the absence of direct information about the rate of lead refining, lead imports are used as an indicator. Changes in stocks are not sufficiently large, absolutely, to cause sizable divergences in movements of imports and refining.

small. But since, during the period covered, the movements of petroleum production and stocks were strongly influenced at irregular intervals by the opening of new oil fields, we do not know what persistent tendencies characterize changes in petroleum stocks.

The average pattern of investment in stocks of raw sugar at refineries is irregular, as is the movement in the rate of inventory accumulation in most cycles. In preceding chapters we have traced this irregular behavior to haphazard fluctuations in sugar crops.

Although the data are too meager to support strongly any general theory about the cyclical behavior of investment in stocks of raw materials, they have been useful in two ways. First, they suggest the possibility that, for the major portion of raw materials whose rates of supply are easily controlled by manufacturers, the rate of investment in stocks may conform positively to movements in the rate of change in manufacturing activity. Apparently, the tendency in this direction was sufficiently strong to leave its mark on data that combine the experience of all manufacturers holding a given commodity despite difficulties which, it is reasonable to think, prevent individual manufacturers from keeping stocks continuously in line with their rate of fabrication. This, in any event, is the showing of the three commodities in this class for which we have figures: cotton, silk, and hides. If additional data confirm these results, we may expect a still closer relation to emerge from the experience of all manufacturers. However, the positive conformity of investment in stocks of raw materials to movements in the rate of change in activity does not necessarily imply synchronous timing. For reasons developed above, inventory investment may well lag behind the rate of change in activity even when the supply of materials is easily controlled.

There is another reason to suspect that inventory investment in raw materials tends to lag behind the rate of change in output. Not all commodities held as raw materials are supplied under conditions that allow manufacturers quickly to adjust their rate of receipt. When manufacturers operate under such difficulties, investment in raw materials tends to lag far behind rates of change in activity, so far indeed that accumulation is highest during business contraction and liquidation highest during expansion.