Volume Title: The Role of Inventories in Business Cyles

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investment, which I have described loosely as turning 'near' the peaks and troughs of business, may not actually lead by a short interval and thus constitute one of the forces that together turn the business tide; (2) to explain the lag in the volume of inventories behind output and the lag in inventory investment behind the rate of change in output. A valid explanation, when attained, will be of great value. It will help provide a basis for more satisfactory predictive models, and it will furnish insight into conundrums such as the division of inventory changes into 'intended' and 'unintended' elements, without which an adequate statement concerning the role of stocks in business cycles is impossible. This paper is offered as a contribution to the second of these problems.

It is my conviction that progress toward an understanding of the cyclical behavior of stocks has been blocked chiefly by the fact that inventories have generally been treated as a homogeneous mass within which differences in behavior are not significant and to all parts of which much the same explanation is appropriate. True, one sometimes finds gross and inadequate distinctions, such as between finished and unfinished goods, or categories with nonoperational definitions such as Keynes' "working capital" and "liquid capital". By contrast, I believe that a sound explanation of the behavior of stocks can be reached only when fairly numerous categories are distinguished, and I propose to support this view by analyzing the large block of stocks—about 40 percent of the total—that is held by manufacturers.

II

The various classes of stocks held by manufacturers differ from one another with respect both to the motives that control inventory policy and to the ability of manufacturers to implement their policies promptly and completely. As a result the cyclical behavior of these classes of stocks differs materially, and the behavior of manufacturers' stocks in the aggregate is to be understood as simply the composite of the disparate fluctuations of the various parts.

To demonstrate this, manufacturers' stocks must be divided into at least three major categories: (1) raw materials, (2) goods in process and (3) finished goods. I define these categories from the standpoint of the manufacturer who owns the goods, not from that of the stage of fabrication. Thus any materials or supplies purchased by a manufacturer and not yet employed in the process of fabrication in his plant constitute raw materials, however much they may have been fabricated at earlier stages. Goods in process consist of commodities the manufacturer has begun to manipulate, but that are not yet in the condition in which they are usually sold by him. Finished goods are commodities a manufacturer is ready to sell either to distributors or consumers or to other manufacturers for further fabrication. Within these major groups still other categories must be distinguished. My analysis will run in terms of the cyclical fluctuations in the *volume* of inventories rather than in terms of cycles of inventory investment.

Of the three major categories, goods in process—comprising about 20 percent of all manufacturers' stocks—are the category whose behavior can most confidently be determined *a priori*. This is fortunate, for data on goods in process are all but nonexistent. The relation of this group of stocks to output can be stated categorically if confined to manufacturers whose activities approximate a single-stage or continuous operation—probably about half the total. In their plants, technical factors fix the relation between output and goods in process. If a small lead of goods in process over output is allowed for, direct and proportional variation must be the rule.

Goods in process in industries that combine several discontinuous stages or operations are not bound to output by rigid technical necessity. There is reason to believe, however, that in these industries, too, goods in process and output move in generally similar cycles. First, the goods being processed at each individual stage of a multistage operation must vary with the activity of that stage according to the rule applying to continuous-process industries. Secondly, while goods 'between stages' may, if manufacturers so desire, be allowed to lag behind output or even to vary inversely, the consequent accumulation

of partly processed goods is, in many situations, of no advantage or positively disadvantageous. In such situations, manufacturers avoid the accumulation of surplus stocks of semifabricated goods, and materials flow from stage to stage in much the same fashion as they do through single stages.

The conclusions valid for continuous-process industries are, therefore, applicable in qualified form to goods in process in the aggregate. It is probably safe to say that total stocks of goods in process rise and fall together with output, that their movements are roughly proportional to those of output, and that they tend to reach their cyclical peaks and troughs at about the same time as output.

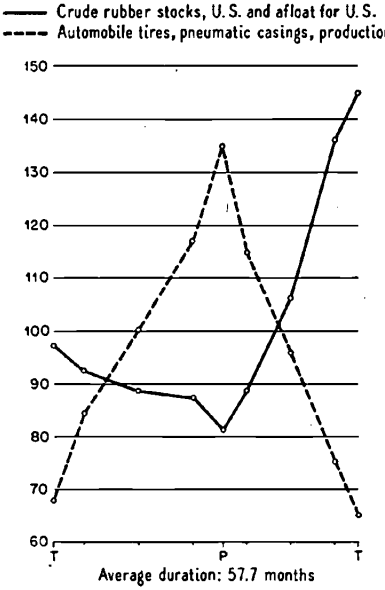
Turning to raw materials, which normally constitute about 40 percent of manufacturers' stocks, I shall develop my views by considering four examples of commodities supplied to manufacturers under different conditions: raw silk, crude rubber, newsprint and raw sugar, each a basic staple. The statistics for these commodities consist entirely of data in physical units. By means of average cyclical patterns, Chart 1 illustrates the behavior of stocks of these commodities in the hands of manufacturers during cycles in the rate at which each commodity is processed. Such cycles are marked off by the cyclical peaks and troughs of automobile tire prodution in the case of rubber, of silk deliveries in the case of silk, of newsprint consumption in the case of newsprint and of sugar meltings in the case of sugar. The National Bureau method of calculating cyclical patterns is described in the Appendix Note. At this point it is enough to know that the patterns purport to represent the typical standings of these commodity stocks at various stages of cycles in the fabrication of these goods, and except for sugar, as I shall explain, they do so quite adequately. For purposes of comparison, the chart shows also the average cycle patterns of the various indicators of the rate of raw material processing mentioned above.

The patterns of the four inventory series are markedly dissimilar. Raw silk stocks move up and down with the rate of silk deliveries but stocks lag by a short interval. Newsprint stocks, on the contrary, fall when newsprint consumption rises,

CHART 1

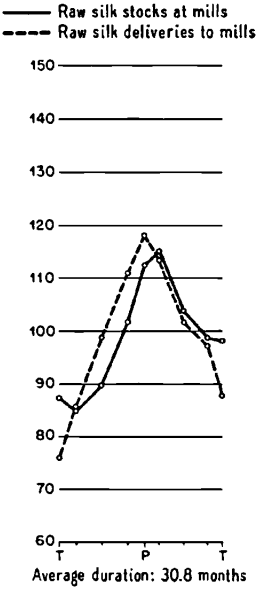
Stocks of Raw Materials
Average Cyclical Patterns during Cycles in Manufacturing Activity

FIG. 1
Crude Rubber
3 Cycles, 1923-1938



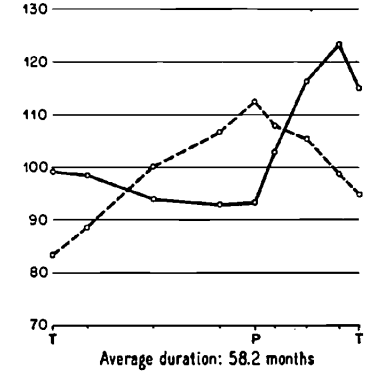
Average duration: 57.7 months

FIG. 2
Raw Silk
5 Cycles, 1920-1933



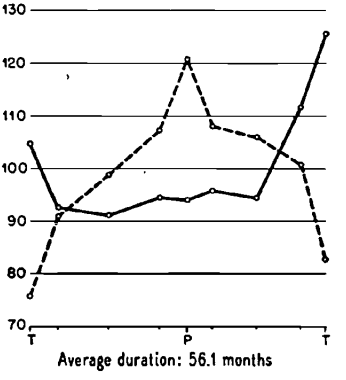
Average duration: 30.8 months

FIG. 3
Newsprint
4 Cycles, 1919-1938



Average duration: 58.2 months

FIG. 4
Raw Sugar
10 Cycles, 1893-1940



Average duration: 56.1 months

but there is some evidence of an upturn at the very end of expansion. Again, when consumption falls, stocks rise during most of the contraction, but begin to fall in the last stage. One can, if one wishes, think of this as a very long lag. The other two commodities display still other patterns. Rubber stocks typically vary inversely with rubber consumption, while the *average* pattern of raw sugar stocks moves inversely with activity at the beginning of expansion and at the end of contraction, but otherwise shows little response to fluctuations in sugar refining.

These differences may, at first sight, seem surprising, but I believe their explanation goes far to suggest a theory about the movements of manufacturers' stocks of raw materials as a whole. To begin with crude rubber held by United States manufacturers: the inverse behavior of these stocks is about as unlike the usual expectation concerning the behavior of inventories during business cycles as is possible. The reasons are simple. (1) The output of crude rubber on plantations is fairly stable in the short run. It is little affected by weather conditions, and it responds very sluggishly to changes in demand because the price must sink very far before it becomes worth while to suspend the tapping of mature trees and to disperse plantation labor forces. (2) Crude rubber deteriorates if kept long in the tropics. Hence only pipe line stocks are maintained in the Far East. (3) The few large automobile tire manufacturers in the United States are the world's chief consumers of rubber. They cannot, in any short period, radically alter the share of the total output they normally buy without causing enormous changes in price. Hence, something like a constant fraction of the total output flows to United States manufacturers steadily. (4) Cyclical fluctuations in the demand for crude rubber for automobile tires are relatively large. When demand increases, therefore, stocks in manufacturers' hands soon begin to fall. When demand declines, stocks rise.

Contrast this situation with that affecting mill stocks of raw silk. If a short lag is allowed for, these stocks have typically grown and declined together with manufacturing activity. Whence the difference between silk and rubber? As in the

case of rubber, the output of raw silk is fairly steady and responds very sluggishly to changes in demand. Like rubber, silk is grown in the Far East and must make a long journey to the United States, the principal consuming area. Also, silk consumption fluctuates much more widely than the supply of raw silk. There is one crucial difference. In the case of rubber, manufacturers have been the chief holders of the crude material; their inventories, therefore, absorb the effect of disparities between the current rate of output of rubber and its current rate of utilization. In the case of silk, dealers' stocks in both this country and Japan serve as buffers between the producers of silk and the manufacturers who consume it. Manufacturers in this country can quickly obtain additional supplies by drawing on domestic warehouse stocks, and current supply, if not immediately required, tends to pile up in the hands of dealers. Thus manufacturers can quickly adjust their stocks as they desire. In such circumstances, their holdings tend to follow the rate of fabrication with a short lag. This rule is confirmed by the behavior of other commodities when manufacturers are able quickly to make large changes in the rate at which they receive supplies.

Newsprint and sugar stocks illustrate the effect of still other conditions of supply. Publishers' stocks of newsprint have a long lag or inverse pattern because newsprint is bought on long-term contracts, and the rate of delivery of paper to each publisher is usually set only once a year. The inverted average pattern of sugar stocks conceals their erratic fluctuations during individual cycles in meltings. These erratic movements reflect the similarly erratic movements of sugar crops, for which United States refineries are a major market.

These examples, supported by others of the same sort, suggest a general theory about cyclical fluctuations in stocks of raw materials which may be stated in the following terms: 1) If manufacturers had perfect control over their stocks of raw materials, they would increase and reduce their holdings with fluctuations in their output. Manufacturers would follow this course for several reasons. To begin with, stocks of raw materials have a pipe-line function. They include goods in

transit to the manufacturer's plant when delivery is taken at the shipping point. And they include all goods arriving at a plant, being unpacked, sorted, checked, and passed through the establishment's distributing system to the processing shops. Moreover, a manufacturer needs a reserve of materials, the size depending upon his rate of activity, to ensure continuous operation against irregularities in the arrival of supplies and to meet promptly any likely near-future expansion of sales.

Whether manufacturers try to maintain a constant ratio of stocks to output is not clear. Conceivably, when their rate of activity is high, they can operate with fewer weeks' supply on hand because more categories of materials are then moving steadily into production. Fear of delays in the arrival of supplies and of price rises near the peak of business, however, work in the other direction and tend to induce manufacturers to keep a larger stock than usual for the volume of business. From the data now available we cannot determine whether the ratio of raw materials inventories to output typically remains constant. But I regard the generalization that stocks of raw materials typically move in the same direction as manufacturing activity to accord well with the facts when manufacturers are able quickly to alter the rate at which they receive supplies. This tendency is, I think, well illustrated by raw silk stocks. 2) Even under the best conditions—the case of silk is again a good illustration—the rate of raw material receipts cannot be adjusted instantaneously to the rate of consumption. Though supplies may be procured from dealers in this country or from other manufacturers in a position to fill orders from stock, days, perhaps weeks, are required to pack and ship the goods. The interval presumably depends chiefly on the backlog of orders, the means and availability of transport, and the distance. If the goods must be made to order—the normal situation for some types of goods—the interval between order and arrival is stretched several weeks, sometimes longer, depending on the length of the production period and the promptness with which a supplier can attend to a particular order.

Unless manufacturers anticipate cyclical turns in their rate of activity accurately and act promptly, therefore, a few days

to a couple of months may elapse between, say, a downturn in their output and a consequent diminution in the rate at which they receive raw materials. Meanwhile stocks will continue to accumulate. This lag will be lengthened by whatever period intervenes between a curtailment of output and the time a manufacturer takes cognizance of it by reducing his rate of purchases. And the lag will be further lengthened unless the new rate of purchases is below the rate to which consumption may have fallen by the time the newly ordered goods begin to arrive. Thus a lag of several months is reasonable even when no special obstacles to an adjustment of supplies to requirements are present. In the case of raw silk, for example, where manufacturers draw their supplies from dealers in the same section of the country, the lag of stocks at cyclical turns in the rate of silk deliveries has been about two months. Presumably, it is somewhat longer in the stocks of other goods.

This expectation, that cycles in inventories conform positively with a lag to cycles in output, is valid, I think, for the bulk of raw materials stocks. An analysis of Census data shows that about two-thirds of all the raw materials used by United States manufacturers are the products of mines or of other manufacturers in this country. As far as this portion of their supplies goes, manufacturers are in a position to buy from stock or from suppliers who can rapidly adjust output to demand and who can ship goods in the main by rail or motor transport. To this class of goods we should add both raw materials that are the products of United States agriculture and imports, as long as manufacturers procure their supplies from domestic dealers who hold considerable stocks.

Even after making some allowance for goods bought on long-term contract, as in the case of newsprint, I think the proportion of raw materials whose supply can be rapidly—not immediately—adjusted to requirements does not fall far short of 75 percent. For this class of goods, as stated, I think we can expect stocks of raw materals to follow manufacturing activity with a short lag, say, of two to four months.

3) When manufacturers encounter special obstacles in adjusting their supplies to requirements the lag is longer. About

10 percent of the supplies used by United States manufacturers are imported. The part procured from domestic dealers rather than directly from abroad creates no special problem, provided the dealers carry ample stocks. For the remainder, however, a long interval must elapse between a manufacturer's decision to purchase and the arrival of the goods at his plant. We must expect stocks of such goods to lag by a much longer interval than do stocks of goods procured from domestic sources. The same will be true of goods bought on long-term contract, the quantity of which is unknown. The two groups together may account for some 10 percent of raw materials stocks and the effect of their behavior is to lengthen the lag that characterizes raw materials stocks as a whole.

4) A final class of goods in which adjustments are difficult are the products of agriculture, where supply, controlled largely by natural conditions, is virtually independent of short-run changes in demand. Over 20 percent of manufacturers' raw materials come from such sources. In many, perhaps most, cases wholesalers, not manufacturers, hold most of the stocks and absorb the haphazard effects of fluctuations in agricultural output. When manufacturers are the chief holders, however, their inventories of raw materials tend to fluctuate in random fashion during business cycles, injecting an element of irregularity into the behavior of the category as a whole.

We have now reviewed two major divisions of manufacturers' stocks: goods in process, about 20 percent of the total, which vary directly and in rough proportion with manufacturing activity; and raw materials, about 40 percent of the total, which, in the aggregate, probably lag behind activity by three or four months, or perhaps more. I turn now to the third major division—finished goods. These are the goods ready for shipment to purchasers whether for final use, for distribution, or for further fabrication. They ordinarily make up about 40 percent of all manufacturers' stocks.

Here again some distinctions are necessary. The primary division is between goods made to order and goods made to stock. Next, goods made to stock must be divided between goods

whose output in the short run responds mainly to impulses from the side of demand and those whose output responds mainly to impulses from the side of supply. For purposes of statistical verification, one may identify these two classes (not wholly satisfactorily) with goods made from nonagricultural raw materials and those made from agricultural raw materials. Finally, goods made from nonagricultural raw materials should be divided into durable staples and perishables. Of these several groups, the behavior of all except perishables is illustrated in Chart 2. Here again the statistics consist of data recorded in physical units.

As far as goods made to order are concerned, it is easy to predict that finished stocks will rise and fall with production or shipments. Finished goods made to order are, in fact, simply the goods in the pipe line between production at one end and delivery at the other. When manufacturing activity is higher, there will be more goods in this pipe line; when it is lower, the pipe line will be less well filled.[6] The importance of the group cannot be fixed precisely, but some rough estimates suggest that it accounts for 15 to 20 percent of all finished goods or perhaps 6 to 8 percent of all manufacturers' stocks. An example of the behavior of goods in this group is provided in Chart 2, Figure 1, where inventories of steel sheets made to order are compared with inventories of such goods made to stock. The contrast is striking. The inventories of goods made to order rise and fall with shipments, as we expect; the inventories of goods made to stock vary inversely.

Figure 2 indicates that this inverse behavior of finished goods made to stock is characteristic of staples made from non-

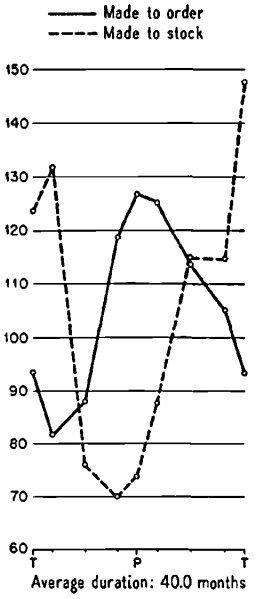
[6] This is not to say that the movements of stocks of goods made to order will always tend to be strictly proportional to the movements of output and shipments. Mr. P. H. Brundage suggests that when demand is high, goods tend to be shipped more promptly in order to satisfy the needs of customers. When business falls off, orders may be canceled or goods may be billed when finished but actual delivery delayed at the purchaser's request. These considerations suggest that the ratio of stocks to output may be lower than usual near the end of expansion and rise immediately after the turn of business. They suggest also the possibility that the turn of stocks may actually lag behind output and shipments at peaks. On the same line of argument, one would expect stocks of goods made to order to be somewhat high for the volume of business towards the end of contraction and lower after the upturn.

CHART 2

Stocks of Finished Goods
Average Cyclical Patterns

FIG. 1

Steel Sheet Stocks During 4 Cycles in Shipments
1919 – 1932



Average duration: 40.0 months

FIG. 2

Finished Staples Made from Nonagricultural Raw Materials
17 Commodities

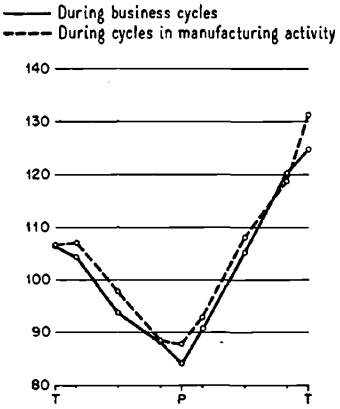
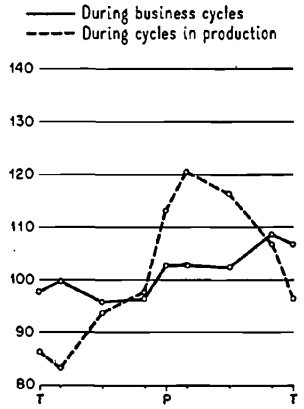


FIG. 3

Finished Staples Made from Agricultural Raw Materials
9 Commodities



agricultural raw materials.[7] I have estimated that such staple finished goods produced from nonagricultural raw materials and normally made to stock account for about half of finished goods inventories and, consequently, for about one-fifth of all manufacturers' stocks. Records for this category are fairly plentiful, and whether we observe the fluctuations in such stocks during cycles in manufacturing activity in the industries holding the stocks or during cycles of business at large, their pattern is clearly inverse. Consequently, the fluctuations of this group of stocks, which continue to rise during contractions after goods in process and raw materials have begun to fall and continue to fall during expansions after the other two divisions have begun to rise, must contribute materially to the over-all lag observed in total manufacturers' inventories.

These behavior characteristics are clear, but their explanation is elusive. Production and shipments data for goods of this type reveal what one would expect: a close connection between rates of production and of shipments, reflecting the rapid adjustment manufacturing industries that do not depend upon agriculture for supplies can make to changes in demand. The cyclical turns in production, to be sure, tend to lag behind those in shipments by a short interval. This lag probably stems from two conditions. The first is uncertainty about the trend of demand near cyclical turns. When sales and shipments turn down, for example, it is hard to tell, for a time, whether the downturn represents the beginning of a period of contraction or simply a transient reversal of an uptrend to be followed within a few weeks by a renewed surge of orders. It is natural, therefore, to delay curtailing manufacturing operations for a short time. A second cause of the lag is the time consumed in fabrication. Even after a manufacturer reduces the input of materials into the process of fabrication, some weeks must pass, on the average, before the output of finished goods begins to fall. Failure to forecast turns in demand thus helps to account for the fact that stocks tend to rise at the

[7] The 17 commodities whose cyclical behavior is summarized in Figure 2 include merchant pig iron, lead, slab zinc, steel sheets, refined copper, newsprint, gasoline, paper (all grades), portland cement, oak flooring, southern pine lumber, lubricants, automobile tires, inner tubes, kitchen sinks, bath tubs and lavatories.

beginning of contraction and to fall at the beginning of expansion. But questions still remain. After demand has been falling and stocks have accumulated for some months, why is production not curtailed sufficiently to bring output below shipments? Why are stocks allowed to continue to accumulate? These same questions apply to expansions when stocks continue to decline for many months after demand has turned up.

I suggest the following answer with some diffidence. While manufacturers are willing to cut their purchases of raw materials drastically when surplus stocks begin to accumulate, since the burden of such cuts falls on their suppliers, they are reluctant to alter the operations of their own plants radically. For this there are two reasons. One is that in view of the perennial uncertainty surrounding the business future, manufacturers wish to minimize the costs involved in changing their rate of operations, of which the chief is probably the cost of dispersing large numbers of workers who may have to be reassembled in the not distant future. A second, less rational, reason is the dislike, often expressed by business men, of spreading overhead costs over a smaller output. In consequence, manufacturers seem content to adjust their rates of production tardily and incompletely to changes in shipments and to resign themselves to the resulting accumulation of stocks of finished goods. This hypothesis, in my view, reasonably accounts for the difference between the short lag of raw material stocks and the inverse behavior of durable, staple finished goods made from nonagricultural commodities.

Several limitations on this statement, however, are of great importance. First, it applies to durable staples alone. Manufacturers of goods that may lose value rapidly, either because of physical deterioration or change in style, can hardly afford to accumulate any considerable stock. Hence, though data are not available, we should not expect the minor inventory category of perishable goods made for the market to vary inversely with output. Accumulations of staples, however, are relatively safe. Producers of such goods can, therefore, tolerate a policy of tardy and inadequate adjustments of output to changes in demand.

A second point is that even in the case of staple goods, accumulation of stocks cannot go on indefinitely. Let a contraction last long enough, say more than two years, and a substantial number of such stocks begins to turn down. Let the contraction last three years and the number that begins to decline becomes a substantial majority. A classification of the behavior of these stocks by the duration of the contraction phase in manufacturing activity shows that the tendency for stocks to begin to decline before production has reached its trough mounts steadily with the length of the phase. In short, let the contraction be long enough, let stocks pile up high enough, and output will be cut drastically. The longer the contraction the stronger is this tendency. With appropriate changes of wording, the like is true of expansions.

Finally, these observations apply only to commodities whose output responds, in the short run, chiefly to impulses from the side of demand. The opposite case, commodities whose output in the short run responds chiefly to changes in the supply of raw materials, is illustrated by the composite patterns of Chart 2, Figure 3.[8] These stocks of fabricated commodities made from agricultural raw materials rise and fall with output in their industries although stocks lag behind output by a short interval, on the average. This behavior is unlike that of the nonagricultural staples, which vary inversely with output in their industries. During business cycles, the stocks of fabricated farm products behave irregularly—again in contrast to nonfarm products, which fluctuate inversely during business cycles.

The explanation is simple. Some—not all—farm products cannot be stored economically in crude form, either because they would deteriorate or because they are too bulky. For them, increased output of the crude material causes the output of the fabricated product to rise. Since the rise in production has been stimulated by an augmented supply of crude materials, not by an increase in demand, output soon outruns consumption. Hence stocks of finished goods rise with output

[8] The 9 commodities whose cyclical behavior is summarized in Figure 3 include linseed oil, inedible tallow, crude cottonseed oil, refined cottonseed oil, shortenings, evaporated milk and cold storage holdings of pork, lard and beef and veal.

after an interval long enough to allow output to overtake and exceed consumption. But since changes in the supply of agricultural raw materials, which in this case are the governors of the entire process, are usually not correlated with the state of business, stocks of finished goods made from such materials behave irregularly during business cycles.

III

By way of conclusion, I should like to develop very briefly a few implications of these observations and of the theory of inventory fluctuations to which they point.

As already stated, the total stocks of business men can be divided into numerous significant categories. The cyclical behavior of these categories reflects differences in the motives behind inventory policy and in the ability of business men—for reasons of technique, market organization, or contractual arrangements—to implement their policies. The validity of this view is, I think, demonstrated in the case of manufacturers' stocks. Here the observed lag of total inventories behind output is to be explained as the net resultant of the disparate behavior of at least seven classes of stocks: (1) goods in process, which vary together with output; (2) raw materials purchased from domestic manufacturers or dealers, which lag by, say, two or three months; (3) raw materials purchased from distant sources or on long-term contracts, which lag behind output by many months; (4) finished goods made to order which, like goods in process, are closely tied to output; (5) perishable finished goods sold from stock, which probably lag behind output by a few months; (6) staple finished goods made to stock, which vary inversely with output in short cycle phases and positively with a long lag in long phases; (7) agricultural raw materials and finished goods made from such materials, which, under certain conditions, inject an irregular element into the movements of manufacturers' stocks.

The need to distinguish numerous classes of stocks, moreover, is not confined to manufacturers' inventories. Aggregate inventories of wholesalers and retailers also appear to have