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INFORMATION, EXPECTATIONS, AND INVENTORY FLUCTUATION

A Study of Materials Stock on Hand and on Order

Overview and Summary

The stubborn curiosity that motivates the hard labor of empirical investigation is likely to be based on a hunch about what, in a complex process, is important and what less so. This study is no exception. The thought that gave rise to it is that the size of inventory holdings and how they change is more significantly influenced by considerations other than the expected volume of sales than is generally supposed. Because of the character and extent of these influences, new concepts are required to encompass them.

Of course, such ideas are not visions flashed on a pink cloud. My study of the shoe, leather, hide sequence [1] left a legacy of preoccupation with the impact on purchasing in general, and on inventories in particular, of expectations about market conditions and about changes in other costs and the assurance with which these expectations are held. Indeed, the efforts to explain how fluctuation moves from shoes, to leather, to hides, and back again were partly flouted by the inability to picture the flows of information and of the resultant expectations which were counterpoint to, and largely cause of, the flows of output and employment.

The study attempts to come to grips with these elusive problems by viewing materials stocks on order (outstanding purchase orders) along with those on hand. When possible it examines these stocks in the light of the orders that companies receive for their own products and the shipments they make, as well as in the light of the orders they place with their suppliers which are eventually shipped to their plants.

The book is complicated as well as long. The reader therefore requires a map of the terrain to be traveled before setting out on the trip. This chapter attempts the cartographic product and it will of necessity leave much to be desired. I have worked with concepts that are unfamiliar and data that are clumsy. The argument is difficult and a summary of it is likely to float uncomfortably on the reader's mind until the pieces out of which it is built have had a chance to soak in. Nevertheless, it will be useful to know at least the subjects to be dealt with and why. I shall mainly, though not necessarily, follow the chapter sequences.

Part I of the book consists of three chapters which set the stage for the subsequent examination of time series.

A brief review in Chapter 1 of empirical work with inventory models yields no cause for complacency. Quite the contrary. The statistical representations fail to show a relationship of stocks to sales which is forceful and prompt enough to accord with the notion that businessmen are chiefly concerned with keeping stocks aligned with sales. When new orders or changes in unfilled orders are introduced, they tend to steal the show, though just why is not adequately explained.

BUSINESS FUNCTION THAT STOCKS SERVE

The unsatisfactory character of these explanations sends me back to the business firm

[1] *Consumption and Business Fluctuations: A Case Study of the Shoe, Leather, Hide Sequence,* New York, National Bureau of Economic Research, 1956.

in Chapter 2. What does managerial economics and a desultory group of discussions with businessmen indicate about the function that stocks serve? They indicate, first, that many of the functions are performed by materials or merchandise stocks on order as well as by those on hand. Besides, the chief action that controls the size of stock on hand is that of placing an order, and this necessarily likewise controls the size of stock on order. Indeed, it is the act of ordering to which managerial rules for stock management direct their attention. In consequence, the sum of materials both on hand and on order, an aggregate which I call "materials ownership," better reflects the intentions of firms than does stock on hand alone. Accordingly, for many purposes it is essential to think in terms of ownership; for other purposes each part needs separate consideration.

Understanding of how materials stocks are likely to vary during business fluctuations must be built up by detailing the several functions that stocks serve and determining for each the influences that prescribe their appropriate size.

SIX MAJOR FUNCTIONS OF STOCKS ARE IDENTIFIED

1. The first is the obvious and unique function of stocks, that of sustaining time-consuming economic processes. Assume that any process, when performed with usual efficiency, requires a stipulated time to complete, and that process-time stocks maintain the flow of goods over this period. Then, if the flow increases because of larger sales, stocks must increase proportionately (except when overtime or multi-shift operation permits a more intensive use of the twenty-four hours of the day, and, therefore also, of stocks).

The other five functions involve the use of stocks as one of the many ways of serving some business objective. Each of the alternative ways of serving the same purpose has a cost; the output of a dollar of such costs constitutes the opportunity cost of a dollar spent on stocks. Exhibit 1 displays a wide variety of the alternatives. How stocks vary during fluctuations in general business depends, then, not only on how stocks need to vary with changing sales (and how sales change during business cycles) but also on how the opportunity costs of stocks behave during business fluctuations.

Three of these further functions that stocks serve are:

2. Providing efficient production and purchasing lot-sizes.

3. Insurance against losing sales because of unpredictable variation in demand or other flows.

4. Smoothing operations by provision for more or less foreseeable fluctuations, such as seasonal change. Assuming that the costs of stocks and of alternatives, such as providing flexibility in processing or selling, are unchanged, stocks serving these functions need to vary substantially less than proportionately to sales. Indeed, for functions 2 and 3, stocks should change more nearly in relation to the square root of sales than to sales proper.

Neither the cost of carrying stocks nor other business costs are likely to be constant during fluctuations in sales or in general business. As the functions are examined, it seems highly probable that many stock-carrying costs per unit will undergo relative declines during prosperity. But several alternative ways of meeting variable sales, notably by flexible production schedules and overtime work, are likely to be subject to rising costs during prosperity. If so, the opportunity costs of stock fall in prosperous times both because the cost of stocks declines and because the costs of alternative ways of meeting the same management need rise.

Two further functions that stock serves are:

5. Making it possible to grasp the potential advantage (or avoid the disadvantage) of actual or expected changes in conditions in markets in which manufacturers buy materials or retailers buy merchandise. In prosperity these changes can take the form of longer lead time, poorer selections, more uncertainty about delivery dates, and rising materials

prices. This set of factors has a strong positive relationship to business conditions. Changes in stocks on order, rather than in stocks on hand, are the first line of defense against them.

6. Providing elective freedom from the tyranny of planning for uncertain events. Some uncertain events are best handled by simply providing a stock reservoir large enough to take care of them, whatever they may turn out to be. Stocks serving this function tend to rise when sales fall and vice versa. Other uncertain events cause unintended change in stock which needs to be reversed as soon as discovered. How stock of this sort relates to sales depends on forecasting and purchasing procedures such as those discussed later on.

When these observations concerning the functions of stock and the association of stocks with sales are consolidated, it becomes clear that stocks as a whole need to vary less than proportionately to sales, other things the same: of all the functions, only that of covering process time (and that not always) implies that a constant average ratio is required.

However, other things that appear to be relevant are not at all likely to remain the same during changes in business activities. Clearly, then, investigation must be sensitive to searching out how these other things do in fact change—other things such as the cost of carrying stock, the cost of accommodating unforeseen fluctuation in sales by flexible production, the opportunities for obtaining materials swiftly, surely, and at an advantageous price, and so on.

The analysis also suggests the variety of impacts that orders have on the purchasing and stock-carrying functions. Viewed from the vantage point of a particular firm, new orders for the product the company sells (here termed sales orders) can help to forecast shipment schedules and thus minimize unintended stock; outstanding sales orders reduce risk in purchasing and therefore the cost of carrying stocks. Outstanding purchase orders for materials are a type of secondary stock of materials; new purchase orders convey information about total demand—demand for a company's sales plus change in stocks and materials outstanding—to the next earlier stage of production. Certainly empirical study of stocks and procurement problems must be structured so as not to confuse these diverse meanings.

A further group of implications lies dormant until the last chapter, where it is pressed into heavy service: the variety of functions that stocks serve and the variety of factors that influence their relative cost imply that sensitivity to any one factor will vary widely among different inventory goods, firms in an industry, or different industries. The resulting frequency distribution of firms with respect to sensitivity to any one factor that influences stock can have important implications concerning the process of economic change.

ANALYSIS OF AGGREGATES

These insights, based on analysis of the functions of stock viewed from within the firm, must be put to work at the level of aggregate analysis—the only level of investigation attempted in this book. Chapter 3 develops standards for statistics on ownership capable of throwing light on the vertical transmission of fluctuation in aggregate data. An illustrative table, Exhibit 2, diagrams the relation between sales orders, purchase orders, and outstanding orders of both varieties for the economy as a whole. It shows how the meaning of a given change in stock in the economy is altered by whether changes in outstanding purchase orders for several vertical steps are positive or negative.

As for the empirical materials available for study, only two areas of the economy can be represented. The first covers large department stores. For these, information on sales, stocks, outstanding purchase orders for merchandise, and receipts of and new orders for merchandise are all available. They conform to the conceptual requirements and are used for 1946 through 1963, at which time the data were discontinued.

The second set of statistics pertains to durable goods manufacturers. They are the book-value data for shipments, orders, and stocks formerly assembled by the Office of Business Economics and presently by the Bureau of the Census. Since all information for manufacturers' new orders refers to sales orders, the matching information for purchase orders (and consequently for materials outstanding), which ought to be for the same firms that submit the other information, must in fact be pieced together on the basis of sales orders for industries which presumably make the materials that other durable goods manufacturers buy. The unfilled sales orders of these materials manufacturers are, then, roughly, the outstanding purchase orders for materials of all durable goods manufacturers. By these devices, we tack together information for materials stocks on hand and on order for durable goods manufacturers and associate them with imperfectly matching information on sales orders, unfilled sales orders, and purchase orders. These figures, though very shaky with respect to absolute magnitudes, seem adequate for showing the basic patterns of changes in stocks. In any event, they are all that we have and I believe a useful tool at least for exposing a process. What, then, do the figures show?

The question is pursued in the context of two broad subjects: first, the dynamics of the inventory cycle itself; second, the participation of stocks and materials purchasing in economic fluctuation, particularly in its vertical transmission.

As always, when tools are poor, work is arduous and roundabout, and the description of it difficult to write and to read. All these miseries are unavoidable, and it is unhealthy to dwell upon them having once chosen to proceed. Part II of the book reports on how stocks and purchasing behave. Part III seeks to explain behavior, examine interrelationships with the economy at large, and consider some implications. Part of this search ventures at the periphery of what the actual data warrant. However, I make no apologies for my inability to resist the seduction of the dimly seen; if the hard-won glimpses prove of interest, further study can contrive to sharpen outlines.

EMPIRICAL DESCRIPTION OF MATERIALS STOCKS ON HAND AND ON ORDER [2]

The investigation of statistical data follows a standard form. All data were corrected for seasonal variation. Rates of change were calculated as five-month centered moving averages of month-to-month change. Specific cycles were marked on all series according to the usual National Bureau methods. Occasionally additional lesser movements seemed worth including in timing measures, and these specific subcycles were separately identified.

Amplitude measures follow, with slight variation, the standard National Bureau procedures. Timing measures compare specific cycles with matching business cycle reference dates, and, in addition, with these dates plus two additional minor movements in 1947 and 1951–52. Timing measures also compare specific cycles plus minor cycles in one series with those in another. Average timing characteristics are developed. Judgments about concurrence are based on the number of matching turns, average deviation, and the percentage of all months (1946 to 1961), during which the series compared were in like specific subcycle or cycle phase. For further details, examine Table 1 in Chapter 4.

Magnitude of Outstandings. Outstanding orders for materials are of substantial magnitude. For department stores, they are about half the size of stocks on hand; for durable goods manufacturers, they are also about half the size of all stocks and about twice that of materials stocks alone.

Judged in terms of instability, the relative importance of outstandings is far greater still.

[2] I use "materials" to refer to either purchased materials (sometimes called raw materials) of manufacturers or to all merchandise of department stores.

Comparison of the average rise or fall during specific cycles shows outstanding orders for department stores accounting for twice as much fluctuation as did stocks; for durable goods manufacturers they accounted for four times as much as did materials stocks. The contribution of inventories to instability in the flows of goods tends to be a function of the *rate* at which stocks build up or draw down. In these terms too, specific fluctuation in outstanding orders is substantially larger than in stocks of department stores and far larger than in materials stocks of durable goods manufacturers.

Leading Cyclical Pattern. For both department stores and durable goods manufacturers, materials ownership, as well as each of its two parts (materials on hand and on order) conforms to all postwar business cycles. Stocks proper tended, as frequently observed, either to synchronize or lag. But outstanding orders showed a lead of half a year or a year, particularly at peaks (and for department stores, substantial leads at troughs too).

Investment in these stocks (their rate of change) also conforms to all postwar cycles and even for stocks proper leads business cycle turns. Rates of change in total ownership reach their maxima about a year (on the average) before business in general; troughs lead by a half a year. About the same statement applies to change in outstandings alone.

Extra Cycles. Outstanding orders for both sorts of enterprises underwent contraction at the time of general fear of a postwar recession toward the end of 1946, and after the Korean boom had climbed to a peak in early 1951. They revived prior to the major cyclical peaks in 1948 and 1953, but the second peaks were lower than the first. Rates of change in all of the data for ownership and its two parts, for department stores and for durables, showed these same characteristics.

Though discontinuity in the data makes conclusions highly tentative, there are suggestions of a similar interruption of the post-1961 expansion, very early in 1962, though in this case the first peak in the ownership data was certainly far lower than the second.

Relation of Stocks on Hand to Those on Order. The evidence of the time series concerning parallelism and timing relationships between stocks on hand and on order is relevant to the dynamics of inventory fluctuation. We find first, as might be expected, that outstandings always reach peaks or troughs before stocks do. But the lead at peaks is puzzlingly long. For both department stores and durable goods manufacturers, it averages seven months; the three-months' lead at trough seems more nearly what might be expected. Rates of change for durables repeat the basic finding of long leads at peaks, though for department stores the picture was somewhat moderated.

Second, we find that stocks on hand and on order, two forms in which materials can move toward production or sales, seem to show not-insubstantial parallelism. For durable goods manufacturers, the relative height of each specific cycle rise in stocks tends to parallel that of matching cycles in outstandings. For department stores, perhaps because of distorting influences of the upward trend, it is the falls which seem related. For rates of change, particularly for department stores, similar parallelism is evident. The parallelism suggests that an understanding of the forces that cause shifts in outstanding orders can contribute to an understanding of shifts in stock.

However, the fact that outstandings turn down so early needs to be explained. At least two elements doubtless contribute. The first is a technical one: the lag of stock relative to that of outstandings may be a function of changes in the length and volume of orders carrying longest delivery periods, rather than of the average period for which all orders remain outstanding. The second concerns the group of influences associated with market expectations which have a strong influence on outstandings and seem, on the basis of independent information discussed later, to

reach a peak well before prosperity starts to fade. The two parts of the explanation are, of course, related.

Early Thrust of Expansion. Characteristically, outstanding orders, and presently stocks, move strongly upward in the neighborhood of cyclical troughs in business activity. For department stores, the upward thrust in outstandings and total ownership started in the last month of recession. The period of rapid rise can be dated in various ways. But whatever method is used—whether on the basis of a wide collection of series or the ownership data themselves—the rise tails off after about a year to a year and a half. The median figure is fourteen months after the business cycle trough. The average rate at which outstandings rose during these periods of upward thrust was at least as strong as was the fall during business contraction. The termination of the thrust was followed either by decline or by slower rates of expansion.

These periods when the rise in ownership, and particularly in outstandings, seems out of proportion to other things going on in the economy are of considerable theoretical interest. The interest is heightened by the fact that the rises are early enough to give the economy a booster shot out of depression, that they cease while output and income are moving upward. Moreover, they do not always occur at the outset of a business expansion. (In 1961, for example, though outstanding materials orders for durables increased just before the trough, they did not increase relative to shipments, whereas a strong and much publicized thrust began in 1964.) The phenomenon of the thrust calls for explanation not only of how it gets under way, but also of how it stops. My effort to provide an explanation of this, as well as of some other facts we encounter, culminates in the "ecological model" of the final chapter.

Other Findings. Examination of the time series in Chapters 4–8 uncovers relationships between stocks and adjacent flows, and these are of course of critical interest to studying the dynamics of fluctuation. However, for purposes of this summary, the behavior can be reported at the point where its significance is discussed.

Part III strives to explain the observed behavior of the time series in the light of the insights afforded by the analysis of the functions that stocks serve in individual enterprises. The first of the five chapters, Chapter 9, studies the link between stocks and sales. The second examines other influences that may help to explain stock fluctuation. The next chapter brings the various pieces together in two related inventory models from which, however, multiplier effects have been excluded. Chapter 12 examines the impact of inventory fluctuation on the economy and focuses the conclusion on multiplier mechanisms. The final chapter adds to the model a description of an aspect of the process of change—the ecological interplay between business enterprises and the environment in which they operate—which appears necessary to the understanding of the time course of inventory fluctuation.

THE SALES LINK

The analysis of the functions that stocks serve in Chapter 2 suggests that stocks must change in the same direction as do sales, but not, at least in the short run, by as much as a constant stock-sales ratio implies. The analysis further indicates that many events other than a change in sales might well affect the desirable size of stocks on hand and on order. What, then, do the time series show about the actual relationship of stocks to sales?

For both durable goods manufacturers and department stores, ownership and sales underwent generally synchronous and matched fluctuations. But for department stores the relation is substantially tighter and more pervasive than for materials stocks of durable goods manufacturers. Especially impressive is the fact that the twelve specific cycle phases that were marked both for rates of change in

ownership and in sales of department stores are in like phase on a synchronous basis for 84 per cent of the months covered. For durable goods manufacturers the comparable figure was 76 per cent. Change in stocks, of course, moved more tardily; it lagged change in sales by about four months for both sorts of enterprises and showed poorer correspondence.

The logic of the efficient stock-sales link calls for less than proportional change in stocks. However, the figures show more than proportional change over substantial periods when there is no reason to attribute behavior to the inability to enforce objectives. For all expansion months in sales, stocks rose at a faster rate than sales, that is, the stock-sales ratio was in rising phase 59 per cent of the months for department stores and 44 per cent for durables; the corresponding figures for the ownership ratio were 68 per cent and 37 per cent. For business cycle expansion phases, three of the four figures were substantially higher (Tables 7 and 16).

The higher than proportional rise in stocks was not, as often thought, a phenomenon of late expansion. The rise in the stock ratio started on the average within ten months of the trough in sales, for both department stores and durables. For the ownership ratio the median lag was five and six months for the two sorts of enterprises. For outstandings, as implied by the discussion of early thrusts, the ratio rose on the average within one and two months of the trough in sales for durables and department stores respectively.

The figures indicate, then, that stocks and ownership are changing in a more lively fashion than the efficient servicing of sales requires, other things the same. It would be useful to form a judgment as to the order of magnitude of this hypothetically nonsales-linked fluctuation.

To do so requires an assumption about what the efficient sales link would actually imply, and calculations were made on the basis of three such assumptions. The first supposes that ownership maintains a constant ratio to sales, but one that is at trough (and therefore presumably "hand-to-mouth") levels. The other two assume a constant incremental rather than average ratio, plus a further allowance for change in buffer stocks; the incremental levels chosen were presumably generous—a two months' and a one and a half months' supply. Fluctuation in hypothetically sales-linked ownership was calculated by applying these relationships to actual fluctuations in sales. The calculations were confined to ownership because of uneasiness about applying the identical logic to stocks on hand.

Summing change for all cycle phases, the hypothetically sales-linked change in ownership was then compared with actual specific cycle change in ownership for matched phases. Sales-linked change, presuming the constant average ratio, was 69 per cent of total change in ownership for department stores and 67 per cent for durable goods manufacturers. Assuming the constant incremental ratio plus buffer, the figures were 38 per cent and 45 per cent for two months supply, 29 per cent and 34 per cent for one and a half months' supply. I conclude that a very substantial amount of the fluctuation in materials stocks on hand and on order for the two very different sorts of enterprises appears to be influenced by variables other than changes in sales.

THE IMPACT OF OTHER INFLUENCES

The examination of functions that stocks serve in Chapter 2 indicated what some of these factors may be. We noticed that changes in stock can be prompted by shifts in the costs of carrying stocks vis-a-vis those of covering in other ways the management functions that stocks serve. They can be prompted by changing expectations concerning, or actual conditions in, the markets in which materials are purchased. Moreover, whatever the specific objective with respect to sales, there are bound to be disparities between actual and

desired stocks on hand and on order; some of these disparities are passive in the sense that they are tolerated; others are unintended in the sense that they are rapidly reversed.

Chapter 10 endeavors to devise empirical representation of some of these influences and to compare them with the unexplained portion of total fluctuation in ownership. Unfortunately, the means at our command are limited and afford observations chiefly for the durable goods industries, and I shall confine my summary entirely to that field. Also, I single out for discussion here only those factors for which the data seem to show impressive association.

Representation in time series can be contrived for two factors that may represent shifts in cost. Backlogs of sales orders provide a period of option during which materials can be bought further ahead with less risk of buying unneeded goods than there would otherwise be. Apparently *rates of change* in backlogs anticipate levels of advance materials buying. Back orders start to decline or rise less vigorously with interesting regularity about a half-year before the *level* of outstandings (measured in months of shipments for which they provide) start to rise or fall, respectively (Table 38, line 11). If either levels or rates of change for both sorts of unfilled orders are compared, the levels for materials lead and the associations are irregular. The time series show a very impressive association between profits of durable goods manufacturers and materials outstanding about a half a year later (Table 35, line 15). Could this suggest that unusually high profits provide a source of funds for which the relatively liquid asset, stocks, is considered a particularly appropriate investment?

Market conditions are represented by an interesting body of data collected by the Purchasing Agents Association of Chicago, most of the members of which are in durable goods industries. There are time series representing the average term of purchase orders for major materials and the speed with which vendors undertake to deliver major materials. These two series have a very systematic and slightly leading association with the census data for outstanding orders of materials of durable goods manufacturers; 87 and 88 per cent of the months are in like phase.

Expectations that materials prices will rise could be another reason for extending materials ownership. The *level* of extension would theoretically be a function of the *rate* at which prices are expected to rise. On the assumption that expectations are based on spot prices actually experienced, one might expect parallel movements of the level of outstandings and the rate of change in the spot prices of metals. If so, of course, the *level* of prices would lag; but instead it actually leads the level of outstandings. A possible reason for this is developed in the final chapter.

These several factors which seem associated with changes in outstandings share three characteristics worth noting. The first has to do with the patterns of change: they undergo strong fluctuations which reach their peak well before those of general business; they participate very strongly in the phenomenon that I have called the first thrust of expansion; a number of series have an unusual triangular pattern—they rise at a steady rate and reverse without the customary period of retardation.

Other characteristics concern the dynamics of change. Two of the factors that have been examined seem to be primarily demand-linked —back orders for the product the company sells and profits (conceived as low-cost funds for financing stocks). One factor reflects primarily supply-linked factors—the delivery period that vendors are willing to promise. Several are obviously linked jointly to supply and demand, such as changes in prices and the varying weights in total outstandings of goods having different delivery terms.

But on further thought, *all* of the elements are potentially jointly influenced by both demand and supply. For example, delivery periods might never lengthen if buyers were not

trying to build up stock; backlogs of sales orders might not accumulate if producers were able to get materials as fast as they could use them. Only if physical-capacity ceilings are clearly responsible for some of the supply limitations could one of the blades of the scissors be singled out. But the examination of the data available on plant capacity and its utilization fails to provide the basis for attributing the buildup of buying waves to physical-capacity limitations. However, at least the intensity of some movements may not be unrelated to the frequency with which plants and products bump capacity ceilings.

It is not surprising, then, to find that the dominant characteristic of all of these cost- and market-oriented influences on ownership is that they move up and down together, either as data proper or as rates of change (Table 39). There appears no way of avoiding the messy job of viewing the process in all of its complex interrelatedness.

OUTLINES OF A MODEL OF INVENTORY FLUCTUATION

A first necessity is to endeavor to view the inventory process without an artificial separation between the impact of the sales-linked influences and of all the other influences that bear on stocks on hand and on order. In Chapter 11 we re-examine time series bearing on both sorts of influences, and consider their combined impact on stocks or ownership for each of two types of enterprises. It is not feasible to describe the empirical studies in a few paragraphs. Nor is it feasible to do more than name the pieces of a model which is presented first in a form applicable to department stores and then to durable goods manufacturing. The theory is constructed primarily in terms of materials ownership, though it can be converted at some sacrifice to apply to stocks on hand.

A basic characteristic of the apparatus is its reliance on the time lags that are actually inherent in each type of situation that is covered. The formalized lags of "period analysis" are inappropriate, partly, because of the swift information system implicit in the focus on ownership and new orders. The natural time periods—those that characterize the time required for facts to be appreciated, action to be undertaken and completed, costs to change, and the like—pace the action-reaction patterns of the model with one exception. When expectations are important, change appears at first glance to be potentially explosive; however, the last chapter develops a theory which implies that it is not.

The model as presented in Chapter 11 covers the following elements which participate in inventory fluctuation; many of the particulars are significantly different for durable goods manufacturing and for department stores, and some of the differences are indicated in the parenthetic statements.

1. *A forecasting procedure which forms the basis of initial buying.* Description must recognize the information typically available to management and the time periods for which forecasts are actually required in view of the way in which orders are placed. (Department stores, having no advance notice of what consumers will buy, must largely rely on some sort of rule of thumb for extending past sales. Forecasts must project several months into the future for "preseason" orders, but orders of progressively shorter term can, in effect, modify forecasts. For durable goods manufacturers, the orders placed by customers often provide advance knowledge of how shipments may be expected to change. And, incidentally, knowledge of this sort is not confined to a special-order type of business.)

2. *A link of desired ownership (or stock) to expected sales* which is best formulated roughly in constant incremental, rather than average, terms. If the objective is firm, it imprints buying with an element that conforms to the rate of change in sales, and therefore has the usual tendency to lead sales proper. The larger the desired ratio, the stronger the imprint. (For department stores, the relatively large stock, and the high priority that stock

control assumes, is likely to cause the influence to be relatively large and sharp.)

3. *The desired levels of stocks or of changes in stocks are affected by changes in the opportunity costs* of serving given management objectives in other ways. The analysis and evidence suggest that these changes in opportunity costs of stocks, whether or not they are formally recognized by business managers, may tend to cause more liberal stock policies in prosperity than in recession.

4. *Choices about the timing of buying*—that is, just when materials that are expected to be required should be bought—recognize changing conditions in materials markets. Relevant conditions include what manufacturers offer by way of selections and delivery periods, and expectations about these things and about prices. (In the durable goods industries, factors effecting the timing of buying can have an important influence. The empirical data show an association between materials outstanding and vendor performance, or (with reservations) metals prices, which seem subject to this interpretation. But even for department stores, market conditions apparently influence the proportion of the seasons' expected requirements that are covered by the preseason order rather than bought much closer to the time when sales are expected to take place.

5. *Methods of defining, recognizing, and correcting errors* in materials ownership. There are at least three aspects to this problem:

(a) Inventory management itself has an opportunity cost which influences the precision with which objectives are formulated and enforced; "passive stock," in other words, may be relatively large or small. (For department stores this element is at a minimum.)

(b) The pattern of error in forecasting sales is a function of the character and the informational basis of the sales forecast and the structure of ordering procedures. (For department stores, the need to order on the basis primarily of sales of some appropriate past period means that correction of error will have the pattern of rate of change in sales. The shingled structure of orders means that orders for near delivery tend serially to correct for errors in forecast. At the same time, the seasonal characteristics of demand and ordering may tend to magnify errors and corrections. I attribute to this mechanics some of the strong parallelism between rates of change in sales and in ownership, which the data showed for department stores. For durable goods manufacturers, the informational input of forecast supplied by sales orders would presumably tend to make error smaller and in any event would have a different relationship to shipments.)

(c) Insofar as factors 3 and 4 above influence buying, errors in forming expectations about relative cost and market conditions will generate corrections in stocks on hand and on order. These corrections apply both to incorrect evaluations at the time they were made, and to changes in markets which make the actions taken no longer advisable. (The importance of this type of correction is likely to correspond to the size of the impact on stocks on hand and on order of factors 3 and 4. Consequently their impact on ownership for durable goods manufacturers is doubtless stronger than for department stores.)

This outline of the elements of an inventory model is incomplete. First, a sixth element is required—a *multiplier mechanism* covering the reaction of the economy as a whole to changes in stocks and materials purchasing; it is supplied by Chapter 12. Also required is a *spacing apparatus for the expectational aspects* of all of the elements, but particularly No. 4; this the final chapter provides.

THE VERTICAL TRANSMISSION OF INSTABILITY

The several threads in the second strand of the investigation, the impact of the inventory-purchase syndrome on the economy, are pulled together in Chapter 12, in which, along with the data previously examined, we study such information as can be readily as-

sembled on vertical sequences in broad aggregates for output and new orders. The development of this strand is also necessary to determine the feedback to inventories of the economy's response to inventory fluctuation—a missing piece in the model previously described.

The timing and amplitude of the various series as described in Part II imply that the force exerted by the inventory-purchase complex differs at various stages of business cycles: (1) Prior to business cycle peaks and during the early months of contraction its influence is depressant. (2) Midway in the brief business contractions which have characterized the postwar economy, its leavening influence sets in. This influence gains force during late contraction and still more so during the first year of expansion, after which it is sharply subdued. (3) During the rest of expansion its force varies. It tends to be depressant while the readjustments following the cessation of the buying surge take place. But if the forces of expansion are strong enough, they tend to reactivate further investment in merchandise or materials. However, the market extension which follows is generally more moderate than the first. The 1964–65 situation is a clear exception.

The force and timing of the inventory-purchase syndrome are reflected in how demand moves from the final buyer to earlier economic stages. There is no evidence in the data examined of a tendency for turns in production to be set ahead as demand moves toward the raw-materials end of the sequence. Amplitude of fluctuation, however, is stronger at the earlier stages. As a consequence of the early thrust of inventory expansion, this increased amplitude is typically most marked early in expansion as well as, of course, during contraction.

The information conveyed by orders seems to play an important role in making this pattern possible.

Due in part to sensitivity to rates of change in the orders placed by consumers (consumer buying), retailers' orders for merchandise turn early, particularly at peaks. This anticipatory capability of retailers' materials orders, well maintained at earlier manufacturing stages, makes it possible for production starts for goods sold to consumers to increase or decrease at much the same time throughout a sequence of vertical stages. There is no need for progressively earlier action and greater amplification over the several steps of the whole vertical sequence, as conventional acceleration models seem to imply. Indeed, since individual production processes for materials tend to be reasonably swift, there is no need for production, as depicted in monthly data, systematically to anticipate sales to consumers.

For capital equipment, the orders placed by final buyers tend, as is well known, to turn early in business cycles. Those placed for materials, our data show, maintain the same pattern on the average.

It is perhaps less generally appreciated that orders for merchandise placed by department stores turn, if anything, earlier than do orders for materials placed by durable goods manufacturers. This is, of course, much earlier than consumer buying turns, particularly at peaks. Orders received by retailers' suppliers reflect the instability of both retail sales and the rate of change in merchandise ownership of retail stores. The figures reveal that the cyclical instability of the orders received by the manufacturers of the things that department stores buy is two or three times as great as that of consumer buying.

What does all this mean about the multiplier mechanisms that tend to magnify the impact of inventory fluctuation on the economy? Income multipliers are of course present in the usual sense: income associated with building up stocks is gradually distributed as it is spent and respent. The process takes time. In consequence, the multiplier impact is gradual. As mentioned before, it does not require theoretical representation in terms of discrete intervals or "periods."

A second type of multiplier is implicit in the system whereby information generates and communicates. Orders affect the plans producers make, the prices and market conditions they expect, the defensive and offensive actions they undertake. Orders affect these things differently if, on the one hand, they are interpreted as serving to build up stock or outstandings or, on the other hand, as corresponding to the flow of goods to final users. Yet for reactions of these sorts, natural time periods are not readily apparent.

In short, in a world where business conduct is based on expectations and a message circles the earth in a few minutes, what paces the speed with which expectations increase or depress activity?

Similar questions have also appeared in connection with expectations about materials markets. They are based on a network of information about market conditions in general and about what suppliers, customers, and competitors are doing. The information is rapidly conveyed. The actions that these expectations set off can be quickly formulated and executed. They affect the market and therefore subsequent expectations. Why does buying not seesaw back and forth from one extreme of opinion to another? Yet the data show that it does not.

Other bits of information in search of a theory are the ten-to-fourteen-month thrust, the triangular pattern of market extension, the long lead of peaks in outstandings relative to those of stocks, the fact that outstandings lag even the level of prices rather than showing an association with their rates of change. These are mavericks that appear at odds with obvious explanations, yet seem to fit in well enough with one that I propose in the concluding chapter.

AN ECOLOGICAL MODEL OF PRICE-TIMED BUYING

The chapter focuses on one aspect of market-oriented buying (by no means the most important one), prices; it constructs a model that describes how the expectation that materials prices will rise is capable (under appropriate circumstances) of causing a wave of price-timed buying with rising and falling phases of reasonable duration and containing intrinsic reversing mechanisms.

Price-timed ownership (a positive or negative quantity) is defined as the difference between the amount of materials actually on hand and on order when materials prices are expected to change and the amount that would be held if prices were not expected to change, ceteris paribus.

The model is constructed on the basis of a group of assumptions which, however much they require testing and further specification, are believed to be basically realistic. The assumptions refer to *structural* and *behavioral* characteristics of business situations and *market reactions*. Natural time lags are recognized where they exist. Let me present the scaffold of the argument.

Business structural characteristics: (1) Extension of stock on hand and on order predicated on an expected rise in prices (positive price-timed ownership) occurs at increasing costs and this causes price-timed ownership in any firm to have ceiling levels. (2) Firms in an industry differ with respect to their "proclivity to benefit from price-timed buying." The proclivity reflects the potential advantage to be gained from shifting the number of weeks' supply on hand and on order in accordance with expected changes in materials prices. These differing sensitivities are implied by the variety of factors that influence the advantage to be derived from price-timed buying and the highly particular pattern which they must have in a given firm. (3) The distribution of firms with respect to their proclivity to benefit from price-timed buying is such that fewer firms have a very high proclivity than have a more moderate proclivity, and probably somewhat fewer have a very low than a moderate one. Thus, for the familiar notion of the "representative firm," the model substitutes a "hill-shaped distribution of firms."

Business behavioral characteristics: These concern the circumstances that dictate a change in price-timed ownership. Desired change is effected promptly by appropriate positive buying or negative buying (reducing other buying), though there can be lags of an administrative sort. The level of price-timed ownership that is desired by a given firm is predominantly a function of (1) changing cost structures within the firm, (2) the expected rate of change in materials prices, and (3) the assurance with which the expectation is held. Assurance builds gradually in response to a number of influences, including sequential validation of previous expectations.

The structural and behavioral characteristics imply that desired price-timed ownership can be described as constituting the vertical dimension of a three-dimensional surface (Figure 5). The horizontal direction records, from left to right, progressively larger expected rates of increase in prices. The backward dimension records increasing assurance. The surface lifts moderately from left to right and sharply in a backward dimension as assurance increases. But the structural characteristics prescribe that the rise slows and finally ceases before the rear right corner of the surface is reached.

Desired changes in ownership are achieved by price-timed buying (positive or negative). For an industry as a whole, price-timed buying tends to be positive when more companies flock to move from a lower spot on the ownership surface to a higher one than move in the reverse direction. When upward movements are the rule and concentrate in the steeper portions of the surface, total price-timed buying is relatively large. But as the situation matures, the movements tend to concentrate increasingly at the flatter (rear right) part of the surface. Thus total price-timed buying declines; that is, the buying wave passes its peak. I might add that other characteristics of the model also cause or contribute to the reversal. Decline is augmented as firms start actually to reduce their ownership by negative buying (move downward on the surface).

Price-timed buying has an impact on the materials markets and thereby on future expectations and the assurance with which they are held. Consider the impact on the market of positive price-timed buying: This addition to the buying that would otherwise occur may be conceptualized as a consequence of short-term shifts in demand and perhaps supply schedules; it thus tends to increase materials prices, lengthen delivery periods, or deteriorate selections, other things the same. These responses, though reasonably swift, are not immediate. Finally, evidence of the market responses feed back via various information systems to market participants, influencing their expectations about further change in price, the assurance with which such expectations are held, and consequently subsequent actions in response thereto.

The model, then, describes a wave in price-timed buying in terms of an ecological interplay among business firms and their environment: a changing number of firms buy changing quantities of materials to effectuate shifts in desired ownership. The buying in turn changes the very conditions toward which expectations are addressed and, communicated, gives rise to further rounds of expectations, evaluations, buying, and market impact.

But the specifics of the process prescribe that response must cumulate, accelerate, and soon decline. This results partly from the structure of proclivities and of their ceilings, partly from the fact that perception and learning are involved and take time to mature and to respond to environmental change including change in opinion, partly from the character of the market reaction, and partly from the information it generates.

The theory of price-timed buying, extended as it could readily be to cover all market-oriented buying, applies particularly to paragraph 4 of the model of inventory fluctuation previously described. It prescribes the natural time lags that are necessary to leash the poten-

tially frenetic course of expectation-based buildups. It applies also in a more general sense to aspects of the expectation multiplier mentioned at the end of the previous section.

DIRECTIONS FOR FURTHER WORK

Since the lags are not formal but factual, the time required for the fluctuation to occur is implicitly specified by the particulars of the input concerning structural, behavioral, and market reactions. The study has suggested that the expansion phase is shorter than expansion phases of postwar cycles; the ten- to fourteen-month thrust may be more nearly typical. It would be instructive to explore by means of computerized simulation how sensitively the duration and amplitude of fluctuation vary with changes in each of the critical parameters. Interview studies could give to some of these parameters more than the airy shape which the present state of ignorance prescribes. New time series could provide aggregates against which a theory based on the behavior of individual marketeers could be checked and filled in. The study closes with a brief discussion of some of these avenues of further learning. The difficulty is that they branch so widely. The difficulty and the excitement.

Excitement lies, I think, in further exploration of how the intimacies of business problems and situations reflect and shape aggregate economic activity. One of the many aspects of this interrelationship concerns the dynamics of interplay between action, information, and expectation, between the individual and the environment. Of particular interest is what the approach can contribute to the understanding of the course of business expansions and what brings them to a close. Needless to say, the process described in the model must have very different particulars in connection with cycles in inventories and with those in consumer purchase of durables or business investment in capital equipment; yet it seems barely possible for ecological interplay to be present in one situation and absent in the others.

POSTSCRIPT FOR THE TIME-RATIONED READER

The reader, who has in the past few pages heard so much of the speed with which information travels, must find the length of this book puzzling. Should he wish to be guided by what I preach rather than what I do, I suggest the following shortcuts.

Chapter 2—Introductory and summary sections and Exhibit 1.

Chapter 3—Exhibit 2 and a glance at the description of the time series.

Chapters 4 and 5—Summary in Chapter 5 and study of Table 1, including notes to get the method of analysis. Charts 1 through 5.

Chapter 6—Summary and charts.

Chapters 7 and 8—Summary in Chapter 8 and Charts 8 and 9.

Chapter 9—First and last sections.

Chapter 10—Summary and charts.

Chapter 11—The models and the rest if he can make it.

Chapter 12—Summary and charts.

Chapter 13—If he likes models; in any event, the last section.