9. *Causes of Fluctuation in Ownership: The Sales Link*

The observations based on time series and described in the previous five chapters have relevance to two major groups of questions: the objectives, problems, and procedures that govern purchasing and inventories in business enterprises and their implications with respect to patterns of fluctuation; the impact of this behavior on economic fluctuation in the economy at large. This and the following two chapters explore and analyze the first group of considerations. Chapter 12 tackles the second group, though in a cursory fashion. The final chapter of the book asks how the interaction of the two sorts of processes—business conduct and aggregative impact—may be more adequately understood and effectively explored.

HYPOTHESES AND PROCEDURES

The actual behavior of stocks and ownership as displayed by the time series needs to be analyzed in terms of the business objectives and managerial problems that give rise to it. What these may be was discussed at the outset of the study. Several generalizations emerged. Though they require a great deal of further testing and specification, I want simply to use them here as a point of departure.

Generalizations About Factors That Influence Stocks

1. Stocks on order are an integral part of the stock management problem. Since purchasing or refraining from purchasing materials is the most direct and usual act by which a stock objective is achieved, stocks must be planned in terms of the time required for purchases to be delivered as well as in terms of the time required for processing and marketing operations to take place. Accordingly, if the behavior of stock is to be linked with the business procedures that give rise to it, it is necessary to focus on both stocks on hand and those on order—to focus, that is, on ownership as well as on each of its two parts.

The size of stocks on hand and on order, individually and collectively, is influenced by what is known and what is expected concerning the specifics of several sorts of business problems and the behavior of the several sorts of business costs.

2. The volume of sales is an important determinant of the volume of stocks that should be held on hand or on order. However, the ideal relationship is not that of a constant ratio. When sales rise, total stocks do not need to rise as much as proportionately; nor do they need to fall as much when sales fall. A proportionate change is required for the part of stocks that serve to sustain the period required for processing, whether the process involved is that of manufacture, of preparation of raw materials, or of delivery by the supplier to the purchasing company. But for the portion of total stocks that serve various sorts of insurance and efficiency functions, appropriate

variation is ordinarily substantially less than proportionate to sales.

3. Whatever the specific objective with respect to sales, there are bound to be disparities between actual and ideally desired stocks on hand and on order. Disparities of the "passive" variety tolerated or perhaps not recognized; if clearly "unintended," efforts to reverse them are made. They are of several sorts:

The disparity will reflect the relation between the sales that are expected at the time when orders have to be placed and the sales that actually occur. The disparity is likely to be less for total ownership than for either of its parts, since the inflow, new orders, can be readily adjusted to the outflow, sales. The upward adjustment can be made almost at will. The downward adjustment may be a bit more circumscribed, but nevertheless speedy compared with the adjustment of stock alone.

The disparity will reflect the procedures that it is worthwhile to institute for the purpose of defining, correcting, or even detecting undesired change in stock. These procedures have an opportunity cost in terms of management time and the exacerbation of other management problems. Simple ineptitude may cause large disparities.

The difference between actual stocks and their ideal sales-linked level will also reflect other factors that are intended to influence their size, factors mentioned in the following two paragraphs. It reflects also failures to foretell these other factors precisely.

4. Changes in stocks can reflect changes in cost both of stocks and of other ways of serving the management function that stocks serve. An example of the first is the changing cost of financing stock. This includes not merely the interest charges often examined in this context but also the opportunity cost of internal funds, which may have their own patterns of variation as funds from retained profits rise or fall. Examples of the second are: the higher cost, when factories are busy, of minimizing stocks by means of flexible production schedules; the lower cost of obsolescence of stocks acquired to cover sales for which advance orders have been taken.

5. Changes in stocks on hand and on order can reflect changing conditions in or expectations concerning the markets in which materials are bought. Such conditions include the expected price of materials, speed and reliability of deliveries, and the adequacy of selections or the reliability with which quality specifications are met. Stocks on order typically reflect most of the initial impact of such change.

Methods of Study

The time series examined in Part II have displayed two basic characteristics that generalizations based on the firms-eye view of stocks suggest: the importance of stocks on order and their strong patterns of fluctuation; and a behavior that does not simply mirror sales. Evidence on these two general points appeared in all sorts of specific forms.

ECONOMETRICS TABLED

It would now be possible to take a further step and make some guesses about what sorts of things account for the behavior unexplained by the sales link. These hunches could be dignified by a formal hypothesis which then might be submitted for econometric test.

However, there are several reasons why it would be foolish at this point to follow this pedigreed procedure. For one thing, there is much more preliminary work to be done in order to weed out some and underscore others of the many factors that may, according to my basic view, play a part in causing fluctuations in ownership.

Further, the basic view is resistant to well-founded hypothesizing. On the one hand, it holds that a great many things can influence the size of stocks. On the other hand, it provides only a shaky a priori basis for selecting which are likely to be quantitatively important. For one thing, the judgment can at the present time be based only on normative con-

siderations and not on sound knowledge about actual business behavior. For another, the judgment implies knowledge of the business conditions that prevailed during the period under study—how significantly what sorts of costs were actually expected to change in what way. As a result of this inability to arrive at a confident hypothesis by deduction, we need to coax the time series to go as far as they can to narrow down alternative explanations.

But even after this further specification has been completed, it is still not at all clear that econometric analysis of the time series presently available would advance the inquiry very far. In any event, it is not undertaken in this study.

There are two chief difficulties which in the context of our particular problems aggravate the perennial headaches associated with multivariate analysis of time series:

The Data. The statistics for durables manufacture are, as has been pointed out, inadequately matched. Directions of change are, I believe, fairly reliably indicated, but the volumes involved are not. Statistics in book-value terms increase the difficulty still further. In consequence, quantitative comparisons are very risky, both with respect to the relations of the various stockpiles to one another and with respect to each of their relations to shipments and orders. The difficulty of proper empirical representation is still more acute in connection with some of the other variables for which the theory calls: forecasts of sales, actual and expected change in replenishment time, expected materials prices, financing costs, and other opportunity costs such as that of flexible employment schedules.

Multidirectional Causal Relationships. Yet in spite of the indubitable deficiencies of available proxies for the independent variables, it is not at all clear whether the multivariate analysis would under- or overstate their true explanatory value. On the one hand, the causal relations at an aggregate level are multidirectional: the accumulation of inventories influence market expectations concerning delivery times and prices as well as vice versa; the level of sales influences the cost of financing, which influences the size of stocks, which influences the cost of financing, and so on.[1]

On the other hand, these multidirectional influences follow no prescribed temporal sequence. The association in time may be immediate as well as anticipatory or lagged. Consequently, the coefficient of whichever variable is designated "independent" will actually reflect a zigzag of cause and effect between independent and dependent parameters.

Finally, each of the broad aggregates is responsive to the general level and temper of business conditions. In consequence, some portion of the displayed association between independent and dependent variables reflects the association of each with general business conditions. This problem is, of course, intrinsic to any effort to impute causal connection on the basis of temporal parallelism. In a crude form I have, as indicated earlier, kept it in mind in judging whether, in a particular case, the percentage of months in like phase seems to suggest a "close" relationship. Other things the same, it does so more strongly when conformity of both series to reference chronology is poor than when it is good. For formal correlation analysis the problem can falsify both the regression coefficients as typically interpreted and the multiple and partial correlation coefficients. Techniques for subduing the difficulty are not, as far as I know, in use.[2]

[1] Equation systems are, of course, directed toward dealing with this problem, but the extent to which they succeed appears to be highly problematical. For one thing, prerequisite to success is adequate representation of all of the important causal elements.

[2] Consider a simple regression of Y on X. The measures of significance and correlation express in some form the proportion of the deviation of each of the $y_1, y_2 \ldots y_n$ from the average $\bar{y}$, which is explained by, on the one hand, some designated systematic association with corresponding x values and, on the other hand, left unexplained.

The deviation of the y's from their average reflects analytically distinct influences: (1) the impact on Y of general business conditions via their influence on demand, business mood, supply, finance, and so on; (2)

There is a third impediment to multivariate analysis which I can only mention very tentatively. The importance of expectations in the causal nexus with which we are concerned casts doubt on the appropriateness of linear models. The final chapter explores the question further.

A FLEXIBLE DIALOGUE

For these many reasons, then, I aim at modest and preliminary goals: to focus the empirical findings on the factors that influence inventory and purchasing procedures by means of a flexible dialogue between the statistical data and the logic of management problems and procedures. We aim to arrive at answers, admittedly tentative answers, which are as specific and precise as the data permit. I might add that I shall frequently go farther than the data permit. No investigator can adequately curb his prejudiced enthusiasms. This is one reason why "facts" are such relative things.

In the main, the statistics provide four handles by means of which one may attempt to draw the figures and the explanation of behavior together:

1. The over-all pattern of fluctuation of stocks and its gross correspondence with that of data to which it is hypothetically causally related.

2. The distinction between these relations in the case of stocks on hand and those on order; the logic of behavior calls for differences which evidence could confirm or deny.

3. The distinction between the relations among stocks and explanatory variables for department stores and for durable goods manufacturers; here again the logic of behavior calls for differences which the evidence could confirm or deny.

4. Finally, a distinction that lies outside of the main scope of this work, but one on which scattered light can be shed, concerns differences between other business expansions and the one starting in early 1961; until some time in 1964, this expansion was notably lacking in the usual buildup of optimistic market expectations, and this presumably would cause distinctive behavior of stocks on hand and on order.

In this chapter I concentrate on the association between sales and stocks, either on hand

the impact of X on Y; (3) the impact of other particular influences that fail to be represented in the equation or equation system; (4) a residual (theoretically unexplained) random element.

But each matching value of X and Y share in some degree influence 1. If so, the correlation and regression coefficients that are developed reflect not only the influence of X on Y (influence 2), but also the influence of general business conditions on *both* X and Y. Coefficients reflect only these influences if we can assume that there is no causal influence of Y on X, and no other independent influences correlated with X which have been omitted (influence 3). For broad economic aggregates, influence 1 can be large and consequently produce high measures of correlation, even if the "true" association between Y and X is quite small. For narrow aggregates, data for individual industries or geographic areas, the influence of general business conditions may be less strong (relative to the influences that are isolated) or they may simply be different—the general affairs of the industry or the region.

To correct for influence 1, it seems to be necessary to isolate that portion of the total standard deviation of Y's subject to the particular explanation which the regression proffers. Conversely, it is necessary to specify that portion of the total deviation which is explicable without recourse to the particular explanation that the regression proffers, the portion reflecting the impact on Y and X of the general business climate. As a result of this impact, Y and X would have some specified chance of conforming in some specified degree to the time pattern traced by a group of series of a like order of generality. What this pattern may be could be determined in a number of ways. But the raw materials for the determination would seem to be a *bank of series of like order of generality*. From these one could evolve, by simulation or other methods, a generalized pattern and a probability distribution of the degree of divergence of individual series from the pattern.

This approach gives expression to a common-sense procedure that an analyst uses intuitively. He judges that a correlation of such and such is "pretty good" for "this type of data," whereas the same figure would be "not very impressive" for another set of time series. As suggested in the text, I have constantly resorted to this sort of framework in pointing to the percentage of months in like phase, which in the several and different contexts seems to me to suggest meaningful association.

or on order, and ask whether it explains the behavior of stock in terms either of a desired relationship or of one reflecting inevitable error and its correction. I conclude that a large amount of the behavior of stocks on hand and particularly of stocks on order remains to be explained after any reasonable association with sales has been taken into account. The residual is greater for durable goods manufacturing than for retailing. It is greater prior to 1961 than thereafter.

The next chapter turns to the residuals—the portion of the behavior of stocks on hand and on order that seems unexplained by the pattern of sales. We examine the evidence that suggests the role of market conditions and of expectations with respect to changes in delivery periods, prices, and backlogs of sales orders. Attention is also given to whether market expectations can be explained largely in terms of capacity limitations of suppliers.

Chapter 11 looks at how the two major influences—sales and market conditions—combine in shaping the unfolding history of changes in materials ownership and new orders for materials; it leads to modification of the usual formulations of the "acceleration principle."

THE SALES LINK

Stocks could not, of course, fail to have some sort of broad parallelism with sales, and Charts 2 and 4 have pictured this general association. The association must in part reflect basic business requirements which are too obvious to discuss. Interest attaches rather to the particular quantitative characteristics of the parallelism and its precision. What light can the time series throw on these matters? Measures of conformity and timing are reviewed in this section and quantitative relationships in the next.

Timing Relationships

Table 31 assembles previously presented measures of association between peaks and troughs and specific cycle peaks and troughs. In studying the location of turns alone, a gross simplification is imposed on the history of events: things may either improve or worsen, and nothing else. Moreover, since it is not always crystal clear just when the reversal takes place, there is often an arbitrary element in the designations. The moment when a series begins to descend, and therefore ceases to ascend, may be compared with the analogous moment in another series which may, not unreasonably, be causally related to it. If these particular moments (characterized by the fact that they are moments of reversal) tend systematically to, say, precede those of the first series, it seems reasonable to assume that other moments also would. In other words, a regression analysis which allowed for the lead would show a higher coefficient of correlation than one using synchronous or other timing. This is the logic of studying the specific cycle measures of timing and the percentage of months in phase.

For both department stores and durable goods manufacturers, stocks turn two or three months later than sales, on the average. Table 31, line 3, shows that, allowing for the three months' lag, 80 and 84 per cent of the months, respectively, are in like phase for the two sorts of enterprises.[3]

The figures suggest some minimal systematic association for both sorts of enterprises, and comparison of the visual contours in Charts 2 and 4, above, support this conclusion. However, its meaning in terms of direct causal association cannot be pushed very far, since both sales and stocks move with general busi-

[3] Since there is no specific cycle in department store sales prior to 1948, the retardation in the stock series is bound to be out of phase. Limiting the comparisons to January 1948 through December 1961, the percentage of months in phase for department stores is 82, and for durable goods manufacturers 83.

TABLE 31

Summary of Timing association of Sales and Stocks on Hand and on Order, Department Stores and Durable Goods Manufacturers, 1946-61

Table Line	Specific Series[a]	Reference Series[a]	Median Timing: Lead (-) Lag (+) P	T	All	Timing Adjust.	% in Like Phase: % of Months 7/46 to 12/61	1/48 to 12/61
			Department Stores					
1	Ownership	Sales	+0.3	+2.0	+1.0	+1	80	84
2	Change in ownership	Change in sales	+0.5	-0.5	0	0	84	
3	Stocks	Sales	+2.3	+5.0	+3.0	+3	80	82
4	Change in stocks	Change in sales	+4.0	+3.5	+4.0	+3, +4	81	
5	Change in stocks	Sales	-6.3	-0.7	-1.5	-1	71	74
6	Outstandings	Sales	-4.3	+1.3	-0.5	0	75	
7	Change in outstandings	Change in sales	-1.5	-1.5	-1.5	-2	80	
8	Sales	Subcycles	-1.0	-4.0	-1.5	-1	83	
9	Change in sales	Subcycles	-11.5	-6.0	-10.0	-10	66	
10	Ownership	Subcycles	-0.5	-2.5	-2.0	-2	82	
11	Stocks	Subcycles	+0.5	0	0	0	91	
12	Outstandings	Subcycles	-6.5	-2.5	-3.5	-4	81	

Table Line	Specific Series[a]	Reference Series[a]	Median Timing: Lead (-) Lag (+) P	T	All	Timing Adjust.	% in Like Phase: % of Months 7/46 to 12/61	1/48 to 12/61	Source Table: Dept. Stores	Durables
			Durable Goods Manufacturing							
1	Ownership	Shipments	-1.5	-0.5	-0.5	-1, 0	72	75	15	6
2	Change in ownership	Change in shipments	-1.0	+1.0	+0.7	+1,0	76		20	18
3	Stocks	Shipments	+4.7	+3.0	+2.5	+2, +3	84	83	15	6
4	Change in stocks	Change in shipments	+11.5	+7.3	+9.3	+4, +5	70		20	18
5	Change in stocks	Shipments	-2.7	-3.3	-3.0	-2	81	87	20	18
6	Outstandings	Shipments	-1.7	-0.7	-1.0	-1	73	80	15	6
7	Change in outstandings	Change in shipments	-1.0	+0.7	+0.3	0, +1	72		20	18
8	Shipments	Subcycles	-1.7	+0.3	0	0	84		15	6
9	Change in shipments	Subcycles	-9.0	-6.7	-8.7	-9	68		20	18
10	Ownership	Subcycles	-4.0	+1.0	-1.5	-2	75		9	1
11	Stocks	Subcycles	+1.3	+3.7	+3.0	+3	82		9	1
12	Outstandings	Subcycles	-6.0	+0.5	-2.5	-3	74		9	1

[a]"Stocks" are stocks of purchased materials. Outstandings are, of course, outstanding purchase orders for materials. (The series is actually the unfilled sales orders of the primary metals, fabricated metals, and "other" durables goods industries.)

ness conditions (Table 31, lines 8 and 11). We cannot, therefore, rule out the possibility that such similarity as the two series show is the result of each of them moving in accord with the general tides of business. Other relationships serve to fill in this ambiguous picture.

Ownership is capable of prompt adjustment to intentions, and its behavior is therefore of interest. For durable goods, line 1 of the table indicates a very poor association between ownership and shipments; only 72 of the months are in like phase. And Charts 1 and 2, it will be recalled, revealed notably different shapes, as well as timing, of cycles in the two series. For department stores, on the other hand, ownership and sales are in like phase 80 per cent of the time after allowing for a one-month lag in ownership. If comparison is confined to the period after 1948, department stores are in phase 84 per cent and durable goods manufacturing 75 per cent of the time.

Rates of change in both sales and stocks provide further evidence concerning management objectives and their validation. It is possible for stocks and sales proper to be precisely in like phase and yet for first differences in the two series to be in opposite phase for a substantial part of the time. The relationship between cycles in rates of change and in data proper are diagramed below:

	Accelerating		*Decelerating*	
	Data Proper (a′)	Change (a″)	Data Proper (d′)	Change (d″)
1. Rising	↑	↑	↑	↑
2. Falling	↓	↓	↓	↓

Thus data proper for two series could both be rising; but if one was rising at an accelerating rate (box 1a′), and the other at a decelerating rate (box 1d″), the rates of change for the two series would be out of phase. Analogous remarks apply to falling phases. It is equally possible, of course, for phases in rates of change in two series to be matched and the data proper out of phase for substantial intervals. This occurs in boxes 2a″ and 1d″ or 1a″ and 2d″. Finally, of course, phases for both data proper and rates of change for two series can be matched (the a′ and a″ boxes), thus indicating a more exacting parallelism than for either characteristic alone. Which of these several possibilities apply to the actual data and to what degree?

For department stores, Table 31 shows that change in stocks (inventory investment) was in like phase with change in sales 81 per cent of the months after allowing for a three- or four-month lag. The lag, like that of stocks with respect to sales proper, seems to reflect some of the difficulties of effectuating intentions. Note that it is not present for change in ownership, which, on a synchronous basis, is in phase with change in stock 84 per cent of the months (line 2). Reference to Table 20, line 5, indicates that twelve turns are matched, only two of which diverge by more than three months; seven turns are within plus or minus one month of one another. These figures then, and those for ownership proper, seem to reflect some very determined effort to keep stocks aligned with sales when alignment is sensitive not merely to directional change but to rates of change as well.

This double criterion is not exhibited for durable goods manufacturers. The alignment between rates of change in stocks of materials and in shipments (line 4) or in ownership and in shipments (line 2) has about the same average timing association as for department stores. But phase-by-phase correspondence is relatively sloppy; 70 per cent of the months are in like phase for change in stocks and 76 per cent for change in ownership. Apparently, when sales are rising or falling at declining rates, stocks do not usually follow suit.

Line 5 of Table 31 suggests what they may be doing, though perhaps not forcefully enough to carry much weight. For durable goods manufacturers, rates of change in stock

tend to bear a fairly systematic relation to shipments proper. Allowing for a two-months lead in inventory investment, changes in stocks and shipments proper are in like phase 81 per cent of the whole period and 87 per cent beginning in 1948, whereas the corresponding figures for department stores are 68 and 71 per cent.

Do the figures for durables reflect a purposeful effort to maintain this association between inventory investment and shipments proper? If so, the logic would be obscure, but even the evidence does not speak for it, since change in ownership, for which validation of an objective is mechanically easy, has a very unsystematic association with shipments proper.[4] A second explanation might be in terms of adjustment lags. Hypothetically, the effort to increase stocks as sales rise at first succeeds only in the form of a retardation in the fall in stocks (box 1a′ for sales and 2d″ for stocks). Only after the rise in sales starts to slow down do stocks manage to rise and at an accelerating rate (box 1d′ for sales and 1a″ for stocks). An association of this sort is in accord with the evidence. However, note that in any event it could hardly result from a high management priority to enforce a precise average or incremental association between sales and stocks, in view particularly of the possibility of foreknowledge of requirements which advance orders for finished goods implies.

I conclude that the figures suggest a relatively strong sales link for department stores and a much weaker one for durable goods manufacturers. That this is a sensible finding seems implicit in the difference between the procurement problems of retail merchants and of manufacturers of durable goods.

For department stores, stock control is a central management concern. A large part of the capital of a retailer is invested in stocks. Moreover, a department store's customers make their selections primarily out of goods in stock; poor stocks mean lost sales. However, since at best the items that may be wanted are vast in number, the natural tendency for stocks to grow too large can only be kept in check by carefully devised stock-control methods and perpetual vigilance. A situation of this sort virtually demands a sharply defined stock objective, the enforcement of which carries high management priority.

For durable goods manufacturers, on the other hand, stocks of materials account for only a small part of total invested capital. A specific unit of material often has only a loose physical link to a specific finished article, since processing is sufficiently flexible to use it as an ingredient in any one of a number of finished items. Obviously, the penalty for a relaxed link of sales-to-materials stocks is far smaller than for department stores. At the same time, a durable goods manufacturer would technically be in a better position to keep shipments and materials strictly aligned than would a retailer. His customers are often willing to wait, whereas those of department stores are not. The advance knowledge of projected shipments that order backlogs provide can be the basis of materials buying capable of enforcing a stock objective: both the inflow to and the outflow from the stockpile, receipts and production starts, can be predetermined. Even the two- or three-month lag of stocks relative to shipments seems to evidence a weak sales-linked intention for manufacturers, whereas for retailers it could simply reflect the absence of the clairvoyant's capacity to foretell sales.

The examination of one sort of evidence, then, data on timing and confluence of fluctuations, seems to suggest the inevitable link of stocks or total ownership to sales. The association tends to be synchronous for ownership, whereas stocks lag about three months. But for department stores the figures seem to show a substantially tighter and more pervasive association than for materials stocks of durable

[4] Allowing for a five-month lead, 71 per cent of the months are in like phase.

goods manufacturers. That this would be the case seems implicit in the differences in the business operations that the two sorts of enterprises perform.

Quantitative Relationships

The evidence examined is of course most incomplete. For one thing, we have looked at relations between one of the factors that could influence stocks and sales, whereas there are necessarily other factors too; the joint impact of sales plus the others could easily obscure the effect of sales, other things the same. For another thing, our measures have been concerned not with either sales or stocks but, as mentioned at the start, a schematic representation of both—in effect, a sequence of triangles marked off by the low and high months of movements identified as specific cycles or minor cycles. The height of the peaks and troughs and the pattern of intervening months have been largely ignored. Ratios of stocks to sales provide a steppingstone around both limitations. It is necessary to try to take this further information into account.

MORE THAN PROPORTIONAL RISE OR FALL

One type of quantitative relationship between sales and stocks, one with a venerable analytic history in economics, is that of a constant average relationship. Yet we saw, on the one hand, in Chapter 2 that there is little reason to suppose that a close adherence to management rules, directed toward efficient servicing of sales, other things the same, would produce a constant ratio. The empirical data, on the other hand, showed that in fact stocks not only increased as much as sales but increased more during substantial periods of either business expansion or expansion in sales. And it seems reasonable to interpret this behavior as intended, at least in some loose sense, since when sales are rising, stocks are not likely to back up unexpectedly.

For department stores, the ratio of stocks on hand to sales rose in 59 per cent of the months during which sales themselves rose; for the ownership-sales ratio the corresponding figure was 68 per cent. For durable goods manufacturers, the comparable percentages were 44 and 37 respectively. Table 32 gives these figures.

The beginning of the more than proportional rise in stocks does not wait for the latest stages of expansion in sales but starts within a year of its commencement.[5]

Ownership started to rise faster than sales or shipments within eight months of the trough in the flow series or, for that matter, the trough in business cycles except for the long lag after the 1961 trough. A glance at Charts 3 and 5 will help to recall the appearance of these ratios.

During contractions in sales, a rise in the ratio might mean either that stocks could not be reduced at all or that they could not be reduced fast enough to keep pace with the fall in sales. And certainly either of these situations could well occur, however lamented by management. But a decline in the ratio—stocks falling faster than sales—would, like a rise during expansion, seem intended in the sense that it must result from efficacious purposeful procedures. Table 32 shows that stocks were falling faster than sales for only 40 per cent of the months for department stores and 36 per cent for manufacturers. Several months elapsed after the peak in sales before stocks started to fall, and several more before their rate of fall passed that of sales. The median lag for peaks in the ratio relative to those in sales was four months for department stores and nine for durables.[6] Certainly the lag represents a failure of control mechanisms, and it is interesting that again control is closer for department stores than for the manufacturers.

[5] An exception was a lag of fourteen months after the 1954 trough for the department store data referred to here and in the following paragraph. These and subsequently mentioned figures are from Table 8, lines 3, 7 and 13; and Table 17, lines 4, 9, and 14.

[6] Timing comparisons were given in Tables 17 and 8.

TABLE 32

Comparison Between Sales and the Stock-Sales Ratio
Department Stores and Durable Goods Manufacturers
1948-1961

Ratio	Sales Rising[a] % of months when ratio rose	Sales Falling[a] % of months when ratio fell
	Department Stores	
Ownership-sales	68	66
Stock-sales	59	40
Outstanding-sales	59	83
	Durable Goods Manufacturers	
Ownership-sales	37	88
Stock-sales	44	36
Outstandings-sales	47	83

Note: "Sales" signify sales of department stores or shipments of all durable goods manufacturers.

[a]All comparisons cover the months January 1948 to December 1961. Months of rise (fall) in sales or shipments are delineated by the location of specific or minor specific cycles and likewise for the ratios. Figures in column 1 were originally presented in Tables 7 and 16. Those in column 2 have not been previously given.

Ownership, on the other hand, was brought in line much faster, and the ratio declined during 66 and 88 per cent of contraction months respectively for department stores and durables. This high correspondence was associated with the fact that the ratio sometimes started to fall before sales reversed, and in no cases waited longer than three months for department stores and four or five months for durables.[7]

In general, then, such directional parallelism as we observed previously between stocks and sales had the further characteristic that stocks on hand and on order rise relatively more than sales during a substantial portion of the time that sales rise; an analogous statement applies to the fall in total ownership, though not to that of stocks alone.

[7] Charts 3 and 5 bring out the fact that for durable goods the ownership-shipments ratio declined for substantially more months than it rose. This explains in part both the low conformity of the ratio with shipments during expansions and the high conformity during contractions.

HYPOTHETICALLY EFFICIENT SERVICE STOCK

If I am correct in thinking that, were all other factors to remain the same, the efficient sales link would not dictate increases or decreases of these magnitudes, then it must be concluded that other factors have not in fact remained the same. How great a part of the total fluctuation in stocks may result from the impact of these factors?

I know of no way to answer this question with confidence at the present time. We can neither simulate the typical management

procedure for linking stocks to sales, other things the same (this requires knowledge of management conduct which we do not have) nor can we (as explained at the start of the chapter) resort to the time series, represent all relevant variables that affect the size of stocks including that of sales, and see how much of the total variance sales explain.

Nevertheless, I want to make three assumptions and see what they imply. I apply them to ownership and not to stocks alone. The choice is conditioned by the need to concentrate on *intended* behavior. The basic procedure is first to determine sales-linked stocks by applying some assumption about the character of the link between stocks and specific cycle fluctuation in sales, and second to compare the fluctuation in ownership so generated with the actual fluctuation during specific cycles in ownership. The difference is attributed to influences other than those of sales.

The picture is confused insofar as unintended change is caught up and displayed in the comparison, for unintended change can be generated by error in estimating either sales, market conditions, or any other relevant consideration. But unplanned stocks of both the passive and unintended sort distort the pattern of stock on hand far more, it seems reasonable to believe, than they do the pattern of total materials ownership. The timing associations as well as the logic point to this conclusion. For ownership, then, it seems permissible to consider the total *specific fluctuation in ownership* as more or less intended and compare it with the sales-linked part of this total as defined in terms of a specified relationship to the total *specific fluctuation in sales.*[8] The assumptions concerning the efficient sales-stock link, other things assumed unchanged, are:

Assumption A. Efficient service requirements are defined as change in ownership which is proportional to the change in sales when the proportional relationship is specified by the low points in the actual relationship (the figure used is the average for specific cycle troughs in the ratio). This assumption presumably makes the sales-linked portion of change in ownership unrealistically high, and consequently the part requiring further explanation correspondingly too low. Nevertheless, for department stores, an average of three-quarters of the increase in ownership during each specific expansion is accounted for by this assumption, and accordingly one-quarter by factors other than sales. The cycle-by-cycle figures are given in Table 33, line 10a. For durable goods manufacturers, the corresponding hypothetical sales-linked portion of ownership developed in Table 34, also averages three-quarters of the total, and the percentage increases over the period (line 10a).[9] It accounts for *more* than the total during the 1958–59 expansion and during the first year of the expansion starting early in 1961 (Table 34, line 10a).

Assumptions B and C. Both share the basic assumption that the efficient sales-service link implies a constant *incremental* association, plus buffer stocks changing according to a square-root principle. The two assumptions differ only with respect to the size of the ratios that were used.

The incremental ratios that I have selected are in all cases smaller than the average ratio of ownership to sales over the years. For department stores, the average ratio was close to four months' supply. However, I have assumed (C) that if sales are expected to rise, ownership need rise no more than two times the size of the expected increase. I think of

[8] An alternative would be to confine examination to what occurred to ownership during specific cycles in sales only (that is, not those in ownership itself). But this automatically rules out the possibility of viewing the impact of factors whose incidence may not precisely parallel that of sales. In Chapter 11 we make a calculation of this sort because we ask this specific question.

[9] The increase would have been much more marked had not the downward trend in the ratios been recognized in the computation. See Table 34, note b.

TABLE 33

Hypothetical Sales-Linked Change in Ownership, Department Stores, 1948 to 1961

1. Sales, Specific Cycle Dates	P or Exp. 10/48	T or Cont. 7/49	P or Exp. 1/51	T or Cont. 4/51	P or Exp. 5/53	T or Cont. 1/54	P or Exp. 8/57	T or Cont. 2/58	P or Exp. 4/60	T or Cont. 1/61	Average P or Exp.	Average T or Cont.	Average All Phases
2. Standing at P&T (3 mo. av.), mil. $	385.3	351.7	416.5	371.5	408.7	400.3	465.7	445.7	497.3	481.7	+434.7	-410.2	
3. Change during cycle phase, mil. $		-33.6	64.8	-45.0	37.2	-8.4	65.3	-20.0	51.7	-15.6	+54.7	-24.5	±37.9
Hypothetically sales-linked change in ownership under three assumptions[a]													
4a. Assuming aver. ratio of 3.74, mil. $[b]		-125.6	+242.3	-168.3	+139.1	-31.4	+244.6	-74.8	+193.0	-58.3	+204.8	-91.7	±141.9
4b. Assuming incr. ratio of 1.5 mil. $ (line 3x1.5)		-50.4	97.2	-67.5	55.8	-12.6	98.0	-30.0	77.6	-23.4			
4c. Assuming incr. ratio of 2.0 mil. $ (line 3x2.0)		-67.2	129.6	-90.0	74.4	-16.8	130.6	-40.0	103.4	-31.2			
5. Buffer, $2.33\sqrt{D(T+N)}$ mil. $[c]		-2.7	5.4	-3.7	3.1	-0.7	5.2	-1.5	3.9	-1.2			
6b. Assuming ratio of 1.5 + buffer, mil. $ (line 4b + line 5)		-53.1	102.6	-71.2	58.9	-13.3	103.2	-31.5	81.5	-24.6	+86.5	-38.7	±60.0
6c. Assuming ratio of 2.0 + buffer, mil. $ (line 4c + line 5)		-69.9	135.0	-93.7	77.5	-17.5	135.8	-41.5	107.3	-32.4	+113.9	-51.0	±79.0
Actual ownership													
7. Specific cycle dates for ownership	12/47	6/49	2/51	10/51	6/53	5/54	7/57	5/58	5/60	12/60			
8. Standings at P&T (3 mo. av.) mil. $	1575.0	1255.0	1848.7	1495.7	1623.3	1510.3	1814.0	1735.0	2007.7	1953.3	+1773.7	-1589.9	
9. Change during cycle phase, mil. $		-320.0	593.7	-353.0	127.6	-113.0	303.7	-79.0	272.7	-54.4	+324.4	-183.9	+246.3

(continued)

TABLE 33 (concluded)

	P or Exp. 10/48	T or Cont. 7/49	P or Exp. 1/51	T or Cont. 4/51	P or Exp. 5/53	T or Cont. 1/54	P or Exp. 8/57	T or Cont. 2/58	P or Exp. 4/60	T or Cont. 1/61	Average P or Exp.	Average T or Cont.	Average All Phases
Percentage relationship: hypothetically sales-linked change in ownership to actual change													
10a. Under assumption A (line 4a ÷ line 9)		39.2	40.8	47.7	109.0	27.8	80.5	94.7	70.8	107.2	75.3	63.3	68.6
10b. Under assumption B (line 6b ÷ line 9)		16.6	17.3	20.2	46.2	11.8	34.0	39.9	29.9	45.2	31.9	26.7	29.0
10c. Under assumption C (line 6c ÷ line 9)		21.8	22.7	26.5	60.7	15.5	44.7	52.5	39.3	59.6	41.9	35.2	38.1
Ratio, change in ownership to change in sales													
11. Actual (line 9 ÷ line 3)		9.52	9.16	7.84	3.43	13.45	4.65	3.95	5.27	3.49	5.63	7.65	6.75
12a. Under assumption A (line 4a + line 3)		3.74	3.74	3.74	3.71	3.74	3.75	3.74	3.73	3.74	3.74	3.74	3.74
12b. Under assumption B (line 6b ÷ line 3)[d]		1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58
12c. Under assumption C (line 6c ÷ line 3)[d]		2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08
Ratio, level of ownership to level of sales, actual and hypothetical (when change during expansion under three assumptions is added to actual trough standing)[e]													
13. Actual (line 8 ÷ line 2)		3.57	4.44	4.03	3.97	3.77	3.90	3.89	4.04	4.06	4.09	3.86	3.96
13a. Under assumption A			3.59		4.00		3.77		3.88		3.81		
13b. Under assumption B			3.26		3.80		3.46		3.85		3.59		
13c. Under assumption C			3.33		3.85		3.53		3.70		3.60		

Notes to Table 33

[a]Assumptions are (A) the ownership-sales ratio is constant and its level is averaged for the three major troughs; (B) the ratio of change in ownership to change in sales (incremental ratio) is constant at 1.5 months; sales plus allowance for insurance stock; (C) same as B, but an incremental ratio of 2 months' sales.

[b]The ratio of 3.74 is applied to the *standings* at peaks and troughs; rises and falls are calculated using these figures.

[c]The formula utilizing the Poisson distribution, at a level that permits stockouts 1 per cent of the time is $2.33\ D\sqrt{(T+N)}$. D is 1 month's sales, T (The replenishment period) is assumed to be 1 month, and N (The order interval) 2 weeks; thus we solve for $2.33\sqrt{1.5(D)}$.

[d]Note that these ratios round to the same figure because line 5 represents so small a portion of the total and does not vary enough to change the number and the second decimal place.

[e]To illustrate: Trough standing of ownership, 6/49, from line 8 (1255.0) plus sales-linked rise in ownership, 7/49 to 1/51, from line 4a (242.3) = hypothetical standing under assumption A of 1497.3. This divided by sales from line 2 is $\frac{1497.3}{416.5}$ or 3.59.

this as consisting of about an extra six weeks' supply on hand and two weeks' on order.[10] Analogous remarks apply to falls. Assumption B cuts the incremental requirement to six weeks' supply. For durable goods manufacturers, the same figures were used—the B and C assumption is that change in sales require changes in materials ownership one and a half times and two times as large respectively. I picture the distribution for durables as consisting of two weeks on hand under both assumptions whereas four weeks and six weeks are held on order under B and C respectively. I am afraid that the C assumption is rather too large. To apply these relationships to the data, the ratios are cut in half to allow for value added in the sales dollar. The specifics of the calculation are given in notes to Tables 33 and 34. I shall not repeat them, since it is probably simpler to study the details of the calculation in connection with the figures themselves.

The logic that underlies selections is contained in Chapter 2. An incremental ratio that is substantially smaller than the average ratio implies that the level of total stocks is supported by a number of things which, on the one hand, it is not desirable to duplicate and, on the other hand, not worthwhile to eliminate—the history of previous purchases, some less successful than others, the need to carry slow-moving items, the need in some cases to make long forward commitments, the cost of tailoring stock to precise requirements. I do not hold any special brief for the particular parameters that were chosen, and it might be interesting to try some further alternatives. But I think that the C lines at any rate define efficient sales-service requirements sufficiently liberally to provide a very conservative estimate of the portion of ownership that must be explained in terms of "other factors." [11]

[10] For convenience I have equated two weeks with half a month.

[11] An alternative calculation, on which it may be useful to report, was tried and abandoned. The factors that determine the average, as distinguished from the incremental, association are, in one sense at least, also part of what may be thought of as an efficient sales-ownership relationship. They imply that higher levels of sales require higher levels of ownership. But the dynamics of the association would seem to involve long-term influences that settle back into these overall relationships rather than anything that needs to be, or indeed should be, an explicit management goal.

This line of thought suggests that a simulation of an efficient sales-ownership link might have two parts: (1) a trend part that takes account of an increase in ownership corresponding to the long-term trend in sales, (2) a cyclical part built on an incremental principle.

I made such calculations for expansions, but found that they came to grief when they were applied to contractions. For durable goods, a six-week incremental ratio was used to define the cyclical component of sales-linked change in ownership. Total sales-linked change—trend plus cycle—represented 51 per cent of the total actual increase in ownership. This figure is comparable to that of 58 per cent for the two-month incremental relationship alone (see text below). The corresponding figure for department stores, using a

TABLE 34

Hypothetical Sales-Linked Change in Ownership, Durable Goods Manufacturers, 1948–1961

1. Specific Cycle Dates for Shipments	P or Exp. 12/48	T or Cont. 10/49	P or Exp. 7/53	T or Cont. 10/54	P or Exp. 1/57	T or Cont. 4/58	P or Exp. 6/59	T or Cont. 1/61	a 4/62	Average P or Exp.	Average T or Cont.	Average All Phases
2. Standing at P&T (3 mo. av.), mil. $	7,860	6,736	12,794	10,889	14,758	11,615	15,557	13,370	16,377	12,742	10,653	
3. Change during cycle phase, mil. $		-1,124	+6,058	-1,905	+3,869	-3,143	+3,942	-2,187	+3,007	+4,623	-2,090	±3,175
Hypothetical sales-linked change in ownership under three assumptions[b]												
4a. Assuming aver. ratio with trend, mil. $[c]		-2,146	+8,547	-3,592	+4,816	-5,201	+4,976	-3,687	+3,344	+6,113	-3,657	±4,709
4b. Assuming incr. ratio of 1.5, mil. $[b] (line 3x.75)		-843	+4,544	-1,429	+2,902	-2,357	+2,957	-1,640	+2,255	+3,468	-1,567	±2,382
4c. Assuming incr. ratio of 2.0, mil. $[b] (line 3x1.00)		-1,124	+6,058	-1,905	+3,869	-3,143	+3,942	-2,187	+3,007	+4,623	-2,090	±3,175
5. Buffer = to 2.33 $\sqrt{D(T+N)}$ mil. $[d]		-16[d]	+72	-21	+40	-30	+40	-21	+28	+51	-22	±34
6b. Assuming incr. ratio 1.5 + buffer, mil. $ (line 4b + line 5)		-859	+4,616	-1,450	-2,942	-2,387	+2,999	-1,661	+2,283	+3,519	-1,589	±2,416
6c. Assuming incr. ratio 2.0 + buffer, mil. $ (line 4c + line 5)		-1,140	+6,130	-1,926	+3,909	-3,173	+3,982	-2,208	+3,035	+4,674	-2,112	±3,210
Actual ownership												
7. Specific cycle dates for ownership	8/48	9/49	9/52	10/54	2/57	6/58	1/60	12/60	3/62[a]			
8. Standings at P&T (3 mos. av.) mil. $	16,874	12,533	27,703	17,376	25,341	18,277	22,983	18,750	21,953	2,323	16,734	
9. Change during cycle phase, mil. $		-4,341	+15,170	-10,327	+7,965	-7,064	+4,706	-4,233	+3,203	+9,280	-6,491	±7,687

(continued)

TABLE 34 (concluded)

	P or Exp. 12/48	T or Cont. 10/49	P or Exp. 7/53	T or Cont. 10/54	P or Exp. 1/57	T or Cont. 4/58	P or Exp. 6/59	T or Cont. 1/61	a 4/62	Average P or Exp.	Average T or Cont.	Average All Phases
Percentage of hypothetically sales-linked change in ownership of actual change												
10a. Under assumption A (line 4a ÷ line 9)		49.4	56.3	34.8	60.5	73.6	105.7	87.1	104.4	74.2	61.2	66.8
10b. Under assumption B (line 6b ÷ line 9)		19.8	30.4	14.0	36.3	33.8	63.7	39.2	71.3	43.5	26.7	33.9
10c. Under assumption C (line 6c ÷ line 9)		26.3	40.4	18.7	49.1	44.9	84.6	52.2	94.8	58.0	35.5	45.2
Ratio of change in ownership to change in sales												
11. Actual (line 9 ÷ line 3)		3.86	2.50	5.42	2.06	2.25	1.19	1.94	1.07	1.92	3.37	2.75
12a. Under assumption A (line 4a ÷ line 3)		1.91	1.41	1.89	1.24	1.65	1.26	1.69	1.11	1.30	1.79	1.58
12b. Under assumption B (line 6b ÷ line 3)		.76	.76	.76	.76	.76	.76	.76	.76	.76	.76	.76
12c. Under assumption C (line 6c ÷ line 3)		1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Ratio of level of ownership to level of sales, actual and hypothetical (change during expansion under three assumptions is added to actual trough standing)[e]												
13. Actual (line 8 ÷ line 2)	1.86		2.17	1.60	1.72	1.57	1.48	1.40	1.34	1.79	1.61	1.69
13a. Under assumption A[e]			1.65		1.50		1.49		1.35	1.55		
13b. Under assumption B[e]			1.35		1.38		1.37		1.28	1.37		
13c. Under assumption C[e]			1.46		1.44		1.43		1.33	1.44		

Notes to Table 34

[a]A high point in 1962, which does not constitute a specific cycle peak, provides an additional comparison. It is not included in the averages.

[b]Assumptions are: (A) An average ratio of ownership to shipments proper applies. The level of the ratio is indicated by its position at troughs. Since these are subject to a constant downward trend, values are read from a straight line on semi-log paper visually fitted to the 3 trough values. (B) An incremental ratio of change in ownership to change in shipments applies; the ratio is taken at 1.5 months; shipments (two weeks on hand and one month on order). But since value added is presumably about half of value of product, the equivalent book value of materials adjusted for value added is $\frac{1.5}{2}$ = .75 months; sales. (C) The ratio is taken at 2 months, sales; adjusted for value added, it is a ratio of 1.0.

[c]The ratios read from the trend line at each peak or trough month were applied to the standing of shipments. The ratios used (see note b) were, 12/48 1.79, 10/49 1.77, 7/53 1.60, 10/54 1.55, 1/57 1.47, 4/58 1.42, 6/59 1.38, 1/61 1.33, 4/62 1.29. Changes between these hypothetical hand-to-mouth levels of ownership constitute the entries in line 4a.

[d]The formula utilizing the Poisson distribution, $2.33\sqrt{D(T+N)}$, was applied under the assumption that the replenishment period, D,T was 6 weeks and, the order interval 2 weeks. Thus the variance allowance is for 2.33 $\sqrt{2}$ mo. shipments. Adjusting to allow for value added and the figure to 1 mo.; e.g., $2.33\sqrt{7,860}$ = 207, $2.33\sqrt{6736}$ = 191, change in buffer = 16.

[e]To illustrate: Trough study of ownership 9/49 from line 8 (12,533) plus sales-linked rise in ownership 10/49 to 7/53 from line 4a (4,544) = hypothetical standing under assumption A of 21,080. This divided by shipments 7/53 from line 2 is $\frac{21,080.}{12,794}$ or 1.65.

The tables show that for assumption C the sales-linked portion of total actual specific cycle expansions in ownership is, hypothetically, 42 per cent and for durable goods 58 per cent. During contractions for either type of enterprise it was only 35 per cent (Tables 33 and 34, line 10c). As we have seen in several contexts, the sales-linked aspect played a larger relative part in the late fifties and in the sixties than in the earlier postwar years. This was particularly true of durable goods manufacturers. Indeed our calculations show that for the first year of the prosperity of the sixties (the only portion of the long expansion for which figures consistent with earlier years are available) virtually the entire change would be attributed to the sales link under the C assumption. If the linked extrapolations (as charted) are used to extend the relationship, even the B assumption overexplains the entire actual change in ownership.

The same set of contrasts can be evaluated in somewhat different terms by examining the relations between ownership and sales that are implied. In the first place, note that the actual incremental ratios (the relation between specific cycle changes in ownership and in sales) are substantially larger than the average ratios (the relation between the level of ownership and the level of sales taken at peaks and troughs)—6.75 and 3.96 for department stores. For durable goods manufacturers the figures are 2.75 and 1.69, which, adjusted for value added, would be about 5.50 and 3.38 (last column, lines 11 and 13 in both tables). It is also noteworthy that the difference dwindles very markedly in the later years of the period under study.

Businessmen seem to speak and think primarily in terms of average ratios. It seems odd, therefore, that the marked differences between

one-month incremental component, was 52 per cent (as compared with 42 per cent for the two-month incremental supply).

I abandoned these estimates because of their implication about the efficient relationship during *contractions*. The assumption that the trend rise in ownership should continue through contractions (and otherwise what is the meaning of a "trend"?) virtually ruled out an "efficient" sales-linked absolute *decline* in ownership, particularly for department stores. This does not seem at all sensible.

average and incremental ratios is not well publicized. It is possible that the reason is simply that unless attention is actually focused on the increments, it would be easy not to notice the disparity. The *average* ratios perhaps do not change enough as a result of the incremental change to call executive attention to discrepancies between plans and actuality. For example, would a ratio of 4.1 (4.0 if the Korean peak were excluded) at peaks in department store sales and ownership be noted as clearly different from the trough ratio of 3.9 (line 13)? For durable goods manufacturers, the same question applies to ratios in book-value terms of 1.8 and 1.6.[12]

I raise the question without knowing the answer. But if it is true that differences of this order do not flash blinking lights in management offices, perhaps the same line of thought would help to explain why actual incremental ratios can depart so far from those which represent efficient servicing of sales, other things the same. For department stores, the actual ratios at peaks in sales averaged 4.0 months of sales if the Korean episode is excluded, and the same figure applies to peaks in the ratio itself. If the incremental ratio had been constant at the trough average (assumption A), the peak standings would have averaged 3.8. If the incremental ratio of 2 had been applied, the peak standings would have averaged 3.6 (summary columns, lines 13a–c). Do differences of this order present problems to managements? They may realize stock *can* be economized while business improves, but the need to do so may not seem urgent. For durable goods manufacturers the peak ratio actually experienced averaged 1.8, excluding Korea. At peaks the ratio averaged 1.5 under assumption A and 1.4 under assumption C.

I wish I could rephrase these questions to apply to stock on hand rather than to total materials ownership. But, as mentioned earlier, the unintended aspect of change in stocks leaves me baffled. In any event, the question that I raise is simply whether the implied change in ownership associated with factors other than change in sales is of an order of magnitude which is likely to worry executives trained in the constant-ratio rule of thumb. Most of the other influences with which this study is so particularly concerned can perhaps be sheltered under the generous umbrella of what passes for a constant-average ratio, tilted a bit this way in recognition of good times and that way in recognition of bad times. If so, it is an interesting arithmetic which can produce figures that appear unimportant at a micro-economic level, but have highly significant implications for the economy at large.

What, then, are some of these other factors that influence ownership?

[12] This question may mean that one ought to think in terms of the actual experienced ratios and *their* peak and trough differences. For the periods covered in the tables, the average standing of the ratios for department stores at their specific cycle peaks, excluding the Korean episode, was also 4.0; for troughs it was 3.7. For durables, the peak and trough ratios were 2.1 and 1.6 respectively; excluding the Korean episode, they were 1.8 and 1.6.