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Volume Author/Editor: Victor Zarnowitz

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Chapter Author: Victor Zarnowitz

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PART I

THE RELATIONSHIPS BETWEEN NEW ORDERS, PRODUCTION, AND SHIPMENTS

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THE ROLE OF ORDERS IN INDUSTRIAL PRODUCTION

Manufacture to Stock and to Order

Two Contrasting Models and Their Significance

It will be helpful to introduce two simple models: one, pure production to stock, and the other, pure production to order. In the first, new orders are shipped immediately upon receipt and hence are virtually synchronous with and equal to shipments. Orders that cannot be so filled are either not placed or not accepted; thus, in the absence of advance orders in the real sense, there are no backlogs. The firm has to maintain, at all times, a sufficiently large unsold inventory of finished products to meet current sales. In contrast, the second case, by assuming production to order only, implies that there are no *unsold* stocks of the finished product.[1] Lacking such stocks, the firm cannot, of course, handle orders for immediate delivery and is limited to advance orders.[2]

A manufacturing concern is typically a multiproduct firm, often with a highly diversified output. Some of its products may be made to stock and others to order. Some may also shift from one category to the

[1] This ignores cancellations of orders, which may give rise to some unsold finished stocks, but the qualification is probably not a major one. The relevant data are scanty, but they indicate that cancellations are relatively unimportant (see the second part of this chapter, beginning with the section "Comparing Long-Term Average Levels of Orders Received and Filled"); and cancellations that occur after the items ordered have been produced must be least frequent because of the large risk of loss, which the seller will try to avoid.

[2] To formulate these two models algebraically, let n_t and s_t be the flows of orders received and shipped, respectively, during the tth unit period, say month, and let z_t be the corresponding flow of output or production. Then $n_t - s_t \equiv u_t - u_{t-1} \equiv \Delta u_t$, and $z_t - s_t \equiv q_t - q_{t-1} \equiv \Delta q_t$, where u_t is the backlog, i.e., stock of unfilled orders, and q_t is the finished-product inventory on hand, both measured at the end of period t. In pure production to stock, $n_t = s_t$ and $\Delta u_t = 0$ in each period, so that u_t is always zero. In pure production to order, $z_t = s_t$ and $\Delta q = 0$ in each period, so that q_t is always zero.

other at certain times. In particular, a product normally sold from stock may temporarily be made to order when orders for it run at peak levels and customers allow lags on their deliveries. But there are good reasons to believe that some goods are produced to order and others to stock because of certain "structural" considerations.

Production will not be to stock if the costs of stocking the product in finished form exceed the costs of having to meet demand exclusively from future outputs. Under this condition, production will be to order if it promises to be sufficiently profitable to be undertaken at all. The costs that must be considered include intangibles that are not easily assessed in dollars (or any other comparable units). Usually, the comparison will take the form of probability considerations involving expected values of the respective net costs. The principal factor is the cost of not selling the stocked product or, more accurately, selling it only at a loss—what might be called a "liquidation loss." If there is a long delay before the sale can be accomplished, substantial carrying charges may arise, but these are often not nearly as important as the liquidation loss. On the other hand, the main cost of not having an item in stock is the loss of potential sales or customer goodwill when there is excess demand. This, however, implies that the customer is not willing to wait for delivery. Clearly, if buyers generally expect immediate deliveries, the product will have to be held in stock.

It may be well to note that manufacture to order need not be characterized by small *total* inventories, only by small stocks in finished-product form. Manufacturers of products made to order will normally hold inventories of purchased materials, which may include, along with "raw" commodities, various fabricated items such as standardized parts, components, and supplies. These stocks help to keep the delivery periods as short as competition requires (given the existing technological constraints). The higher the average degree of fabrication of these stocks, the better they can perform this function. But, presumably, with increased fabrication the inventories will also be increasingly sensitive to the liquidation losses, which, by assumption, are prohibitively large at the finished-product stage, as viewed by the manufacturer.[3]

[3] Cf. J. A. Bryan, G. P. Wadsworth, and T. M. Whitin, "A Multi-stage Inventory Model," *Naval Research Logistic Quarterly*, March–June 1955 (reprinted in T. M. Whitin, *The Theory of Inventory Management*, 2nd ed., Princeton, N.J., 1957, pp. 281–98).

Furthermore, the finished product itself will often be held in stock by the distributor who ordered it from the manufacturer. The distributor, by assumption of the stock-holding function, will then have enabled the manufacturer to produce to order.[4]

Types of Goods Made to Order

The goods for which manufacturers demand, and their customers must allow, "lead times" in filling orders are those that can be held in producer inventory only at very great cost and risk for one or more of the following reasons: (1) The product must precisely meet individual consumer specifications that are virtually unpredictable; (2) the product is, in its finished form, physically or economically perishable, even though it is made from materials that are durable; (3) the product has an extremely unstable or sporadic demand, which is very difficult to forecast.

In the first category belong many diverse goods purchased by expert buyers for special industrial purposes. The extreme subgroup consists of items so differentiated by the buyers' requirements that each customer's order must be handled separately in production; there is no possible combination of orders into batches that can be executed jointly by the producer. Thus, many types of machine tools are highly specialized, with models built to perform a single operation with maximum speed and efficiency.[5]

Such uniqueness of orders clearly imposes limitations, which may be severe, upon the scale of operations and size of a firm. A job machine shop is an example. But manufacture to order is not by any means restricted to these individually differentiated orders. A much larger share of it is accounted for by orders that, while retaining certain individual features, can nevertheless be aggregated into batches to be processed and filled together. Thus, many steel and other metal products are made to customers' specifications regarding dimension and chemical composition. Fabricated plates and sheets are cut to size to

[4] It has often been asserted that it is irrelevant *who* is holding the inventories, and for *certain* problems this is undoubtedly true. However, for other important problems the economic identity of the inventory holder is very relevant. This will be made clear at several points in this study.

[5] Moreover, competition within this industry largely involves changes in design and quality, the success of which depends to a great extent upon close cooperation between builder and prospective user. This industry characteristic should also favor production to order—and it may apply even to those equipment varieties that have more general uses and are therefore capable of considerable standardization.

fill specific orders; structural steel is produced in several hundred different shapes and sizes.[6]

The second category consists of products that cannot be stored over longer periods or in larger quantities without losing much of their value or causing excessive cost or risk. The timing of the production of such items is not influenced by changes in the raw material supply, because the material they are made of can be stored (or used for producing other goods). Products of this kind will be made only to the extent that they can be promptly shipped to outside users or used by their producers. Some producer nondurables belong in this category; for example, certain chemicals (such as explosives) deteriorate with age and/or are dangerous to store.[7] But, other than such special producer goods, most of this class consists of style-sensitive consumer goods. Thus, women's dresses are rapidly made and shipped to order to the distributors, to be sold to consumers before the garments go out of fashion. Only in lines that sell particularly well will a dress manufacturer risk producing a certain stock against the expected seasonal requirements. In most lines, he will only prepare samples and perhaps some small stock to meet the first orders for the coming season. This applies to many other apparel items, especially in the higher-priced lines.

Goods that are less affected by the vagaries of fashion are also primarily manufactured to order if there are specific requirements of the buyers that reflect the varying preferences of the individual consumer in style, color, size, and material. Shoe production, for example, is mostly on an order basis.[8] This then is an overlap of categories 1 and 2.

The third category includes producer durables that are made to order because they are sold to a small number of large companies at infrequent intervals and in quantities varying widely according to the changing business situation in the consuming industry. Railroad equipment, such as rolling stock and rails, offers a classic example. Goods

[6] Cf. Jack Hirshleifer, "The Firm's Cost Function: A Successful Reconstruction," *Journal of Business*, July 1962, pp. 235–55. Hirshleifer uses examples from nonmanufacturing industries (transportation and electric power) to illustrate production to aggregated rather than individual orders.

[7] The damage in case of accident is, of course, directly related to the size of stock. According to an early report, business in this industry is predominantly to order and average stocks seldom exceed seven to ten days' production (dynamite) or a month's supply (black powder). See Edwin G. Nourse and Associates, *America's Capacity to Produce*, Washington, D.C., Brookings Institution, 1934, p. 290. Commerce data for 1923–31 (discontinued later because of small coverage) indicate an average of about two weeks' output for stocks of all high explosives.

[8] Ruth P. Mack, *Consumption and Business Fluctuations: A Case Study of the Shoe, Leather, Hide Sequence*, New York, NBER, 1956, p. 142.

will be produced only upon order if they are characterized both by sporadic or unpredictable demand and by the high cost of filling even the smallest possible order. For example, locomotives or ships cannot be ordered in less than one unit, and even one such unit is very expensive.

Furthermore, even goods that have none of the characteristics which would make their production to stock obviously inadvisable—goods that are staple, low priced, in popular demand, and not perishable—may be produced to order under conditions of great instability and uncertainty. After the painful experiences of the 1930's, the textile industry's concern with the frequent recurrence of both heavy stock accumulations and drastic production curtailments led to an intensive reevaluation of the merits of manufacturing to stock. This was done even for cotton print cloth, a highly standardized product with a diversified demand.[9] In fact, a number of cotton textile products that are only slightly differentiated are woven mostly to order. Textile mills operate in conditions of high short-run instability. Demand for their products is volatile, with strong seasonal patterns as well as cyclical influences. More importantly, there are short but sharp speculative ordering movements that chiefly reflect the anticipation by professional textile buyers of changing prices and shifts in popularity. These fluctuations in buying are extremely difficult to forecast. The cost of output curtailments is high, but so also is the risk of carrying large unsold stocks.[10]

A Criterion for Determining the Prevalent Type of Manufacture

For a good made only to stock, unfilled orders (U) are nil.[11] For a good made only to order, total inventory in finished-product form (Q) is small: Unsold finished stocks tend to be nil (see note 1, above), and

[9] See Hiram S. Davis, "Controlling Stocks of Cotton Print Cloth," *Inventory Policies in the Textile Industries*, No. 5, Washington, D.C., Textile Foundation, 1941.

[10] To what extent these conditions are peculiar to the textile industry, I am not prepared to say. However, it is reported that certain staple materials used in construction (an industry which also faces very unstable demand) are frequently produced to order. The function of wholesaling them and maintaining adequate inventories for that purpose is customarily assumed by distributors; so the manufacturer is largely relieved of the finished-stock burden. Because of this, he sometimes offers the distributors protection against price rises between the receipt of an order and the time of shipment, and the benefits of price declines during the same period. For some historical examples, see Temporary National Economic Committee, *Geographical Differentials in Prices of Building Materials*, Monograph No. 33, 76th Cong., 2nd sess., Washington, D.C., 1940, pp. 66 and 288.

[11] Capital letters denote aggregative variables for individual or major industries, while small letters refer to microvariables (e.g., u is unfilled orders of a given product held by an individual firm; U is unfilled orders of an industry or group of firms). The available data pertain as a rule to aggregative variables. The equations in note 2, above, are valid, *mutatis mutandis* (when expressed in common units such as current-dollar or constant-dollar values) for the aggregative variables as well as the micro ones.

sold stocks would accumulate in large volume only if deliveries lagged behind output by long intervals, which is unlikely. Certainly, Q would in this case be very small *relative to* U. Industries for which there are data on both Q and U cannot be working to stock only; as a rule, they include both production to order and production to stock in various proportions. By comparing the average levels of the Q and U series for these industries, one may determine the relative importance of the two types of production. The larger the proportion of its output that is made to order, the closer an industry will come to resemble the model of pure manufacture to order—and the lower will be its typical Q/U ratio. Conversely, the larger the proportion of its output made to stock, the closer an industry will approach the opposite extreme—and the higher its typical Q/U.

Specifically, one must average the monthly values of Q for each complete calendar year covered by the data, then do the same with U; compute the ratio of these averages ($\bar{Q}/\bar{U}$) for each year; and judge from these ratios, expressed as percentages, whether for the given industry $\bar{Q}/\bar{U}$ is typically larger than 100 or smaller than 100 (or whether it is merely varying around 100 with no systematic preponderance of either $\bar{Q}$ or $\bar{U}$). If $\bar{Q}$ typically exceeds $\bar{U}$, production to stock is said to prevail; if $\bar{U}$ typically exceeds $\bar{Q}$, production to order prevails.

The method must allow for the presence of pronounced cyclical fluctuations in the stock-backlog ratios. During a vigorous expansion of demand for its output, an industry is likely to experience both a fall in its finished-goods inventory and a rise in its unfilled orders. Conversely, contracting demand will be associated with increases in unsold stocks and decreases in order backlogs. Hence Q/U should move inversely to cycles in the given industry's business. Indeed, the ratios studied show a strong inverted conformity to the business cycle at large. They tend strongly to increase between a peak and a trough year, and to decrease between the trough and the subsequent peak year (the dates being those of the National Bureau annual reference chronology).

Table 2-1 takes account of the cyclical factor in the movement of the stock-backlog ratios by presenting the averages of these ratios separately for the expansion (including peak) years and the contraction (including trough) years. In the late 1950's and early 1960's, unfilled orders had a strong downward trend in most manufacturing industries, while finished inventories continued to show a strong upward trend.

Consequently, the Q/U ratios have increased sharply. As a result, the ratios are high for many years in the "expansion" class, since there were few contraction years in the postwar period. Nevertheless, the averages—medians are used to avoid distortion by the unrepresentative extreme items—are in all but a few cases higher for the contraction and trough years than for the expansion and peak years (compare columns 7 and 8). For the individual industry and product series, which cover the interwar and early postwar years, the differences between the two categories are typically large.

If the $\bar{Q}/\bar{U}$ percentage ratios were higher than 100 in each of the contraction and trough years and lower than 100 in each of the expansion and peak years, I would interpret this to mean that the industry in question showed no consistency in working either primarily to order or primarily to stock, but was merely subject to cyclical shifts in which either one or the other type of production prevailed. But there is no example of such behavior of the ratios in the available data. Instead, the annual series of the average $\bar{Q}/\bar{U}$ ratios, although they all fluctuate cyclically, group themselves easily into two major categories: those which in most years—expansion and contraction alike—move substantially above the level of 100, and those which move in a parallel fashion below that level.[12] The former, then, may be regarded as representing goods typically made to stock and the latter as representing goods typically made to order. In the individual-product sample of Table 2-1, the two groups are about equal in number. The inclusion of peak years in the measures for expansion and of trough years in the measures for contraction could bias the results, since the averages of the ratios in expansion years other than the peak year and of the ratios in contraction years other than the trough year need not necessarily show the inverse cyclical conformity that is generally indicated in Table 2-1. (This has been pointed out to me by Geoffrey Moore.) Separate averages were therefore computed for four subsets of data: expansion, peak, contraction, and trough years. With very few exceptions, the median $\bar{Q}/\bar{U}$ ratios turned out to be larger for the contraction than for the expansion years as well as larger for the trough than for the peak years. The exceptions are slight: They relate either to cases in which only one or two observations are available for the subsets to be compared (mainly the

[12] Only about 10 per cent of the more than 600 observations fall in the zone about the critical level of the ratios, between 80 and 120.

Table 2-1

Average Ratios of Finished Stocks to Unfilled Orders, Forty Industries and Products, Various Periods, 1913–64

Industry or Product [a]	Period Covered [b] (1)	No. of Years Covered [c]: Exp. and Peak Years (2)	No. of Years Covered [c]: Cont. and Trough Years (3)	No. of Years in Which [d]: $Q/U < 100$ (4)	No. of Years in Which [d]: $Q/U > 100$ (5)	Median of $\bar{Q}/\bar{U}$ Ratios [d]: All Years Covered (6)	Median of $\bar{Q}/\bar{U}$ Ratios [d]: Exp. and Peak Years [c] (7)	Median of $\bar{Q}/\bar{U}$ Ratios [d]: Cont. and Trough Years [c] (8)
Primary metals								
Merchant pig iron (OR)	1919–26	5	3	7	1	66.2	56.9	75.4
Steel sheets (OR)	1919–36	11	7	17	1	34.4	44.7	30.6
Fabricated metal products								
Steel barrels and drums, heavy type (OR)	1933–54	17	5	22	0	2.2	2.4	0.7
Oil burners (ST)	1929–52	17	7	6	18	228.4	190.7	588.6
Bathtubs (ST)	1919–31	7	6	5	8	150.9	102.8	261.8
Lavatories, sinks, and misc. enameled sanitary ware (ST)	1919–31	7	6	4	9	261.4	261.4	333.8
Wire cloth (OR)	1924–39	10	6	3	13	271.4	164.8	463.1
Clay and glass products								
Illuminating glassware (ST)	1923–37	10	5	0	15	304.3	223.6	408.6
Face brick (ST)	1923–35	8	5	1	12	325.2	284.5	359.0
Lumber and wood products								
Total hardwoods (ST)	1925–31	4	3	0	7	494.9	479.9	591.2
Southern pine lumber (ST)	1929–55	19	8	0	27	515.3	477.2	647.0
Do.	1947–64	14	4	0	18	586.2	556.3	644.8
Western pine lumber (ST)	1947–64	14	4	0	18	435.7	463.0	388.6
Douglas fir lumber (ST)	1947–64	14	4	2	16	161.4	159.4	165.2

Oak flooring (ST)	1913–55	31	12	17	26	138.7	138.1	157.1
Do.	1947–64	14	4	4	14	147.5	147.5	176.5
Maple flooring (OR)	1929–54	18	8	11	15	140.3	140.3	173.8
Do.	1947–64	14	4	15	3	76.2	65.6	89.2
Paper and paper products								
Boxboards (OR)	1924–32	4	5	6	3	56.7	56.0	112.5
Paper, excl. building paper, newsprint, and paper-board (ST)	1934–55	17	5	15	7	62.6	62.0	72.1
Textile products								
Hosiery, total (ST)	1924–30	4	3	1	6	130.6	146.5	130.6
Women's full fash. hosiery (ST)	1928–39	8	4	0	12	299.9	282.2	375.8
Knit underwear, cotton, wool and mixtures [e]	1934–38	4	1	3	2	98.1	93.6	150.8
Rayon cut from own fabrics (ST)	1934–38	4	1	0	5	363.1	340.9	471.0
Sheets (ST)	1928–38	7	4	3	8	179.6	135.0	210.8
Denims (OR)	1928–38	7	4	10	1	77.8	77.8	84.1
Wool, menswear (OR)	1935–39	4	1	5	0	42.7	38.8	71.1
Women's wear [e]	1935–39	4	1	3	2	83.0	77.8	107.2
Carded cottons, wide plain print cloth (OR)	1928–38	7	4	8	3	80.5	80.5	89.9
Combed cottons, lawns (ST)	1930–31; 1933–38	4	3	1	7	202.3	131.1	376.4
Colored yarn shirtings (OR)	1934–38	4	1	5	0	12.4	12.8	10.9
Staple rayons, taffeta [f]	1934–39	5	1	5	1	59.0	58.9	106.4
Cotton yarn								
Carded weaving (OR)	1928–38	7	4	11	0	36.9	29.1	43.6
Carded knitting (OR)	1928–38	7	4	11	0	26.5	20.8	26.0

(continued)

Table 2-1 (concluded)

Industry or Product [a]	Period Covered [b] (1)	No. of Years Covered [c]: Exp. and Peak Years (2)	Cont. and Trough Years (3)	No. of Years in Which [d]: $Q/U < 100$ (4)	$Q/U > 100$ (5)	Median of $\bar{Q}/\bar{U}$ Ratios [d]: All Years Covered (6)	Exp. and Peak Years [c] (7)	Cont. and Trough Years [c] (8)
Textile products (cont.)								
Worsted yarn								
Bradford knitting (OR)	1935–39	4	1	5	0	34.4	34.8	28.6
Broadwoven goods (OR)	1946–64	15	4	19	0	41.0	42.0	41.0
Major-industry aggregates [g]								
Primary metals (OR)	1948–55	6	2	8	0	13.9	13.6	24.0
Do.	1953–64	9	3	12	0	24.4	17.4	27.5
Machinery, total (OR)	1946–55	7	3	10	0	17.9	15.8	23.1
Do.	1953–64	9	3	12	0	21.4	20.7	22.1
Transportation equipment (OR)	1946–55	7	3	10	0	6.0	5.4	6.6
Do.	1953–64	9	3	12	0	3.5	3.6	3.4
Paper (OR)	1946–55	7	3	10	0	44.6	35.7	58.9
Durable goods industries, total (OR)	1939–55	13	4	17	0	11.3	11.3	13.0
Do.	1953–64	9	3	10	0	16.6	16.0	17.2
Nondurable goods industries, total (ST)	1939–55	13	4	4	13	162.1	162.1	189.5
Do.	1953–64	9	3	0	12	284.7	282.7	286.7
All manufacturing industries (OR)	1939–55	13	4	17	0	22.6	22.6	26.6
Do.	1949–62	10	4	14	0	29.3	23.6	36.1

Notes to Table 2-1

Source: Steel barrels and oak flooring (1947–64): U.S. Department of Commerce, Bureau of the Census; wire cloth: Wire Cloth Manufacturers' Association; illuminating glassware: Illuminating Glassware Guild; face brick: American Face Brick Association; total hardwoods: Hardwoods Manufacturers' Institute; western pine lumber: Maple Flooring Manufacturers' Association; textiles, except series on staple rayon, cotton yarn, worsted yarn, and broadwoven goods: Hiram S. Davis, "Inventory Trends in Textile Production and Distribution," Number Seven of *Inventory Policies in the Textile Industries*, The Textile Foundation, Washington, D.C., 1941, p. 27; textile products not in preceding source and primary metals: U.S. Department of Commerce, Office of Business Economics. For sources underlying the remaining items see Appendix A.

[a] (ST) signifies goods made primarily to stock; (OR), goods made primarily to order.

[b] Identifies the complete calendar years for which the average ratios of finished stocks to unfilled orders were computed.

[c] Identified according to the annual reference chronology of the National Bureau. For the calendar-year dates of business cycle peaks and troughs in the United States see A. F. Burns and W. C. Mitchell, *Measuring Business Cycles*, New York, NBER, 1947, Table 16, p. 78.

[d] $\bar{Q}/\bar{U}$ denotes ratio of finished-goods inventory ($\bar{Q}$) to unfilled orders ($\bar{U}$), in percentage terms. The ratios are based on monthly averages of Q and U for each calendar year covered.

[e] The evidence of the ratios is inadequate for classifying this item as either "to order" or "to stock," due to the shortness of the record and the apparently dominant influence of the cyclical factor in the movement of the ratios above and below 100.

[f] The product is described in monographs on management policies in the textile industries as being sold from current as well as future output. See text and note 14.

[g] For each of the industries except paper products, two sets of measures are shown, one based on the OBE data for the years before 1956 and the other based on the current Census data (1963 revision) that cover the later years as well.

contraction years) or to small and uncertain differences (which are in several instances reversed when means instead of medians are used). For the aggregate series which start in 1946 or 1948, the category "contraction years" (excluding trough years) is empty, because none of the recent business declines lasted more than thirteen months. In no case did the re-examination of the ratios lead to a revision of the classification in Table 2-1, column 9, which distinguishes the products made primarily to order from those made primarily to stock.

Interindustry Comparisons of Stock-Backlog Ratios

Some of the products covered in Table 2-1 would be expected to be manufactured primarily to order and some primarily to stock. On the whole, the results obtained by using the $\bar{Q}/\bar{U}$ ratios conform to such expectations. For example, the ratios are low in both good and bad business years for steel sheets, which we know are made largely to specification. The ratios are extremely low throughout for steel barrels and drums, a heavy item of industrial equipment. They run with perfect or high consistency below the level of 100 for those textile products which are style-sensitive or must meet individual buyer requirements: woolen menswear fabrics, colored yarn shirtings, and cotton and worsted yarns. On the other hand, the ratios are typically high (greater than 100) for a variety of staple products: textiles such as hosiery and sheets; construction materials such as southern pine lumber and face brick; and residential building equipment such as oil burners and bathroom fixtures.[13]

However, it must be noted that the dichotomy employed, while emphasizing one important distinction between types of business operation in manufacturing, glosses over another, no less important distinction between modes of adjustment to varying demand. A firm should be able to avoid building a large finished inventory even though it produces goods without having sold them previously on contract. The adjustment of output and price, if sufficiently prompt and large, should minimize the volume of both finished stocks and unfilled orders. (Indeed, the extreme model of perfect competition without uncertainty can be conceived, in which instantaneous market price reactions would prevent the appearance of stocks and backlogs alike.) Although these output and price variations perform a major role in adjustment to business fluctuations, in practice (for reasons to be explored later) they still leave room, in many diverse industries, for product inventories and order backlogs whose average volumes and changes are large.

Where the average levels of both product inventories and order backlogs ($\bar{Q}$ and $\bar{U}$) are small relative to average output ($\bar{Z}$) or shipments ($\bar{S}$), one would assume that the firms rely largely on price-output adjustments and succeed in selling their outputs currently. The comparison of the $\bar{Q}/\bar{U}$ ratios alone does not permit isolation of the elements of the "sell-as-you-make" policy from those of the "sell-before-" and "sell-after-you-make" policies.[14] However, from the available data it

[13] A unique case is presented by maple flooring, where the stock-backlog ratios show a strong decline between the prewar and the recent postwar period. Here the averages for 1929–54 all exceed 100, while those for 1947–64 are less than 100; so a reclassification from ST to OR is required under our criterion.

[14] Note that if output is sold shortly before it comes off the machine, some backlog of orders will

appears that where $\bar{U}$ is large relative to $\bar{Q}$, it is also typically large relative to $\bar{S}$, which tends to validate the notion of manufacture to order described here and the selection of the industries that are representative of this category.

The one significant exception to this among the major industries that report unfilled orders is paper. In this industry finished inventory tends to be smaller than the unfilled orders backlog (see the industry aggregate and compare also "boxboards" and "paper, excl. building paper . . ." in the product section of Table 2-1) but the backlog itself is very small—on the average not more than about two-thirds of monthly shipments. (Of all major manufacturing industries for which unfilled orders are reported, paper alone has a $\bar{U}/\bar{S}$ ratio of less than 1, as shown in Table 6-5, below.) Hence current price and output adjustments would be expected to be very important in the paper industry, and they are, particularly output adaptability.[15]

When the figures for finished stocks and unfilled orders are not physical-volume data for individual commodities but value data for multiproduct industries, the ratios must be viewed in the light of the probability that Q and U represent aggregates of different goods. A predominance of Q over U could then mean that most of the items produced by the given industry are made typically to stock, but it could also mean that the items made to stock, even though less numerous than the others, have a larger value weight.[16] Nevertheless, there is little ambiguity about the evidence in Table 2-1, which clearly confirms that production to order prevails heavily in such industry groups as

exist at any time, though it cannot be larger than the amount of work started in production (assuming that no real "advance" orders, i.e., commitments of output of future production periods, are accepted). Finished stocks do not come into existence, and yet the product is made in anticipation of immediate needs of the market, not in fulfillment of contracts for delivery in the more distant future. It follows that unfilled orders may exceed finished stocks for an industry whose principal policy is "make and sell" rather than "make to order."

[15] The relationship between new orders, production, and shipments of paper is close, and the lags involved are mostly short (see Chapter 4). Information from the American Paper and Pulp Association confirms that, while paper products are produced in large measure to order in accordance with the evidence of our $\bar{Q}/\bar{U}$ ratios, the lags of output and shipments relative to new orders are usually very short. The reasons given are the continuous nature and fairly short duration of fabrication processes and the great adaptability of equipment to production of various items. But prices, too, seem to be more flexible here than in many other manufacturing industries (see Chapter 6).

The pattern of rayon taffetas is similar. Judging from the slender information on the Q/U ratios that is here available, this product would be classified as manufactured to order, but the prewar Textile Foundation study (see source note to Table 2-1) refers to this case as exemplifying a policy of selling from current output.

[16] The ratios for textile products show how heterogeneous the output of a major industry can be when it is classified according to whether the goods are made to order or to stock (Table 2-1, listings for individual products of the industry).

primary metals, machinery, and transportation equipment, as would be expected.[17]

Furthermore, the ratios for the comprehensive major-industry aggregates show that industries which produce mainly to order are dominant in the composite of all durable manufactures. In contrast, production to stock apparently prevails within the aggregate of nondurable goods industries. In appraising this last finding, however, one must remember that all of the major nondurable goods industries report inventory figures, while only four of them—textiles, leather, paper, and printing and publishing—report unfilled orders. For the large part of the nondurables sector that includes food, beverages, apparel, tobacco, chemicals, petroleum, and rubber, new orders are considered to be equal to "sales" (or value of shipments) in the current compilation of the Department of Commerce. For most of the products of these industries the assumption that orders backlogs are negligible should be realistic. (Note that these are, in part, products of industries in which continuity of operation is particularly important for cost reasons; in part, goods whose rates of supply in the short period are subject to only a very limited control by the manufacturer; and, in part, commodities whose producers face fairly stable and predictable demand conditions.) However, some of the component industries of these major groups undoubtedly do receive advance orders which may at times accumulate to substantial volumes.[18]

Finally, for total manufacturing (last two lines of Table 2-1), the ratios again suggest that sectors working to order outweigh those working to stock, despite the inclusion here of the seven major nondurable goods industries "without unfilled orders." No doubt, the ratios can

[17] The points made in this and the following paragraphs are demonstrated in Table 2-1 with the aid of both the most recent series on manufacturers' orders and inventories (as revised in 1963; see Table 2-1, note g) and the data before 1953.

[18] Backlogs of purchasing orders from distributors and retailers are certainly *not* negligible in at least a large part of the apparel industry, which is characterized by small companies that are probably particularly anxious to keep finished inventory low because of the risks inherent in the seasonality and sensitivity to style changes of their operations. In fact, the National Credit Office, Inc., has collected quarterly information on unit production, shipments, stocks of piece goods, *and unfilled orders* from a panel of more than one hundred clothing manufacturers for a few recent years. In the seven quarters between the fall 1950 season and the spring 1952 season, unfilled orders of menswear manufacturers amounted most often to about one-half and sometimes to more than three-fourths of the manufacturers' cuttings (see W. A. Bennett and R. S. White, "Menswear, Past, Present, and Future," *Dun's Review*, August 1952, pp. 29 and 60–66). It may be, however, that the unfilled orders for lines of apparel still more "perishable" from the point of view of the seller (such as women's dresses) would be much smaller because rates of output and deliveries are adjusted with particular rapidity to swings in new business for such articles.

give only a crude indication of how total manufacturing is divided between industries operating to order and industries operating to stock. But as far as this evidence goes, it is unequivocal in pointing to (1) a sharp contrast between the order-oriented durables and the stock-oriented nondurables, and (2) the strikingly high importance of sectors producing to order within the manufacturing division as a whole.[19]

It must be admitted that the period covered by the aggregate data (1939–64) mostly includes years of good or excellent business conditions: the rapid wartime expansion and the generally prosperous post-war times. But even in 1939, which was quite a poor year, finished stocks amounted to no more than 88 per cent of unfilled orders for all manufactures (48 per cent for total durables and 229 per cent for total nondurables).

None of these results should be understood to imply that any neat divisions can be made within industry aggregates between production to stock and production to order. Diversified outputs of large companies would often include both categories in variable proportions. Dependable quantitative information on this subject is scanty or non-existent, and presumably hard to acquire; the indirect and rough measures presented here must not be viewed as compensating for the deficiencies in the data. Nevertheless, the evidence from the $\bar{Q}/\bar{U}$ ratios has claims to both reasonableness and usefulness. It is consistent not only with what is known in general about the industries under study but also with differences in relative timing and amplitudes that are observed for series classified according to type of manufacture (see Chapters 3 and 4, passim). Further evidence bearing on the importance of unfilled orders (and therefore of production to order) in industries covered by the new Census data on manufacturers' shipments and orders (1963 revision) is given in Appendix A (Table A-2 and text).

[19] On the logic of our test, i.e., assuming that the stock-backlog ratios tend to be considerably higher (lower) than 100 for all goods made typically to stock (to order), the range of the ratios for total manufacturing (from 23 to 36) in Table 2-1 would indicate that the greater part of industrial production is organized on an order, and not on a stock, basis. If the contrary situation were true and production to stock were prevalent, then the average level of Q/U would have to exceed 50. For even if the average for all sectors working to stock were as low as 100 and that for all sectors working to order as low as zero, the over-all ratio could not be lower than 50 as long as production to stock accounted for not less than half of total manufacturing output (it would equal 50 if it accounted for precisely half of the total). But we expect the average for the stock-oriented industries to be substantially above 100 and the average for the order-oriented industries to be higher than zero (but significantly lower than 100). This makes it even more certain that an over-all average ratio considerably lower than 50 still indicates the prevalence of production to order.

Interpreting Orders Data: The Importance of Cancellations

Loose Intentions or Firm Commitments?

Much of the preceding analysis implicitly assumes that orders received by manufacturers represent declarations of serious decisions, rather than indications of loose intentions, to buy. A company would hardly be able or willing to engage in production to order, unless it viewed the bulk of its orders as "firm" in this sense. The test is, of course, actual experience: When the proportion of cancellations is steadily high, orders cannot long be regarded as firm commitments. The legal contractual arrangements and industrial customs regarding orders generally reflect the economic considerations that are decisive for the issue; but the economic factors are likely to vary, perhaps not just between industries but also over time, while laws and customs are relatively rigid.

Where production is largely to stock but some advance orders are being received, the usefulness to the company of such orders as predictors of demand should depend on their firmness (as well as their size relative to the total company output). Interesting questions arise here of how advance orders are used in this role and what predictive value they possess, but the available aggregative data, in which advance orders are mixed with orders filled from stock, are clearly not designed to help in examining such questions.

Information of two kinds can be used to appraise the role of order cancellations: reports on trade practices and the evidence of time series. Unfortunately, both sources are meager. The quantitative evidence of time series is by far the more important of the two, and it will permit us to draw some guarded inferences.

First, however, let us refer to some reports on the terms of sale contracts in individual industries. These suggest that establishing and varying the rules on cancellation privileges is one of the instruments by which sellers can influence the course of ordering. But such privileges are often negotiated between the firm placing and the firm receiving the order, and are thus determined by the buyer as well as the seller.

Sales agreements differ substantially in regard to the interrelated clauses on cancellations, acceptances, and deliveries. Consider the following illustrations of the diverse rules accepted by companies in different industries. In the early post-World War II period (a time when "seller's markets" predominated), cancellations were (1) precluded altogether on ordered goods in process of manufacture or on special sizes, shapes, etc. (rayon, steel, and structural clay and pottery products); (2) allowed, provided the buyer answered for the possible losses to the seller (paper); (3) permitted, along with changes of orders, in cases of mutual consent only (foundry equipment); and (4) acknowledged as a privilege of the producer in the event of his inability to secure the necessary materials and parts (electrical supplies and appliances). Purchase contracts featuring an "escalator clause," providing for an increase in sale price in the case of a rise in the costs of the seller, were frequent in many industries, but in some (e.g., chemicals) they also reserved to the buyer the right not to accept the shipment if he deemed the price increase excessive or otherwise unwarranted.[20]

This differentiation occurs partly because customary trade practices vary among industries, and partly because of other factors, such as changing business and market conditions, new legal decisions, mutual confidence of buyer and vendor, etc. Systematic and substantial *interindustry* differences in cancellation privileges reduce the usefulness of the order series for individual industries as general business indicators.[21]

Comparing Long-Term Average Levels of Orders Received and Filled

In most of the series based on directly reported new-order figures, orders canceled during the reporting period have not been deducted. Take a series on gross new orders for a given industry or product and a corresponding series on output or shipments. Assuming the two are strictly comparable in coverage, the average level of the new orders over a long period of time should exceed the average level of the shipments only by the average amount of cancellations (orders include both the advance orders and orders filled or shipped directly from stock). This is the rationale of the simple procedure followed in Table 2-2.

[20] See G. Clark Thompson, "Industry's Terms and Conditions of Sale," National Industrial Conference Board, *Studies in Business Policy*, Conference Board Report 26, New York, 1948, passim; and F. R. Lusardi, "Purchasing for Industry," in *ibid.*, Report 33, New York, 1948, p. 22.

[21] Cf. "An Appraisal of Data and Research on Businessmen's Expectations About Outlook and Operating Variables," *Report of Consultant Committee on General Business Expectations Organized by the Board of Governors of the Federal Reserve System*, September 1955, p. 133.

Table 2-2

Comparison of Average Annual Levels of Gross New Orders, Shipments, and Production, Selected Industries or Products, Various Periods, 1916–55

	Gross New Orders Minus Shipments or Production	
	Amount[a] (1)	Per Cent of New Orders[b] (2)
MERCHANT PIG IRON (THOUS. LONG TONS), 1919–26[c] (8)		
Orders[d] = 4,156		
Shipments	−583	(14.0)
Production	−553	(13.3)
STEEL SHEETS (THOUS. NET TONS), 1919–36[c] (18)		
Orders[d] = 2,416		
Shipments	+21	0.9
Production	−48	(2.0)
MACHINE TOOLS, DOMESTIC (MILL. DOL.), 1946–63[c] (18)		
Orders[d] = 467		
Shipments	+44	9.4
MACHINE TOOLS, FOREIGN (MILL. DOL.), 1946–63[c] (18)		
Orders[d] = 80		
Shipments	+6	7.4
WOODWORKING MACHINERY (THOUS. DOL.), 1921–39[c] (19)		
Orders[d] = 10,697		
Shipments	+91	0.9
FOUNDRY EQUIPMENT (MONTHLY AV. SHIPMENTS, 1922–24 = 100), 1925–39[c] (15)		
Orders[d] = 123		
Shipments	+6	4.6
RAILROAD FREIGHT CARS (NO. OF CARS), 1913–55[c] (43)		
Orders[d] = 69,561		
Shipments	+2,877	4.1
RAILROAD PASSENGER CARS (NO. OF CARS), 1911–55[c] (45)		
Orders[d] = 1,048		
Shipments	−16	(1.5)
RAILROAD LOCOMOTIVES (NO. OF LOCOMOTIVES), 1920–40[c] (21)		
Orders[d] = 698		
Shipments	+2	0.3

(continued)

Table 2-2 (concluded)

	Gross New Orders Minus Shipments or Production	
	Amount [a] (1)	Per Cent of New Orders [b] (2)
FURNITURE (NO. OF DAYS PROD.), 1924–46 [c] (23)		
Orders [d] = 259		
Shipments	+34	13.1
BOXBOARD (THOUS. SHORT TONS), 1924–32 [c] (9)		
Orders [d] = 2,512		
Production	−13	(0.5)
PAPERBOARD (THOUS. SHORT TONS), 1938–55 [c] (18)		
Orders [d] = 9,254		
Production	+111	1.2
PAPER, EXCL. BUILDING PAPER, ETC. (THOUS. SHORT TONS), 1934–55 [c] (22)		
Orders [d] = 7,579		
Shipments	+32	4.2
Production	+2	0.2
OAK FLOORING (MILL. BOARD FT.), 1912–55 [c] (44)		
Orders [d] = 411		
Shipments	−5	(1.2)
Production	−8	(1.9)
SOUTHERN PINE LUMBER (MILL. BOARD FT.), 1916–55 [c] (40)		
Orders [d] = 7,084		
Shipments	−23	(0.3)
Production	+35	0.5
BATHTUBS (THOUS. PIECES), 1918–26 [c] (9)		
Orders [d] = 901		
Shipments	+77	8.5
LAVATORIES (THOUS. PIECES), 1918–31 [c] (14)		
Orders [d] = 1,047		
Shipments	+59	5.6
KITCHEN SINKS (THOUS. PIECES), 1918–31 [c] (14)		
Orders [d] = 1,102		
Shipments	+62	5.6

Notes to Table 2-2

Source: See Appendix A.

[a] The units are those indicated for the individual industry. The averages are based on annual totals of the series for new orders, shipments, and production for each calendar year over the period covered by that industry.

[b] Ratio of the amount shown in column 1 to the amount of orders of the industry, multiplied by 100. The percentages that correspond to the negative values in column 1 are shown in parentheses. Because of rounding, the figures may differ from those computed by calculating the ratios from the levels and differences shown in the table.

[c] Identifies the complete calendar years covered by the corresponding series for gross new orders and shipments or production. The number of years is given in parentheses.

[d] Gross new orders, average annual level.

In this table, average annual amounts of gross new orders are presented for eighteen industries or product groups in column 4; in each case, the figure is the mean of annual totals for all the complete calendar years covered by the given series (the periods and units used are identified in columns 2 and 3). Similarly, mean annual levels relating to the same periods were calculated in the same units for shipments and, where data permitted, also for outputs of the same industries. Algebraic differences computed by subtracting the mean levels of shipments or production from the mean levels of gross new orders are listed in column 5 and are shown as a percentage of the levels of orders in column 6. There are sixteen comparisons with shipments (including two for machine tools, where separate figures are available for domestic and foreign transactions) and seven with production.

The expected sign of the differences in column 5 is a plus (indicating positive cancellations), but in eight of the twenty-three cases the differences are negative. This presumably means that the coverage of the order series is less than that of shipments or production; so the comparisons in these cases are inconclusive. However, in percentage terms these differences are quite small for each case but merchant pig iron. Where the differences are positive, most of them are again small; several amount to less than 1 per cent of the average level of gross new orders (column 6). The figures that suggest very low typical cancellation amounts are found for heavy equipment such as railroad locomotives, but also for diverse investment goods and materials (woodworking machinery, steel sheets), and even some standardized items (paper and paperboard, southern pine lumber). On the other hand, in a few instances the excess of gross orders over shipments is relatively large, notably so for furniture (13 per cent), machine tools (7–9 per cent), and the three items of sanitary ware (6–9 per cent).

Separate data on cancellations are available for machine tools, woodworking machinery, and furniture. Expressing cancellations as a percentage of gross new orders in terms of the average annual levels, the following figures are obtained: for domestic machine tools, 8.8; foreign machine tools, 6.4; woodworking machinery, 2.6; and furniture, 8.1. These percentages are lower than the corresponding entries in Table 2-2, column 6, except for woodworking machinery, but the discrepancies are not disturbingly large.[22] The figures computed directly from the cancellation data are presumably the more accurate estimates.

As will be shown presently, cancellations fluctuate greatly over time; in some periods, they are much larger and more important than the averages of Table 2-2 indicate. Undoubtedly, duplications of orders in times of rapid increases of demand and cancellations of orders in times of large decreases of demand combine to exert a disturbing influence in some of the individual industries to which the data refer.[23] On the average, however, cancellations appear to be relatively small for a large variety of products, including most items produced to order, such as locomotives and (according to industry reports) fabricated structural steel.

In general, one would expect sales contracts to be less easily revocable for the larger order-unit and high-cost goods than for smaller and less expensive items; also, less for specialized than for standardized, general-purpose products. The one case that would seem to contradict this expectation is machine tools, which are highly specialized but show a relatively high incidence of cancellations. However, this is mostly due to the large rise in cancellations during 1950–53 (see the next section), when military and defense-related contracts became very important for many durable goods industries, including machine tools.

[22] The largest discrepancy is for the furniture series, which is perhaps associated with the particular measurement units used for this item. According to the source of these data (the public accounting firm of Seidman and Seidman, Grand Rapids, Michigan), because of the variation in the number of firms reporting each month, the figures are "shown in number of days' production or sales, based on current ratios. . . . The original data are based on value" (see *Survey of Current Business, Annual Supplement*, 1932, p. 297).

[23] Thus, according to the Enameled Sanitary Ware Manufacturers' Association, "orders shipped are the best current index of the industry. Orders received are likely to pyramid during periods of great activity to be followed by cancellations if the demand drops off" (*Survey of Current Business*, May 1922, p. 81). See last three lines of Table 2-2 for figures on the average level and proportion of cancellations for these products.

Such contracts have special characteristics because they originate in the largest single source of buying power, the defense system of the federal government, and reflect certain centralized decisions based largely on noneconomic considerations. The latter may cause heavy bunching of military and related orders at certain times (during a war crisis) and sharp curtailments or withdrawals at others (when hostilities decrease and peace prospects improve).[24]

In an early (c. 1936) unpublished study of building construction, Arthur F. Burns expressed the presumption that cancellations of construction contracts are much less important than cancellations of orders for most commodities. Data to test this hypothesis are not available, but the preceding argument supports it strongly. A decision to build and equip a new industrial plant, for example, represents a commitment over a long span of the future that typically involves far greater costs and risks than a decision to alter the rate of production of a plant already in existence.

Gross and Net Orders

Unlike all other series of new orders in our collection, which are compiled directly from company data for this variable, the aggregative value series of the Department of Commerce are derived indirectly. The reporting unit is here, as in nearly all other compilations of orders data, the firm that has received the orders. The method consists in adding to the estimates of manufacturers' sales (recorded at the time of shipment) the corresponding figures on changes in the backlog of unfilled orders. This procedure results in estimates of new orders net of cancellations.[25]

[24] Apart from such major episodic factors, defense orders, in their short-term movements, are likely to be quite sensitive to a host of minor random influences. The average unit size of these orders will presumably be large and the average number of orders per unit of time will be small if the unit is short (a month or a quarter), e.g., military contracts for aircraft and ships. Orders with these characteristics would be expected to show large irregular short-period fluctuations—to be heavily bunched in one period and very sparse in another. (See Chapter 4 on aircraft orders and aggregate defense obligations.)

[25] That the sum of sales and the change in unfilled orders gives *net* new orders follows from two definitional propositions: (1) the value of all orders accepted but not filled or canceled equals the change in backlogs over the period; and (2) sales measure the value of orders filled. Let N_t^* denote the value of gross new orders accepted; D_t, orders filled (delivered); and C_t, cancellations in period t; N_t, S_t, and U_t have been defined before. Then we have

$$U_t - U_{t-1} \equiv \Delta U_t \equiv N_t^* - D_t - C_t$$
$$S_t \equiv D_t.$$

Adding the foregoing gives $\Delta U_t + S_t \equiv N_t^* - C_t$. But we already know that $N_t = \Delta U_t + S_t$; thus N_t equals $N_t^* - C_t$ (i.e., it is net of cancellations).

The Commerce estimation method also implies that the cancellations that occur in the current month (t) are reflected in the current estimate of net new orders (N_t). But it is the orders received in past months that probably account for a considerable part of current cancellations; the orders just received seem least likely to be canceled. A systematic variation over time in the age or vintage of canceled orders, if it exists, would be an interesting phenomenon that should be taken into account in appraising the impact of new orders on production, shipments, etc. To illustrate, suppose that cancellations are high at about the time of the downturn and shortly thereafter, and that they refer to "old" orders placed in mid-expansion or the early boom. Then new orders recorded in that phase of the business upswing will have been overstated, in the sense that lower estimates would have led to better (less optimistically biased) predictions of future shipments (i.e., of the values of S at the assumed downturn phase). Unfortunately, information about the composition by vintage of the canceled orders is not available. Data on unfilled orders are not decomposed that way either; if they were, many interesting problems in the analysis of short-run behavior of orders and production, including this one, could be treated much more effectively.

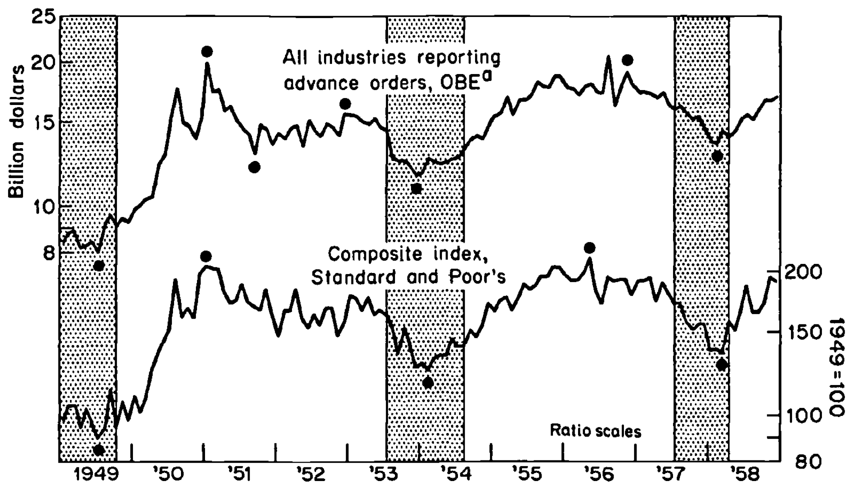
Independent evidence on the behavior of manufacturers' orders since 1949 is provided by series compiled by Standard and Poor's Corporation. These are monthly indexes (1949 = 100) based on dollar values. They have a much smaller sample base than the Commerce series; hence they are considerably more erratic. The indexes for new orders are compiled directly, gross of cancellations.[26]

Chart 2-1 compares the Commerce value aggregate for all industries reporting new orders as distinct from shipments, with Standard and Poor's composite index. (Excluded in both cases is a large part of the nondurable goods sector for which the value of new orders is assumed to equal the value of shipments.) The two series are plotted to uniform logarithmic scales, a standard procedure in most of the charts in this book. [On these scales, vertical distances denote equal relative changes, permitting direct comparisons between all kinds of (nonnegative) data.]

[26] Because of their narrow coverage, the component-industry indexes from the Standard and Poor's compilation are used in this book largely as supplementary evidence. However, in Appendix B, the charted behavior and cyclical timing measures of the indexes for shipments, unfilled orders, and new orders are discussed at some length. The indexes are presented there for 1949–58, for which they have been seasonally adjusted by the National Bureau.

Chart 2-1

Department of Commerce and Standard and Poor's Estimates of Total Advance Orders for Durable and Nondurable Goods, 1949–58



Note: Shaded areas represent business cycle contractions; unshaded areas, expansions. Dots identify peaks and troughs of specific cycles.

[a] Includes all durable goods industries and four major nondurable goods industries reporting unfilled orders.

The periods of general business contraction are shaded, another arrangement followed in most of these charts. It is clear that the two series have very similar systematic movements—trends and cyclical fluctuations. Both their timing and their relative amplitudes are much alike.

The one significant difference is in 1952. There the Commerce series shows an upward movement which, while mild, is yet sufficiently long and clear to qualify as a specific-cycle expansion. In Standard and Poor's index, on the other hand, the corresponding movements are considerably shorter and weaker: a retardation superimposed upon the contraction that began early in 1951, rather than a cyclical expansion.

The reason for this is not easily determined, since the two samples differ greatly in size and to some extent also in composition, but an important part of the explanation is probably the contrast between a net and a gross orders series. In some durable goods industries, especially those with heavy military contracts, cancellations increased very substantially when the threat of a further intensification or an extension of the Korean conflict subsided and the chances of a truce increased. Thus net orders (Commerce) dropped much more rapidly than gross orders (Standard and Poor's) from their Korean peak levels. The increase in cancellations was temporary. When cancellations returned to their substantially lower normal levels, net orders moved upward, again closely approaching the value of gross orders, which may have been declining all along, or perhaps were just leveling off temporarily (Chart 2-1).

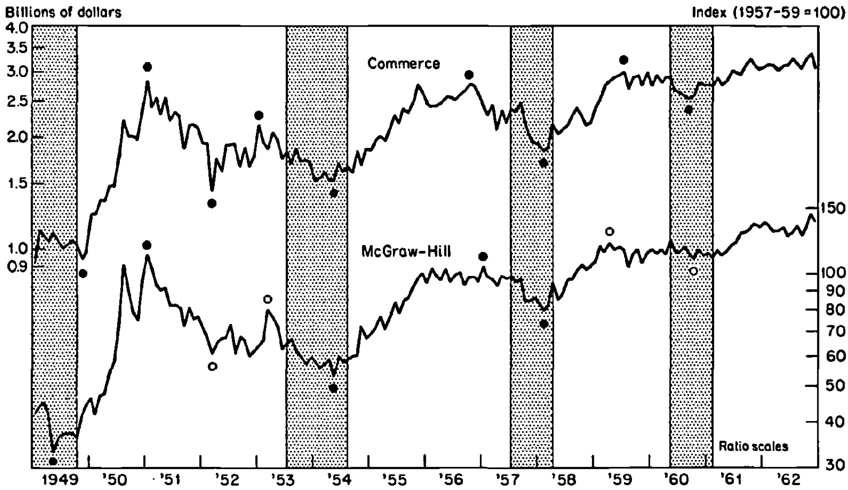
The coverage of the component industries in the Standard and Poor's compilation is too narrow to allow detailed comparisons with the Commerce series for the corresponding industries.[27] However, for one major industry, nonelectrical machinery, an independent survey of new orders is conducted by the economics department of the McGraw-Hill Publishing Company, and these data have some interesting features not available elsewhere. Like the Standard and Poor's series, they are indexes based on dollar values of new orders, gross of cancellations, beginning in 1949. But they are designed to concentrate on that part of nonelectrical machinery output which represents industrial equipment serving the needs of private nonagricultural producers. An effort is thus made to exclude from these indexes orders for defense products, consumer durables (household appliances), and farm machinery. The resulting totals cover seven types of machinery and, since 1957, are also divided into domestic and foreign orders.[28]

Despite the differences in the coverage and estimation methods, there is a substantial similarity between the McGraw-Hill index and the Commerce series on the aggregate value of new orders for total nonelectrical machinery (Chart 2-2). Again, this applies to the longer systematic movements, i.e., to the trends and cycles. The short irregular movements are usually more frequent, if not longer, in the index than in the aggregate, but at times (e.g., in 1951) the opposite is true. There are probably opposite factors at work here: the smaller sample

[27] Some further observations on this point are made in Appendix B.

[28] The seven components are pumps and compressors, engines and turbines, construction machinery, mining machinery, metalworking machinery, office equipment, and other industrial machinery. Indexes are available for all these categories (since 1957, for foreign as well as total new orders). The data are published without seasonal adjustment, except for total new orders, for which the adjusted figures are also given. The base period was 1950 until March 1963, when it was replaced by the average 1957–59 = 100. New seasonal adjustment factors were also introduced at that time (see release of the McGraw-Hill Department of Economics, March 4, 1963, Part III).

Chart 2-2
Department of Commerce and McGraw-Hill Estimates of New Orders for Nonelectrical Machinery, 1949–62



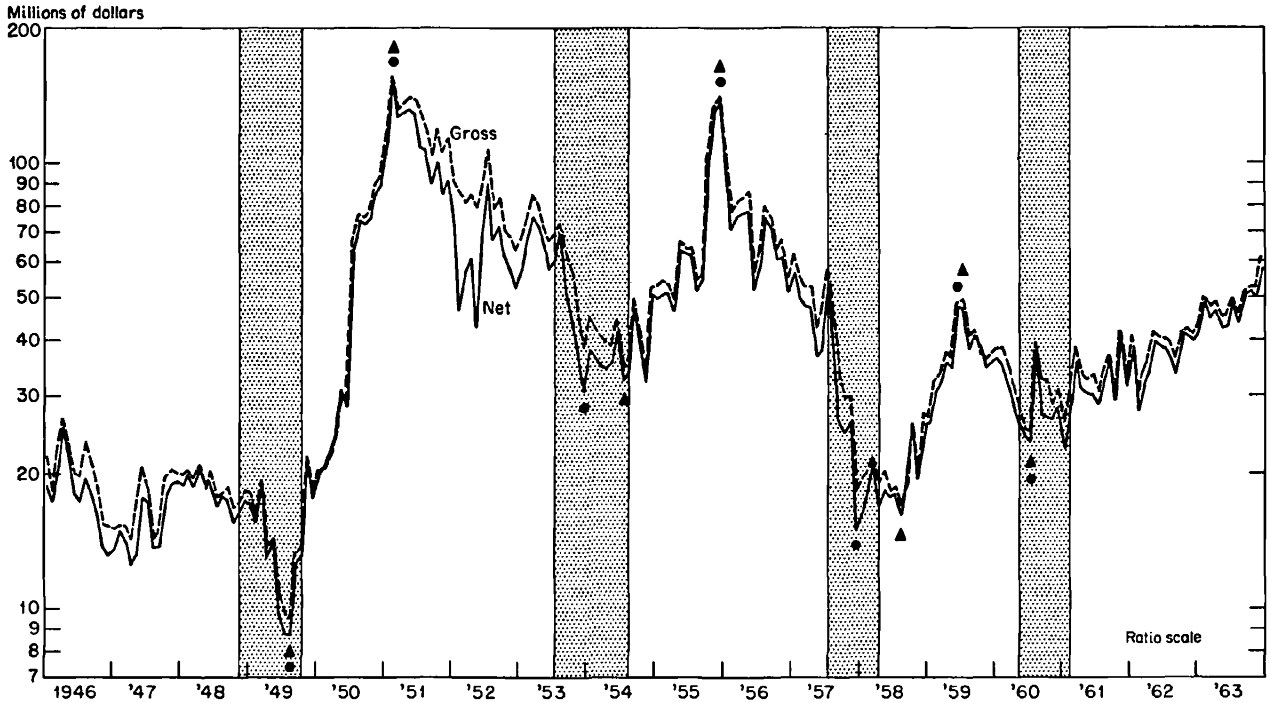
Note: Shaded areas represent business cycle contractions; unshaded areas, expansions. Dots identify peaks and troughs of specific cycles; circles, short cycles or retardations.

tends to make the index more erratic, while the deduction of cancellations tends to add to the variability of the Commerce series.

The kind of difference between the course of the net and gross orders in 1952 that was observed for the comprehensive series in Chart 2-1 is not produced here, except perhaps faintly (see Chart 2-2). This may be related to the exclusion of military orders from the McGraw-Hill series. The other differences between the two nonelectrical machinery estimates which appear significant (in 1956 and 1959–60) may also reflect the discrepancies in coverage more than the effects of cancellations.

The role of cancellations can be isolated from other factors in the machine tool industry, for which data relating to orders are particularly rich. Chart 2-3 compares domestic net new orders for machine tools with the corresponding gross orders. The two monthly series stay close together most of the time but move apart in certain periods, particularly in 1952–53. Their behavior during that phase of the Korean con-

Chart 2-3
Gross and Net Domestic Orders, Metal-cutting Machine Tools, 1946–63



Note: Shaded areas represent business cycle contractions; unshaded areas, expansions. Dots identify peaks and troughs of specific cycles in net new orders; triangles, gross new orders.

Source: National Machine Tool Builders' Association.

flict illustrates strikingly the developments discussed before in connection with Chart 2-1.

The timing of the two series at peaks is nearly identical, but at troughs there are some differences. These suggest that net orders would at times turn upward earlier than gross orders (see Chart 2-3 for the years 1956 and 1958). It will be shown presently that cancellations tend to lag behind orders received; they were declining sharply during most of 1954 and again in 1958, which explains the net-gross discrepancies observed at these troughs.

Cancellations

Orders for industrial products can be canceled for a number of reasons: (1) a change of mind by the would-be purchaser (he no longer wants his order filled because of actual or expected changes in business conditions or revised calculations: the costs of completing the transaction appear greater than the costs of withdrawing); (2) an analogous change by the prospective supplier or vendor; (3) nonfulfillment of contract, or unsatisfactory performance, or disagreement on how the order was to be or was executed (this may be by either party to the transaction or third parties such as subcontractors); (4) liquidation of "surplus" orders by the firm that had placed them (these are tentative, informal orders implying no binding commitment; multiple orders of this kind may be placed at certain times, particularly when a tight supply situation is suspected, to insure timely delivery; after the required items are received, the remaining "duplicating" orders are rescinded).

If cancellations have a "normal" range and rise well above it, would not such an increase be a sign of economic distress, like a similar movement in business failures, for example? An affirmative answer implies that the rise in cancellations can be accounted for primarily by the first two causes, i.e., a deterioration in business conditions or expectations that forced the withdrawal of a great many orders placed at a time when business was better or was expected to improve.

To the extent that they are thus motivated, increases in cancellations should occur mainly during business recessions, perhaps with a short lead where the worsening of conditions was anticipated. This would imply a tendency toward inverted cyclical behavior. In the data on cancellations, however, positive cyclical patterns prevail, modified somewhat by lags and secondary movements. Thus the postwar series for machine tools shows three troughs which follow the business cycle revivals in 1949, 1954, and 1958 by short intervals (see the upper curve in Chart 2-4). It also shows three peaks, a high one early in 1952 (the advanced stage of the "Korean" expansion), and lower ones in 1956–57 and late 1960, again at the close of an upswing or shortly afterward.

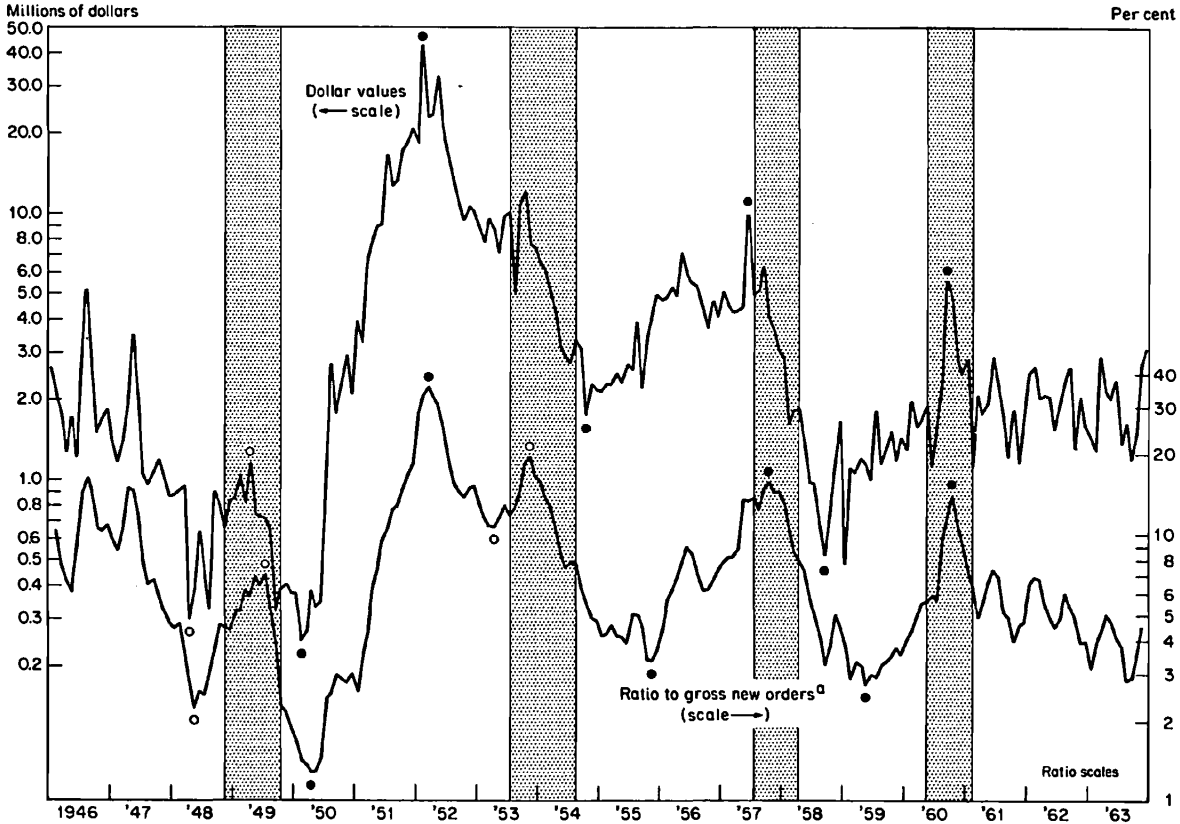
A comparison of Charts 2-4 and 2-3 indicates a substantial positive correlation between cancellations and new orders, with cancellations lagging behind new orders. At peaks, cancellations lagged gross new orders by long intervals, at troughs by intermediate or short intervals, as shown in the accompanying table.

Date of Peak in Gross Orders	*Lead (−) or Lag (+) of Cancellations (mos.)*	*Date of Trough in Gross Orders*	*Lead (−) or Lag (+) of Cancellations (mos.)*
		Aug. 1949	+6
Feb. 1951	+12	July 1954	+3
Dec. 1955	+18[a]	Aug. 1958	+1
July 1959	+14		
Average	+14.7	Average	+3.3

[a] Cancellations had a double-peak configuration in 1956–57 (see Chart 2-4). This comparison is based on the second, higher peak; had the first one been used, a lag of five months and an average of 10.3 months would have resulted.

The positive association between new orders and cancellations can be explained very simply by the assumption that a certain proportion of orders received will usually be canceled. Given that probability, it is clear that a rise in new orders, which usually results also in a rise in order backlogs, would lead to an increase in cancellations. When there is a larger number of orders on the manufacturers' books, the number of cancellations that fall into the third category above is likely to be greater, too. A large influx of orders during a buying boom may also involve a certain amount of multiple orders (as in category 4) that are subsequently liquidated. In short, cancellations of all types are likely to increase (decrease) in response to expansions (contractions) in the volume of industrial orders.

Chart 2-4
Cancellations of Domestic Orders for Metal-cutting Machine Tools, Dollar Values and Ratios to Gross New Orders, 1946–63



Note: Shaded areas represent business cycle contractions; unshaded areas, expansions. Dots identify peaks and troughs of specific cycles; circles, minor turns or retardations. Series are seasonally adjusted.

[a] Three-month moving averages were used to compute the ratios.

The argument seems to apply primarily to the number of orders rather than their aggregative value. One would not necessarily expect cancellations to rise if a rise in total value of orders reflected an increase in the average order size, rather than the number of orders outstanding. There is, after all, no presumption that the probability of cancellation is greater for large orders than for small ones. The available data measure the value or physical volume, not the number, of orders; consequently, these propositions cannot be tested directly. But the distinction between numbers and values is probably not very important in practice, since there is presumably a strong correlation between the two, especially for the large systematic movements in orders, which are here of main interest.

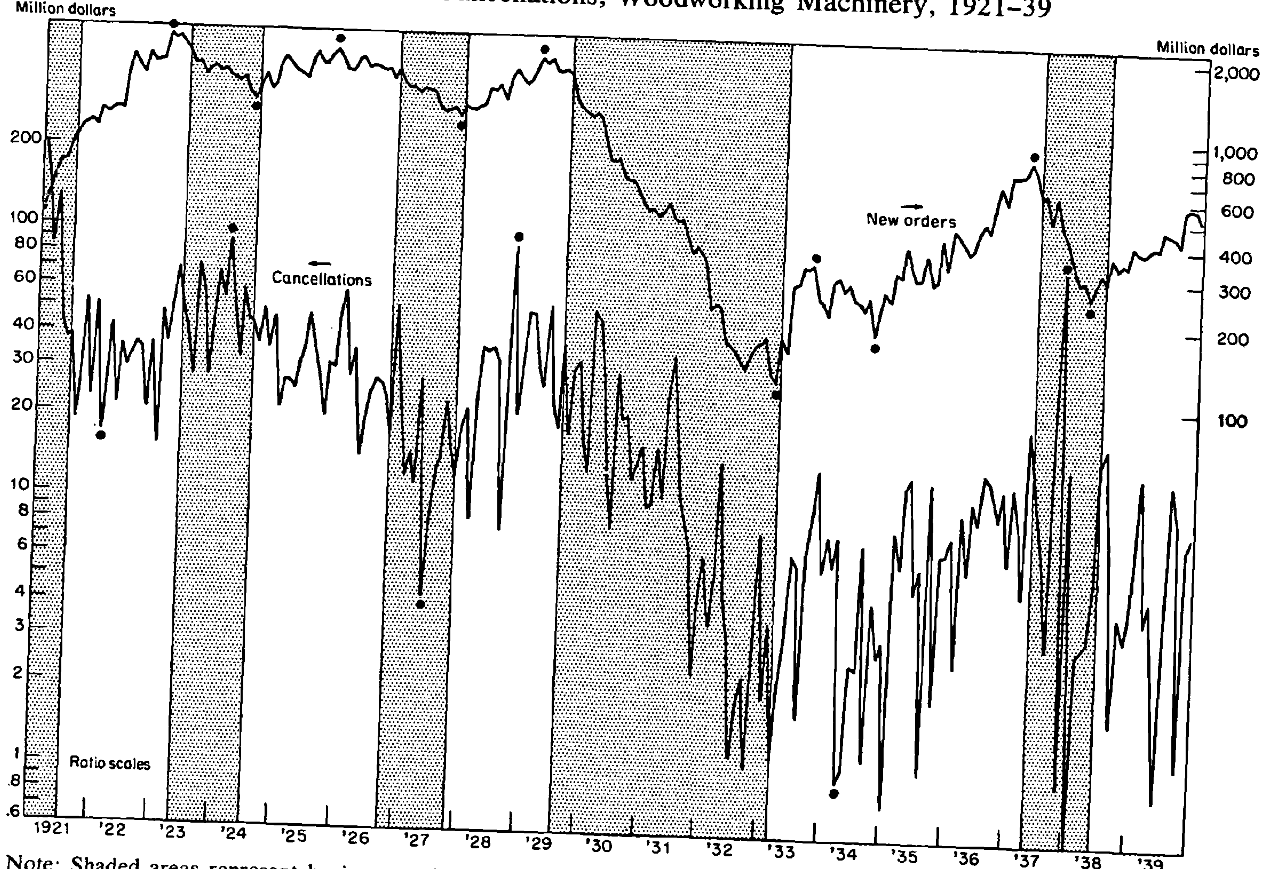
However, to explain that cancellations vary in a positive correlation with the volume of orders because they form a stable proportion of that volume is a gross oversimplification of what actually happens. The second curve in Chart 2-4 shows that the ratio of cancellations to gross new orders undergoes fluctuations similar to those of the cancellations themselves.[29] In other words, when incoming business and backlogs expand, cancellations increase not only absolutely but also relative to orders received. Furthermore, the timing discrepancies between cancellations and orders must be considered as a factor modifying the basic positive association of these two variables. Cancellations lag considerably; so, their peaks occur when new business is already sharply falling and their troughs when it is already sharply rising (compare Charts 2-4 and 2-3). Here, then, is an element of inverse relationship between cancellations and a particular indicator of business conditions, namely, the rate of change (not the level) of new orders.[30]

Data for woodworking machinery extending over the interwar period confirm that new orders and cancellations are positively correlated (Chart 2-5). Cancellations are here again small and highly erratic; their major movements are distinct in the original data but somewhat blurred by the short irregular variations; therefore, it might be useful

[29] Relative movements in cancellations are larger than those in new orders and dominate the changes in the ratio. The ratio lags somewhat behind cancellations partly because it is based on smoothed series (unsmoothed, it is extremely erratic). Gross new orders were used in the denominator but similar results would have been obtained with unfilled orders (judging from the behavior of total backlogs of machine tool orders, since separate backlog figures for domestic orders are not available).

[30] The change in new orders, which often turns ahead of the level, is of course a very early indicator. But the inverse relation in question is clearly meaningful and not just a reflection of timing divergencies (which can produce spurious associations of this kind between leading and lagging series).

Chart 2-5
New Orders and Cancellations, Woodworking Machinery, 1921–39



Note: *Shaded areas represent business cycle contractions; unshaded areas, expansions.* Dots identify peaks and troughs of specific cycles.

to visualize this series in smoothed form. The large swings during the 1930's—down in 1929–33, up in 1933–37—stand out in both new orders and cancellations, but smaller movements in the two series at other times are also correlated. Lags of cancellations prevail at peaks, but there are more leads at troughs, and the timing dispersion is considerable.[31]

Finally, there is also some supporting evidence for furniture orders in the period 1923–29, though these data must be interpreted with caution (see note 22, above). Here new orders measured in value of production per day reached their highest levels in 1926, as did cancellations measured as percentage of new orders. In 1928–29, new orders had average monthly values equal to those of production (about 28 production days' worth); by 1934, they had declined to the equivalent of eight days. Cancellations dropped in the same period from 12 to 7 per cent of new orders. However, cancellations remained very low, with some tendency to decline, in 1934–36 when new orders were definitely improving, and seemed to lag behind new orders at peaks.

The furniture data are difficult to evaluate not only because of the way they are measured but also because they are subject to strong yet rather variable seasonal influences. These reflect a particular institution of the industry, the great furniture markets held four times (in some periods twice) a year in certain key centers of the trade.[32]

[31] The months of lead (−) or lag (+) of cancellations at peaks in gross orders, based on unsmoothed, seasonally adjusted data, are: January 1923, +13; October 1925, +3; January 1929, −3; June 1933, +5; March 1937, +7. The average is −5.0 months. At trough dates, the figures are: June 1924, +6; October 1927, −5; March 1933, −5; September 1934, −4. The average is −2.0 months.

It will be noted (see Chart 2-5) that cancellations declined from a very high level in the first half of 1921; they may well have been even larger earlier in the 1920–21 recession. Direct evidence on the behavior of cancellations during that sharp downswing is very scant, but data for a few textile products suggest that some unusually strong spurts in the amounts of orders canceled occurred in 1920 (as shown directly by series for knit underwear and indirectly by the steep declines in new and unfilled orders and production for cotton goods, all in the second half of 1920; see Department of Commerce, Bureau of the Census, *Record Book of Business Statistics*, Part I, *Textiles*, Washington, D.C., 1927, pp. 31–33, 37–38). These indications are consistent with the statement by Simon Kuznets that ". . . the wholesaler even if he waits for the filling of his order, may cancel it if conditions change. Such cancellations were epidemic during 1920, and although resorted to with great reluctance, they are still providing an escape for the wholesaler. The manufacturer is committed to a far greater degree since all his costs of production are already expended" (*Cyclical Fluctuations, Retail and Wholesale Trade, United States, 1919–1925*, New York, 1926, p. 181).

[32] The largest of these exhibits is the American Furniture Mart in Chicago, but New York, High Point (N.C.), Grand Rapids, and San Francisco are also important (see Kenneth R. Davis, *Furniture Marketing*, Chapel Hill, N.C., 1957, particularly pp. 88–89, 154–60). The January market is the most active one, followed by the June–July market, while the others (in the spring and fall) are much less in evidence. As a result, new orders often show sharp seasonal peaks in January and secondary peaks in the mid-year (especially in the 1920's). Two seasonal troughs preceding the main market months are also conspicuous in the furniture orders data: a longer slack in the spring, centered on

The Variability of Orders and the Behavior of Production

How Firms React to Fluctuations in Orders

Time series on new orders give evidence of great variability in the demand flows for many manufactured products.[33] Few of the many series examined fail to show sizable cyclical fluctuations, and the great majority are also subject to pronounced "irregular" movements from month to month. Seasonal variations, too, are marked in many of these series; but they are presumably less troublesome as a source of instability because they are essentially periodic and therefore more predictable.

To a large extent, fluctuations in manufacturers' new orders are translated into fluctuations in production. In many industries, conditions of substantially elastic supply seem to prevail over broad ranges of variation in the output rates. Such conditions favor the use of production adjustments in response to changes in demand. But even within the range of elastic supply it would not be advisable for the firm that faces highly unstable flows of customer orders to permit its output flows to be equally unstable. To have each small, short, up-and-down movement in new orders followed by a similar movement in production would be costly and, to the extent that it is avoidable, imprudent. In fact, a large proportion of this variation is smoothed out in the output flows through appropriate production scheduling. The resulting divergencies between sales and output are reflected either in product inventory changes or in order backlog changes, depending on whether sales are executed from stock (so that they coincide with shipments) or from future production (so that they coincide with advance orders).

This role of stocks and backlogs as "buffers" or "shock absorbers"

April, and a sharp short low in December. Cancellations, on the other hand, show steep peaks in December and secondary peaks in April or May, and troughs in January–February and in the third quarter of the year. In short, seasonally, the pattern of cancellations is almost an inverted image of the pattern of new orders. This contrasts with the positive relation prevailing in the longer movements of these series.

[33] The statements made in this paragraph are verified in Chapter 3. As argued before, new orders come closer to measuring actual market demand than do figures on current manufacturing activity (production or shipments). The term "demand" is used here rather loosely to mean the volume or value demanded at a given price instead of the function linking the quantities demanded to different hypothetical prices (and other relevant variables). It is believed that where the term is so used no serious risk of misunderstanding is involved.

implies also that prices do not change greatly in response to these short variations in new orders. There is indeed no good reason why even prices in highly competitive markets should be so "flexible" as to react to each small quirk in buying which does not force any major decisions concerning the production levels. Where sellers set prices, consideration of the costs and risks, which will often appear large, would inhibit frequent price alterations and revisions.

The larger *cyclical* movements in buying or ordering are normally associated with similar major movements in production, as would be expected. But an expansion of output is limited by existing capacities, while that of new orders is not. When advance orders reach rates exceeding those of capacity production and this condition of "excess demand" prevails for some time, a cumulative expansion of the order backlog is, of course, bound to occur. Where the process is observed, it must be inferred that prices did not rise sufficiently and in time to prevent it. To be sure, prices do increase when unfilled orders expand, but they do so typically in a lagging fashion. The massive backlog accumulations of recent history reflected growing delivery delays in several major manufacturing industries, and it can be argued that prices would have risen more in the absence of these delays (Chapter 7).

If their degree of "firmness" is sufficiently high, the accumulated orders represent a precontracted volume of work to be done by the supplying firm and the resources it employs. When the demand falls off again, a firm that emerges from the boom with a large backlog of such orders can maintain satisfactory levels of production for some time by drawing upon the backlog. Although the flow of new orders into the backlog would now proceed at rates smaller than the outflow orders filled (and the process would involve a return to shorter average delivery periods), it might take considerable time before a large backlog would be reduced enough to lose its usefulness as a means of stabilizing production.

The role of backlog and delivery-period adjustments in production to order has an analogy in the role of changes in finished-goods inventories in production to stock. A manufacturer may decide to produce in excess of current demand when business is slack but expected to improve in the not too distant future. This would keep equipment and labor working for stock at times when they would otherwise be partly idle or laid off; the unsold stock thus accumulated would await liquidation during the recovery. Of course, unsold stock will often accumulate because of failure to forecast sales correctly rather than as a result of this planning for output stabilization. If production continues to increase for some time after sales have begun to decline, and is cut only with a lag (which is a frequent result of insufficient foresight), this adds to the amplitude of output fluctuation and thus to output instability. Certainly, whatever their cause, changes in finished inventories need not always result in steadier operations. But an inverted pattern of movements in those stocks—increases during contractions and decreases during expansions in activity—is in itself an indication that some stabilization of production relative to fluctuating demand has been achieved, whether deliberate or not.[34]

Examples of Production Stabilization

Chart 2-6 suggests that there are great differences among the various lines of manufacturing in the urgency, method, and effectiveness of producers' efforts to mitigate the consequences of demand instability. Each of the four selected products has distinct characteristics that can be presumed representative of a larger class of goods.[35]

1. Freight cars illustrate the class of large-sized equipment made only to order, in time-consuming production processes. Makers of these capital goods face an extremely unstable flow of demand which they manage to convert into a flow of current operations that is no more than moderately variable.

2. Steel sheets represent goods made mostly to order, with much shorter production and delivery periods. The fluctuations of demand for this item, while quite pronounced and erratic, are markedly smaller in percentage units than the movements in freight car orders, and much more faithfully reproduced in the corresponding activity series. However, production of steel sheets is noticeably smoother than new orders, and shipments are somewhat smoother than production.

3. The boxboard-paperboard series exemplify goods that are either shipped from stock or are manufactured promptly upon receipt of order. Here unfilled orders are persistently low (as a rule less than one month's output), and new orders and production move largely together.

[34] Moses Abramovitz, *Inventories and Business Cycles*, New York, NBER, 1950, pp. 260–62.

[35] The selection, originally guided only by a comparative reading of the graphs, was later rationalized in the light of the classification of goods by type of manufacture and the underlying measures of the unfilled orders–finished stock ratio.

Chart 2-6
Selected Series on New Orders, Production, and Shipments, Four Commodities, Various Periods, 1919–38

1. Freight Cars, 1919-1931

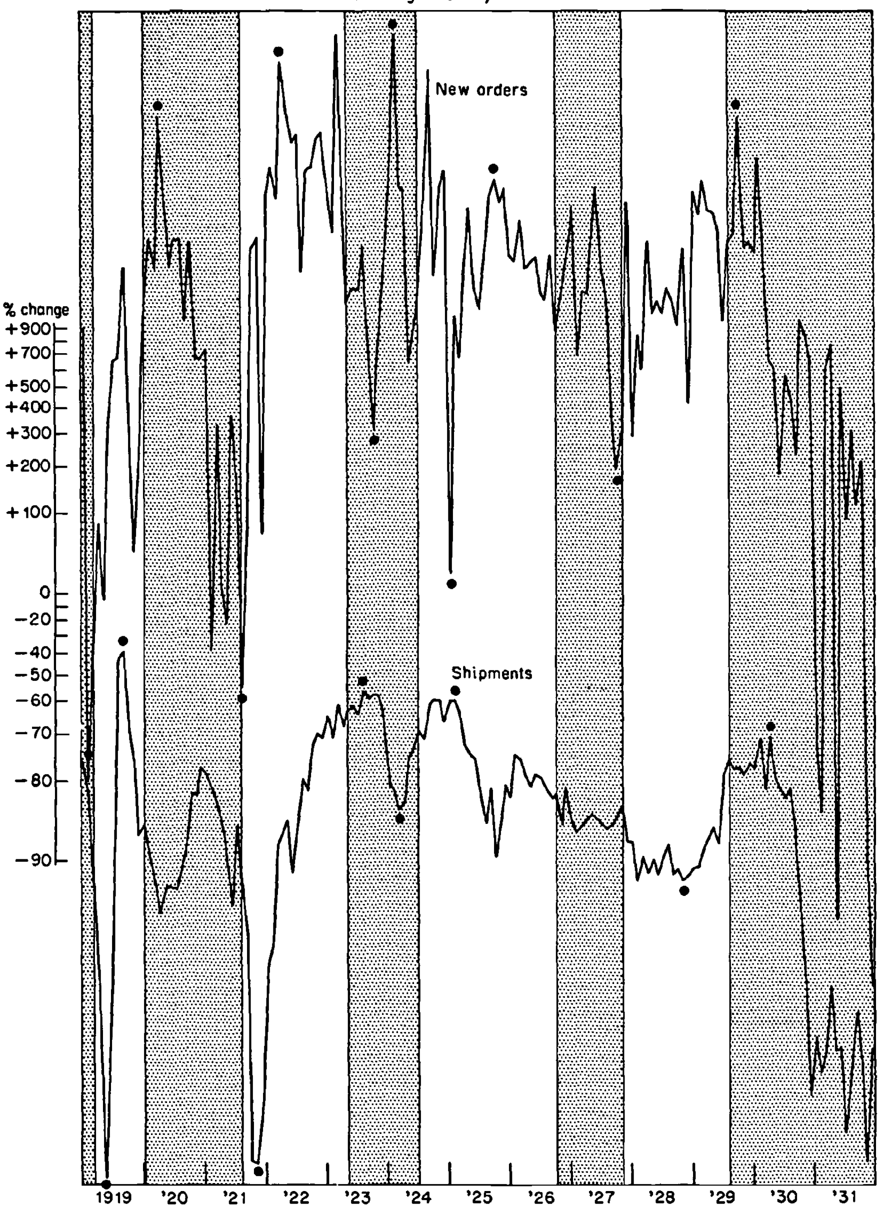


Chart 2-6 (continued)

2. Steel Sheets, 1919-1936

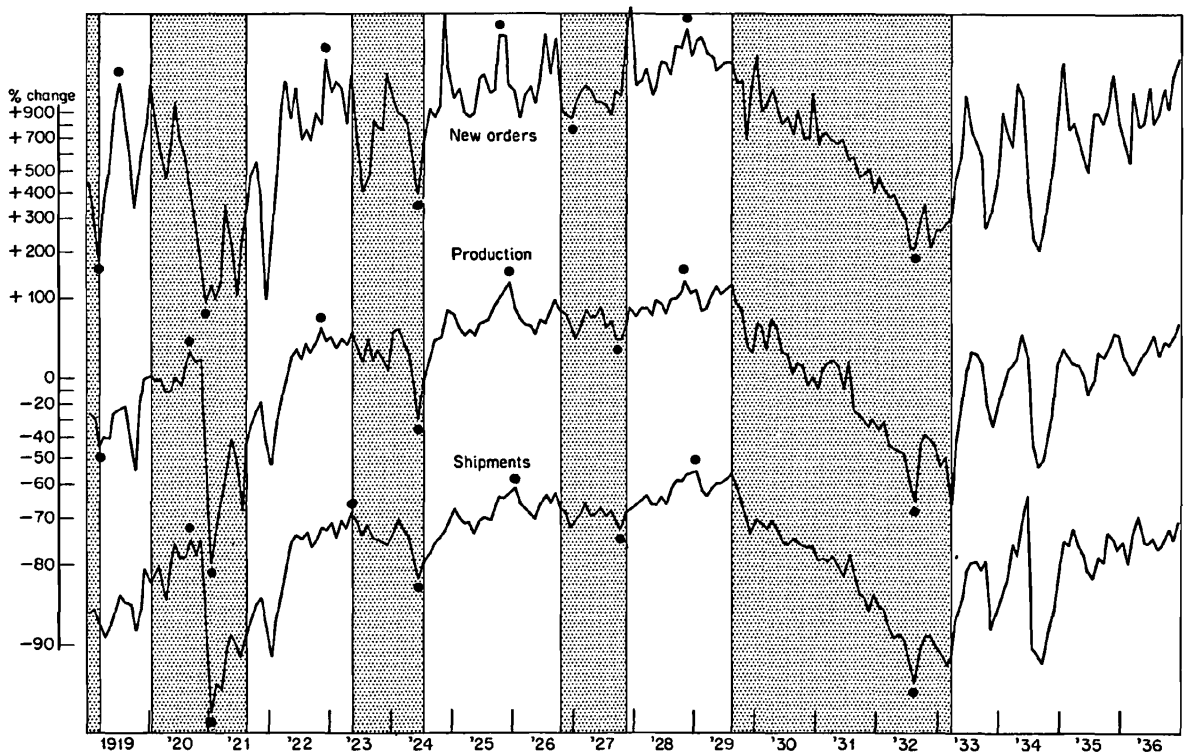
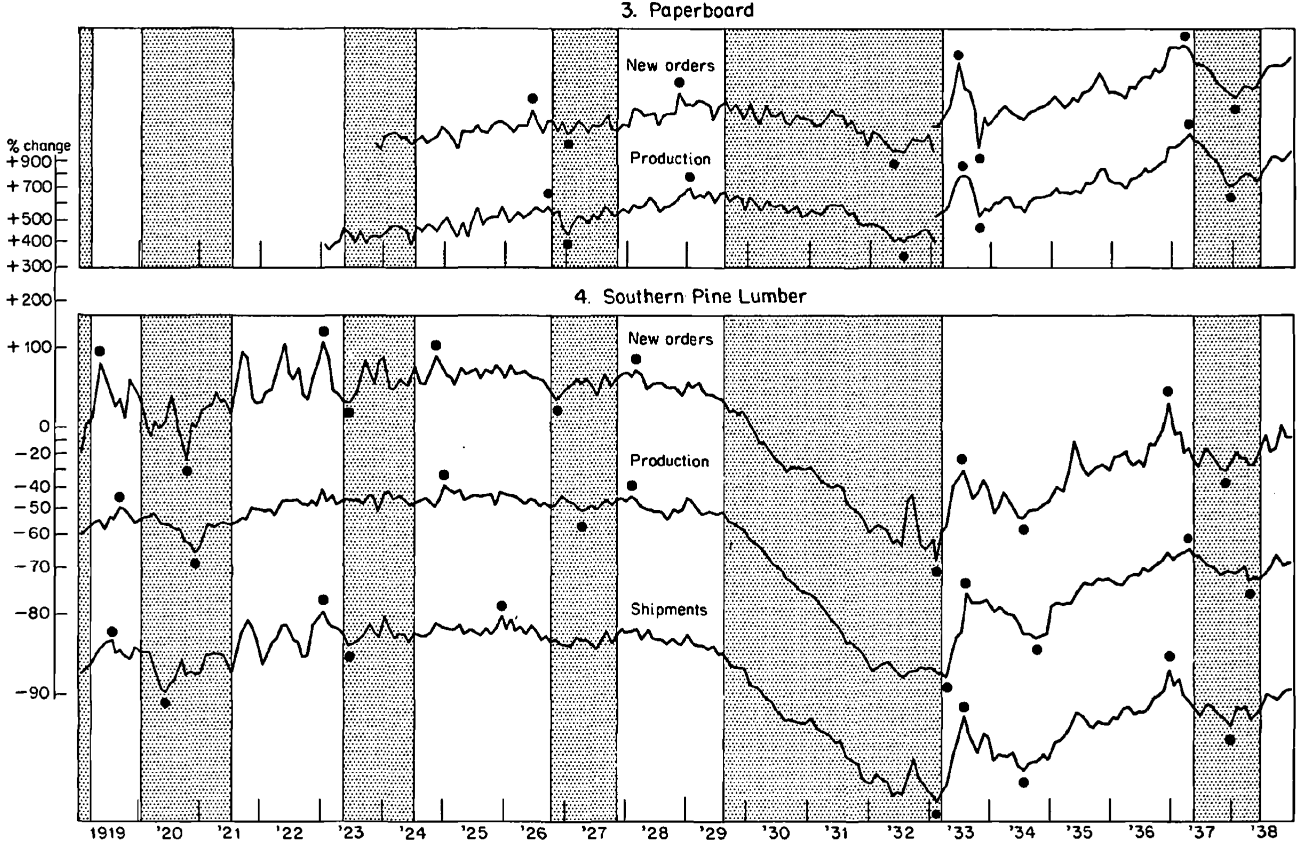


Chart 2-6 (concluded)



Note: Shaded areas represent business cycle contractions; unshaded areas, expansions. Dots identify peaks and troughs of specific cycles. Series are seasonally adjusted.

The variability of demand is rather mild, so there is much less need and scope for output stabilization. Indeed, it takes a close inspection of the paperboard curves to detect where some degree of stabilization has apparently been achieved.

4. Finally, southern pine lumber typifies a situation that is likely to prevail for many goods made primarily to stock. Here shipments must in part be identical with new orders; the two are closely similar, although shipments appear to be smoother. The volume of lumber produced follows a considerably steadier month-to-month course than the volumes ordered and shipped, behind which it usually lags slightly. Hence, it would seem that much of the smoothing has been achieved by means of stock rather than backlog adjustments.

Implications of Dealing with Aggregates

Since single-product manufacture is seldom encountered in practice and even less often in statistics, comparing the course of new orders with that of corresponding production activities usually involves a considerable amount of aggregation over different products.[36] Let us consider a multiproduct industry which works against advance orders. If rises or falls in orders for its various products all reached their peaks or troughs at precisely the same time, the relative amplitude of movements in the aggregate would equal the mean of the relative amplitudes of the components weighted according to their base levels. But such a perfect confluence in timing is most unlikely; the components can be expected to turn at different times, and this will dampen the amplitude of the aggregate as compared with the weighted mean amplitude. Other things being equal, the greater the dispersion in the timing of the components the more dampened the amplitude of the aggregate. The same applies to the aggregate or index showing the current activity of the industry (its production or shipments). But the timing dispersion may well be very different for the component order series than for the component activity figures. If it is greater for the latter—perhaps because of differences of production or delivery periods for the various products of the industry, or because firms deliberately schedule production

[36] Of course, even in single-product manufacture, order and production figures are aggregative in the sense of being the sum for all firms engaged in making the given commodity. The implications of this are in certain respects analogous to those of product aggregation, although probably of considerably less practical importance.

of the diverse items so as to mitigate short-term variations in their total outputs—then this is in effect another mechanism whereby much of the oscillation in new orders received is averaged out in the time-path of the industry's current activity.

Major Factors in Timing of Orders and Production

Model Sequences and Expected Lags

Pure production to order implies a logical sequence—which is also the time sequence—of three stages of operation: (acceptance of) new orders, output, and shipments. The lag of output behind new orders may well be long, due either to a long production period, or a long delay before new orders are started in production, or both. The lag of shipments behind output would usually be short, perhaps less than one month and indiscernible in monthly data. This we assume because there is no general reason why such goods, once produced, should not be shipped promptly to their purchasers. (All finished inventories are *sold,* and it is in the manufacturers' interest to schedule operations so as to avoid accumulating goods in stock awaiting shipment.)

In pure production to stock, the timing of new orders and shipments is coincident when the unit period is not too short, say, one month. The association of orders with *output* is less simply described. Conceivably, output could move with, or precede, orders and shipments. Statistical evidence, however, shows that output of finished nonperishable staples made from storable materials—a class of goods best suited to be produced primarily "for the market," i.e., not against specific orders—tends to *lag* behind shipments, though mostly by short intervals. There are various possible reasons for this. It is usually very difficult to foresee turning points in demand, not only for products sold on advance contracts but also for products sold from stock. Changes in the rate of current manufacturing operations will presumably require some time for completion (increases are likely to be particularly time consuming at higher levels of capacity utilization); consequently, anticipations of shifts in demand, even if correct, will not lead to timely adjustments of the production schedules, unless they are formed far enough in advance. Moreover, the sales forecast will not be regarded as justifying action which is costly and not easily revocable (especially when changes in the labor force are involved), unless the judgment about the future is sufficiently long range and is held with sufficient confidence.[37]

Arguing by inference from the model sequences, one can form certain definite expectations regarding the lags of output and shipments vis-à-vis new orders for products that are identifiable by type of manufacture:

1. Output of staples made for the market may *tend* to lag behind demand as measured by sales or orders shipped from stock. But output of precontracted goods lags behind demand as measured by sales (orders received in advance of production) *constantly,* in what is a necessary relation, not just a tendency. This is logically an important qualitative difference.

2. The lags of shipments relative to new orders should usually be negligible for goods ordinarily sold from stock. In the case of an item shipped from inventory directly upon receipt of an order, this lag obviously approximates zero. In times of booming business, however, the delivery periods[38] will lengthen as rising demand exhausts the available product inventory and exceeds the capacity of the firms to fill orders on receipt, causing unfilled orders to accumulate. For goods made to order, of course, the shipment lags are always positive and never zero, because production always intervenes between the date of the advance sales contract and the date of shipment, and production always requires some time.

"Production period," defined as the average amount of time needed to produce a unit of a given item, is a loose term and indeed an elusive concept. In modern continuous mass production of standardized goods, this period will often be very short; one may neglect it in writing the production function without any input-output lags. A popular car, for example, may be produced at the rate of 2,000 automobiles per day, or three per minute. But the production of a new model of a car requires

[37] The argument presented in the above paragraph follows the lines of explanation given in Abramovitz, *Inventories*, pp. 256–62; see *ibid.* for a more detailed analysis of the forces involved.

[38] For stylistic variety and convenience, the lags of shipments behind new orders are sometimes called the "delivery periods" or "delivery lags." It is, of course, recognized that the dates of shipment and delivery are separated by the time needed for transportation, but this interval should usually be short—less than the unit period in our data, which is one month or one quarter. Disregarding the difference between shipments and deliveries in terminology will cause no error in the context of this study.

months of research, planning, designing, and testing. In job-order production of capital equipment to customer specifications, the situation is often similar. The production periods for the more standardized goods manufactured to order may fall anywhere between these extremes. Clearly, the production periods depend on and change with the available technology, but the conditions determining what we have labeled the "type of manufacture" are here again relevant.

The measures of the average lag of output relative to new orders disclose some marked interindustry differences which accord with the above considerations. The longest lags by far are concentrated in the area of "heavy" capital goods produced to order (Chapter 4).

On the other hand, short-term fluctuations in the duration of output lags for a given industry cannot, as a rule, be ascribed to changes in the average production period over time. Technological developments may produce trends in the production periods, but one would not expect them to cause cyclical movements in the latter. Instead, the short-term changes in the output lags are apparently related to changes in the backlog position and capacity utilization of the firms that fill the orders.

Where customer orders anticipate and commit future output, whether because of a consistent policy of the firm (as in regular manufacture to order) or temporarily under pressure of booming demand (as may be the case even for items that are at other times well stocked by manufacturers and promptly available), the time interval between the acceptance of an order and its material execution cannot be shorter than the minimum production period involved. But when demand continues high for some time and advance orders pile up, the average interval between booking a new order and the beginning date for the work on it must lengthen relative to the essentially stable production period. Thus, of the two components of the total order-output intervals—the time the order has to wait before it is started in production, and the time needed for the actual production process—the former may then indeed become much the longer one. Certainly the former will have increased, often substantially, while the latter may have shortened or lengthened somewhat (efforts to rush orders through may succeed to a certain extent, or they may be "overdone" and self-defeating), but probably it will not have changed much.

Since in such times finished output is presumably promptly accepted by the buyer, the argument can be stated directly in terms of the order-shipment lags. These delivery lags, then, will lengthen in the advanced stages of expansion as a result of an increase in the "waiting periods" on the accumulated orders.

Problems of Measurement and Aggregation

Tracing the history of any particular order to ascertain how much time elapsed between the date it was accepted and the date it was produced or shipped is often impossible and rarely practical. Our measures of timing of new orders relative to shipments and production (Chapter 4) are based on aggregative time series data in which individual orders cannot be identified. In a large part, these measures refer to the length and regularity of intervals between the similar specific-cycle turns in new orders and output or shipments—peaks or troughs which apparently bound corresponding upward and downward movements. Here the lags of activity relative to orders are observed only at certain critical turning points, not in the continual succession which can be presumed to be their characteristic. However, much if not all the evidence from the series being compared is shifted and weighed in identifying the turning points in the series. Also, additional measurements of such lags can be derived by matching and comparing the timing of the turns in shorter movements that these series exhibit.

Lagged regressions provide a different method in which all the observations in the related time series are utilized. The criterion of maximum correlation can be applied to establish the optimal lags. In ordinary regression analysis, however, the lags are assumed to be constant for each given relationship, whereas the lags here considered are likely to show certain systematic changes over time, as already noted.

These considerations suggest the use of both timing comparisons and regression analysis as complementary tools. Further steps will lead to regressions incorporating distributed and variable lags.

Random variation is one major source of measurement difficulties; aggregation is another. The former affects strongly the method of timing comparisons. Large, short, and erratic movements often obscure the cyclical behavior of the series compared and make the dates of their turning points uncertain. Thus, even in the most straightforward case of a single product manufactured to order, occasional lapses from the expected timing sequence may be encountered for technical reasons. While this problem can be lessened by using averages of the individual measures, there are few series that are sufficiently long to provide representative timing averages.

Industry aggregates represent typically diversified multiproduct firms. Hence they often cover goods made to order as well as goods made to stock. The problems of interpretation caused thereby could be very serious, but for the most part do not turn out so in practice. As suggested by the evidence presented earlier in this chapter, many of the industrial aggregates are marked by a prevalence of one or the other type of manufacture. Where this is so, average lag measures tend to reflect, albeit in muted form, the timing patterns expected of the dominant category.

Table 2-3 provides a hypothetical illustration of the differential timing sequences that would be generated by a given flow of new orders under two assumptions regarding the proportion of business handled from stock. We abstract in this scheme from several features that add to the complexity of the empirical relations between new orders and current production activities: incoming business is taken to move in smooth (but not symmetrical) cycles; no representation is given to the process of subduing the fluctuation in output relative to that in orders which was briefly discussed before; and simple, constant timing associations between the corresponding series are assumed throughout. Two models are distinguished, one in which three-fourths of orders received are filled from future production (A) and one-fourth from stock (B), the other in which the proportions are reversed (that is, component A accounts for one-fourth and B for three-fourths of total new business). For A it is assumed that output, equal to shipments, lags new orders by two periods; for B, that output lags new orders and shipments, which are equal, by one period. In Model One, where A outweighs B three to one, timing characteristics of A prevail in the relation between the *totals* for new orders, output, and shipments. In Model Two, where the weights are reversed in favor of B, timing characteristics of B dominate the aggregate relations. But timing observations depend also on the way in which new orders vary about their turning points. Thus at the last trough in new orders in Model One (period 10), the timing of shipments turns out to be different for the totals than for the dominant component A (see columns 2 and 6). This can be due only to the particular pattern of the rates of change in orders during the contraction preceding this trough (periods 6–10). Unlike the expansion

Table 2-3
Timing of Output and Shipments Relative to Orders Under Two Assumptions About the Proportion of New Business Handled from Stock

Period	Total New Orders (N_A+N_B) (1)	Component A Output $(Z_A=S_A)$ (2)	Component B: Shipments $(S_B=N_B)$ (3)	Component B: Output (Z_B) (4)	Total Output (col. 2 + col. 4) (5)	Total Shipments (col. 2 + col. 3) (6)	Unfilled Orders (A only): Monthly Change (col. 1 minus col. 6) (7)	Unfilled Orders (A only): Total U (col. 7 cumulated) (8)	Finished Stock (B only): Monthly Change (col. 5 minus col. 6) (9)	Finished Stock (B only): Total Q (col. 9 cumulated) (10)
MODEL ONE[a]										
1	100		25							
2	92(T)		23(T)	25				150		50
3	104	75	26	23(T)	98	101	+3	153	−3	47
4	120	69(T)	30	26	95(T)	99(T)	+21(P)	174	−4(T)	43
5	128	78	32	30	108	110	+18	192	−2	41
6	132(P)	90	33(P)	32	122	123	+9	201(P)	−1	40(T)
7	124	96	31	33(P)	129	127	−3	198	+2	42
8	112	99(P)	28	31	130(P)	127(P)	−15(T)	183	+3(P)	45
9	108	93	27	28	121	120	−12	171	+1	46
10	100(T)	84	25(T)	27	111	109(T)	−9	162(T)	+2	48(P)
11	116	81	29	25(T)	106	110	+6	168	−4	44
12	140	75(T)	35	29	104(T)	110	+30	198	−6	38
13		87		35	122					

MODEL TWO[b]

1	100		75							
2	92(T)		69(T)	75				50		150
3	104	25	78	69(T)	94	103	+1	51		141
4	120	23(T)	90	78	101	113	+7(P)	58	−12(T)	129
5	128	26	96	90	116	122	+6	64	−6	123
6	132(P)	30	99(P)	96	126	129(P)	+3	67(P)	−3	120(T)
7	124	32	93	99(P)	131(P)	125	−1	66	+6	126
8	112	33(P)	84	93	126	117	−5(T)	61	+9(P)	135
9	108	31	81	84	115	112	−4	57	+3	138
10	100(T)	28	75(T)	81	109	103(T)	−3	54(T)	+6	144(P)
11	116	27	87	75(T)	102(T)	114	+2	56	−12	132
12	140	25(T)	105	87	112	130	+10	66	−8	124
13		29		105	134					

Note: Q is finished stock; N, new orders; S, shipments; U, unfilled orders; and Z, production. The subscripts A and B refer to the two components. T denotes a trough and P, a peak, in the series.

[a] It is assumed that component A accounts for three-fourths, B for one-fourth, of total new orders. For A: $Z_A(t) = S_A(t) = N_A(t-2)$. For B: $S_B(t) = N_B(t)$, and $Z_B(t) = S_B(t-1)$. Initial levels: $N_A = 75$ and $N_B = 25$ (to period 1); $U_A = 150$ and $Q_B = 50$ (in period 2); U_B and Q_A are zero throughout.

[b] It is assumed that component A accounts for one-fourth, B for three-fourths, of total new orders. Initial level and time paths of new orders (N_A and N_B) are the same as in Model One. Initial level of $U_A = 50$ and $Q_B = 150$ (in period 2); U_B and Q_A are zero throughout. Equations for Z_A, S_A, Z_B, and S_B are the same as in Model One.

(periods 2–6), which shows a retardation before this peak, this contraction ends on a reaccelerated decline.

The lead of new orders relative to shipments results in a cyclical movement of unfilled orders that conforms positively to the cycle in demand (new orders), while the lead of shipments relative to output results in a movement of finished stock that conforms negatively (columns 8 and 10). The *leads* alone are sufficient to produce these patterns; no particular assumptions about the relative *amplitudes* of new orders, shipments, and output are necessary for that. But in fact new orders are subject to larger fluctuations than shipments. This results in larger amplitudes of the corresponding movements in the unfilled orders backlog, both absolutely and relative to shipments. Similarly, if output fluctuates less than orders shipped on receipt, the inverted cycles in finished inventory are correspondingly increased.

The Structure and Variability of Lags in Filling Orders

Let s_t be a firm's shipments of a certain product and n_t be new orders for that item which the firm has received, with t relating to some short unit period, say, one month. In general, s_t can be viewed as a weighted sum of new orders previously received. Thus,

$$s_t = \alpha_0 n_t + \alpha_1 n_{t-1} + \alpha_2 n_{t-2} + \cdots = \Sigma \alpha_i n_{t-i}, \; i = 0, 1, \ldots, m, \quad (1)$$

where the summation extends from i to m, and m reaches as far back as necessary to cover the entire relevant past.

In practice, some of the α's will, of course, be zero. In particular, for production to stock, $\alpha_0 = 1$ and $\alpha_j = 0, j = 1, 2, \ldots, m$, when it is assumed that shipments can always be executed from stock without any significant delay. Similarly, in the simplest case of production to order with a constant delivery period k, all the α coefficients would be zero, except that of n_{t-k}; for example, if $k = 2$ (months), then $\alpha_i = 1$ for $i = 2$ and 0 for $i \neq 2$.

However, where manufacture to order is involved, there will ordinarily be more than one nonzero (positive) α coefficient in an equation such as (1); that is, the lags will be distributed rather than simple. For some products, it may be meaningful to think of a technologically defined minimum delivery period, but even there longer periods are feasible and may under certain circumstances be economically preferable. Technology alone does not determine production schedules, which rather are influenced by economic factors such as demand expectations, supply conditions including availability and prices, and the like. In particular, a firm will, *ceteris paribus,* prefer a more stable flow of output to one that varies greatly, since large short-term variations in the production rates add to the costs. The attempt to stabilize operations is likely to involve some smoothing of the impact of new orders by scheduling production to make it less variable than the incoming business. This means a policy of substituting distributed for simple delivery lags; for, in the case of a single constant delivery period k, the flow of output and shipments would be just a replica of the flow of new orders, lagged by k, and this is precisely what the firm would *not* want, assuming that it desires to reduce the variability of s_t.

Another reason is that the rate per unit period at which new orders are received may at times exceed the rate at which the orders can be filled. This happens when the incoming business strains the capacity to produce, and it implies a lengthening of the average delivery periods agreed upon by the contracting parties or imposed upon the buyer. In terms of the distributed lags, this means a shift in the weights, which are now lighter for the more recent and heavier for the more distant past. Hence, not only are the lags distributed, but they are also variable: in times of high capacity utilization the longer lags become more and the shorter lags become less important.

When applied to aggregates comprising groups of firms (industries) and groups of products, we shall have, analogously to (1),

$$S_t = a_0N_t + a_1N_{t-1} + a_2N_{t-2} + \cdots = \Sigma a_iN_{t-i},\ i = 0, 1, \ldots, m, \quad (1a)$$

with the summation taken over the same range as in (1). Aggregation supplies additional reasons for the delivery lags being distributed rather than simple. Even in a single-product industry, summation over different firms would work in this direction, since the delivery periods are unlikely to be always identical for all the firms. In a multiproduct industry, aggregation over the different products also is likely to result in a differentiation of the lags.

Typically, the available data are industry totals, so that (1a) rather than (1) can be estimated. In all applications of (1a) as a regression model based on time series data, the estimates of the a's have, of course, the meaning of temporal averages. They represent the average effects upon S_t of N_t, N_{t-1}, etc. Even if at any given time the delivery lag for any item were of the simple rather than distributed type, variations over time in these orders-to-shipments intervals could produce sufficiently large deviations from the mean to make the distributed-lag model superior to the simple-lag model. Thus the results of such regressions incorporate the combined effect of all the involved types of aggregation —over firms, products, and time.

As usual, aggregation is necessary to simplify and generalize but it also creates problems. Changes in the product mix, for example, will affect the results of applications of (1a) to industry totals. But to the extent that such changes in the aggregates involved are random rather than systematic, they would cause no bias and could be disregarded. And in some cases where they do matter, some disaggregation may be possible and helpful.

Those changes in the delivery lags, however, which come about because of cyclical changes in resource utilization present a different and more substantive problem. They are systematic and may occur at any level of industry aggregation. They can, therefore, be neither ignored nor handled by disaggregation. The answer lies in studying the lags in the context of business cycles; separately at peaks and at troughs, for example, or as a function of the demand pressure (which may be measured by the ratio of unfilled orders to shipments or indexes of capacity utilization).[39]

Manufacturers' Orders as Target and Tool of Forecasts

On the Quality and Functions of Orders Forecasts

Uncertainty about future demand, when sufficiently high, contributes a motive for production to order. If the sales of a specific product can be fairly accurately predicted, then this item, whatever its other characteristics, is likely to be produced to stock rather than to order (assuming, of course, that production is expected to be profitable). It is where sales appear to be particularly difficult to predict and where the costs of acting upon wrong forecasts are punitive that production will follow advance orders.

[39] Evidence bearing on these relationships is presented in several parts of this book: in the comparisons of the amplitudes of new orders, output, and shipments during cyclical and shorter movements (Chapter 3); in the estimates of lags of shipments and output behind new orders (Chapters 4 and 5); and in the discussion of the behavior and function of unfilled orders (Chapter 6).

Nevertheless, forecasts of future sales exist even in manufacturing to order, presumably because they are needed for planning purchases of materials in the short run and also for planning production, fixed investment, and the work force in the long run. For nonelectrical machinery, an industry in which production to order prevails, forecasts of new orders are collected by the McGraw-Hill Publishing Company. The forecasts are reported quarterly for the industry as a whole and for six subgroups [40] by 50 to 60 large companies; they begin in 1956 and cover spans of one to four quarters ahead. Seasonally adjusted indexes, 1950 = 100, are compiled by McGraw-Hill from these forecast figures, to match series on the actual flow of orders reported in the same form.

Recently, an accuracy analysis of the aggregate forecasting index for all companies reporting in 1956–65 has been carried out by George Terborgh.[41] The performance of this forecasting series was found to be very poor, as illustrated in Table 2-4. In fact, the deviations of predicted from actual changes have on the average been larger than the actual changes themselves (compare columns 4 and 5). This implies that predicting that there would be no change from the last known level of new orders would have yielded smaller errors than predicting with the index based on the companies' reported forecasts; in other words, the forecasts in the aggregate have been worse than the extrapolations of the last level.

This finding shows the forecasting index for nonelectrical machinery orders to be definitely inferior to most forecasts by business economists of such series as GNP and its major components and industrial production. These forecasts have typically been better than the simple last-level projections; and most of the GNP and industrial production forecasts in the postwar period show better over-all scores than even the more sophisticated extrapolations of past trends or of the relations between several recent values of the series concerned. This is true for predictions of the next two or three quarters and of the average annual values.[42]

The errors increase systematically with the span of the forecast, as can be seen by reading down columns 1–4 in Table 2-4. This would be

[40] See note 28 above. Construction machinery is combined with mining machinery.

[41] Machinery and Allied Products Institute, *Capital Goods Review*, No. 64, Washington, D.C., December 1965.

[42] See Victor Zarnowitz, *An Appraisal of Short-Term Economic Forecasts*, Occasional Paper 104, New York, NBER, 1967.

Table 2-4
Average Errors of Forecasts and Average Actual Changes, New Orders for Nonelectrical Machinery, Quarterly, 1956–65
(per cent)

Span of Forecast[a] (no. of quarters)	Mean Absolute Error of Forecast[b] 1956–58 (1)	1959–62 (2)	1963–65 (3)	Total Period, 1956–65 (4)	Mean Absolute Change in Actuals,[c] 1956–65 (5)
One	7.2	3.7	6.0	5.4	4.7
Two	8.9	6.4	9.9	8.1	7.4
Three	11.1	7.8	16.0	11.1	10.6
Four	10.3	8.3	19.0	12.1	12.5

Source: Machinery and Allied Products Institute, *Capital Goods Review*, December 1965.

[a] Interval between the last quarter for which actual orders are known at the time of forecast and the quarter to which the forecast refers. For example, for a forecast made in mid-January the last known quarter is the fourth quarter of the preceding year; the forecast with the one-quarter span refers to the first quarter of the current year (in which the respondent stands); the two-quarter span reaches into the second quarter of the current year; etc. The forecasts are made in January, April, July, and October.

[b] Averages taken without regard to sign over the deviations between actual and predicted percentage changes from the base quarter to the target quarter. The first forecast covers II-1956; the last, III-1965.

[c] Averages taken without regard to sign over the actual percentages changes from the base quarter to the target quarter. Comparable to the corresponding entries in column 4.

expected, and it has been shown elsewhere for a variety of aggregative forecasts.[43] But the average change in the observed values also increases with the span (column 5). In fact, the rise in the actual change is faster than that in the average forecast error; so the errors, when taken relative to the changes, *decrease* with the predictive span. This means that the forecasts improve somewhat relative to the extrapolations based on the no-change assumption when the distance between the base and the target period is lengthened, until, for the four-quarter span, the forecasts appear to be slightly more accurate than such "naive-model" extrapolations.[44]

[43] *Ibid.*, Chap. 5.

[44] Among the GNP and industrial production forecasts reviewed in *ibid.*, one can find some sim-

The forecasts for the subperiod 1959–62 were definitely more accurate than those for either the earlier (1956–58) or the later years (1963–65). The worst forecasts were made in the most recent years (except for the shortest forecasts, which were worst in 1956–58; compare columns 1–3 in Table 2–4). This, as noted in the evaluation by the Machinery and Allied Products Institute, probably occurred because in 1959–62 the reported nonelectrical machinery orders showed a fairly steady and moderate advance of the kind that is often expected and comparatively easy to predict. In contrast, the same series experienced in the earlier period a substantial decline and recovery in connection with the 1957–58 business recession. The decline was missed, which gave rise to large overestimates of the level of orders during the recession, while the subsequent improvement was significantly underrated. The forecasts have generally failed to signal the cyclical turns in this period (they seem to have done somewhat better in this respect during the declines of orders in 1960–61 and 1962). As for the 1963–65 period, it was characterized by a steeper rise of orders than that observed in the recent past. Even though this new, faster advance was quite steady, forecasters continued to underestimate it by large margins; they "simply refused to believe that the trend could be maintained." [45]

The McGraw-Hill series shows the average predictive performance of all companies reporting, not the performance of any single one of them. No doubt, some of the respondents have done better than the average, and others have done worse. I have no knowledge of any company scores, but, if the experience with other groups of forecasts is a guide, the better-than-average scores should be decidedly a minority. In terms of the summary measures of error over time, the average forecast for a group is typically more accurate than most of the forecasts for individual members of the group because the former is helped in the long run by the cancellation of individual errors of opposite sign.[46]

Few sources of potential strength seem to exist for microforecasts of advance orders, and none are clearly reliable. Current inquiries from

ilar examples of longer forecasts being better than the short ones in comparison to the naive model here employed, although counterexamples also exist and the observed relations are not very strong or regular. When compared to the more effective extrapolations of trends or autoregressive relations, forecasts typically come out worse rather than better for the longer spans (see *ibid.*, Table 18 and the text).

[45] *Capital Goods Review*, No. 64, December 1965.

[46] See Zarnowitz, *Appraisal*, Chart 6 and text.

old and prospective customers may provide some guidance; but they are probably at best short-run indications and may well be too sporadic or informal to be really helpful. One can presume that sales experience or knowledge of the past behavior of orders received should work to improve the company forecasts; but the past record will be of little assistance where the inflow of new orders is irregular. It would not be surprising, therefore, if the ability to predict new orders on the level of the individual firm were generally quite limited, as the above evidence for nonelectrical machinery suggests it is.

However, another possible, partial reason for the weakness of these forecasts is that the effort invested in them is rather small because the needs they are to serve are modest. As argued earlier, advance orders themselves represent an important guide to production, thereby preempting, at least in part, the function which in manufacture to stock must be performed by sales forecasts.

Sales Forecasts and the Predictive Properties of Orders

New orders are difficult to predict as such but, once known, should be decidedly helpful in predicting shipments (often referred to as "sales"). They certainly make a better tool than a target of forecasts.

If new orders help businessmen to predict their sales more accurately, then the sales forecasts should be better in those industries which receive advance orders for large proportions of their outputs. Recent evidence suggests that sales anticipations are indeed substantially better predictors in the durable goods sector of manufacturing, where production to order is generally important, than in the nondurable goods sector, where this is not the case.

These results come from Michael Lovell's study of new data from the Quarterly Manufacturers' Inventory and Sales Anticipation Survey conducted by the Office of Business Economics, Department of Commerce.[47] This survey, initiated in the fall of 1957, was at first (through 1958) semiannual; continuous and comparable observations on anticipated and actual values are available only for a short period ending in 1963, since later figures are on a revised basis. While the older sales anticipations data, of more limited coverage and perhaps of lower qual-

[47] Michael C. Lovell, "Sales Anticipations, Planned Inventory Investment, and Realizations," in *Determinants of Investment Behavior*, Universities-National Bureau Conference 18, New York, NBER, 1967.

ity, give poor or indifferent results, the predictive performance of the present series appears to be more satisfactory.[48]

The OBE survey collects figures on sales expected in the current and the immediately following quarter, as well as reports on actual sales in the preceding quarter. The "second anticipations," which refer to the current quarter, are only in part forecasts and very short-term at that. They reflect in about equal measure the knowledge of actual current sales, since the survey is taken close to the middle of the quarter to which they refer. Their deviations from the corresponding figures on actual sales would be expected to be small and essentially random.[49] It is therefore not surprising that the correlations between these anticipations and actual sales are high for most industries. But it is worth noting that they are definitely higher for durable goods than for nondurables. The adjusted determination coefficients ($\bar{r}^2$) are .962 for the durables aggregate and .620 for the nondurables one.[50]

The first anticipations relating to the next quarter are of more interest. As would be expected, they show lower correlations with actual sales than do the second anticipations, which have a much shorter span. On the whole, however, these correlations are still fairly high for the durable goods industries: the coefficients $\bar{r}^2$ exceed .8 for two, and exceed .5 for five of the seven components of this sector. For the aggregates of durable goods, $\bar{r}^2 = .738$. The results for the nondurable goods industries are, again, considerably worse, e.g., four of the seven $\bar{r}^2$ coefficients for the components of this sector are less than .5. The coefficient for the aggregates of nondurable goods is .483.

An industry that does receive advance orders for many of its products may of course still have relatively poor sales forecasts because

[48] The older data include the Railroad Shippers', *Fortune*, and Dun and Bradstreet surveys, and the sales anticipations data reported as a by-product of the Commerce-SEC annual survey of intended business expenditures on plant and equipment. They have been evaluated in numerous studies, notably Robert Ferber, *The Railroad Shippers' Forecasts*, Urbana, 1953; F. Modigliani and O. H. Sauerlander, "Economic Expectations and Plans in Relation to Short-Term Economic Forecasting," *Short-Term Economic Forecasting*, Studies in Income and Wealth, Vol. 17, Princeton for NBER, 1955, pp. 261–351; Peter B. Pashigian, "The Accuracy of the Commerce-SEC Sales Anticipations," *Review of Economics and Statistics*, November 1964, pp. 398–405; and several papers in *The Quality and Economic Significance of Anticipations Data*, Universities–National Bureau Conference 10, Princeton for NBER, 1960.

[49] Compare Robert Eisner's "Comment" on Lovell's paper, in *Determinants of Investment Behavior*, p. 595.

[50] Furthermore, four of the seven major component industries listed for the durable goods sector show $\bar{r}^2 > .9$, and the remaining three have $\bar{r}^2$ of the order of .7. The seven component nondurable goods industries covered have substantially lower $\bar{r}^2$ coefficients, ranging from .8 down to less than .2. See Lovell, "Sales Anticipations," Table 3, p. 546.

of the greater variability of its sales (or for other, individually probably less important reasons which may make some series harder to predict or some forecasters less able or less lucky than others). By the same token, an industry selling mainly from stock may have a relatively good forecasting record. There are apparent illustrations of this in some of the differences in the performance of sales anticipations among the component durable goods industries.[51]

Lovell also presents measures for the predictive accuracy of the new OBE anticipations data relative to a naive model of the "same as last level" variety.[52] Once more, according to these ratios of average absolute errors, the durable goods industries have produced much better sales forecasts than the nondurable goods ones. All the ratios for the durables are less than 1, that is, the errors of the anticipations average less than those of the naive model (the former being used in the numerator and the latter in the denominator of each ratio). The ratio for the aggregate durable goods sector is 0.42. The ratios for the nondurables are generally higher and exceed unity for two industries. The ratio for aggregate nondurables is 0.64.

Further tests by Lovell consisted of regressions of actual sales change on anticipated sales change, seasonal dummy variables, and a trend term. Presenting partial correlations of actual with anticipated change, Lovell notes that "while these partial coefficients are quite high in a number of durable industries, it is apparent . . . that the anticipated change makes a negligible contribution toward predicting the seasonally adjusted actual change in most nondurable industries." [53]

Using the same detailed anticipations data, furnished by courtesy of the Office of Business Economics, I was able to reexamine the relations between actual and anticipated sales, including new orders re-

[51] Nonautomotive transportation equipment, an industry producing largely to order with highly variable sales, shows a low $\bar{r}^2$ of .325. The group of other durables, where production to stock is more important and sales are much less variable, has a higher $\bar{r}^2$, .537. (But this group comes out worst of all durables in comparisons with a naive model, which are described in the next paragraph.)

[52] The model produces extrapolations $E_t^{**} = A_{t-4}(A_{t-1}/A_{t-5})$, where A_{t-i} denotes actual sales i quarters earlier. This amounts to adjusting the same quarter of the preceding year by the recently observed trend (or, alternatively, to adjusting the preceding quarter for the change observed last year, since $E_t^{**} = A_{t-1}(A_{t-4}/A_{t-5})$; thus the formula involves a crude seasonal correction). The test was introduced by Ferber in his 1953 study (see reference in note 48).

[53] Lovell, "Sales Anticipations," pp. 548–49. The partial correlation coefficient, squared and adjusted for degrees of freedom, is .444 for aggregate durables. Corresponding measures are reported for only three nondurable goods industries, where they are less than .1. Even for the second anticipations, the partials are insignificant for the nondurables (here the sectoral value of the partial is reported and equals .022; the corresponding coefficient for the durables is .552).

ceived ahead of the target period. It was possible to match data for sixteen quarterly intervals in the period III-1959–II-1963 and to cover four major durable goods industries. Tests confirmed that the sales anticipations are best treated as seasonally unadjusted. Regressions with seasonal dummy variables were selected as the most acceptable method of handling the problem.

Second anticipations, issued in the first half of the target quarter, are more closely associated with actual sales than are new orders received in the preceding quarter. This accords with expectation and, because of the partial overlap and the short predictive span involved, is viewed more as a sign of consistency and reasonable promptness of current information about sales than as a mark of superior ability to forecast. In Table 2-5, therefore, only the first anticipations, which refer to the next quarter, are included. The table presents regressions of the form

$$S_t = a + bS^a + cN_{t-1} + w_1D_1 + w_2D_2 + w_3D_3 - u_t, \qquad (2)$$

with S_t = actual sales in quarter t; S^a = first anticipations of sales (issued in the first half of quarter $t-1$); N_{t-1} = new orders received in quarter $t-1$; D_i ($i = 1, 2, 3$) = seasonal dummy variables which equal unity in the ith quarter and zero in all other quarters; and u_t = residuals. Only new orders received in quarter $t-1$ are incorporated in these regressions; the term N_{t-2}, representing the earlier orders, proved to be of little or no significance when used instead of N_{t-1}, and there is no need here to use both.

In three of the four industries covered in Table 2-6, new orders (N_{t-1}) are shown to be more closely associated with actual shipments or sales (S_t), than are the first sales anticipations (S^a). For primary iron and steel the latter variable has a negative (but in all likelihood not significant) coefficient. For both machinery industries, the partial correlations of S_t with N_{t-1} (column 6) are higher than those of S_t with S^a (column 5). In transportation equipment, however, the situation is reversed: here S^a is highly significant and N_{t-1} is not.

If the partial r of S_t with S^a, net of the effects of N_{t-1} and D_i, is significantly positive, then S^a must have some predictive value that is not contained in new orders (N_{t-1}); indeed, this coefficient (or better, its squared and adjusted form) is a measure of the net contribution of S^a to the prediction of S_t. At the same time, if the partial r of S_t with N_{t-1}, net of the effects of S^a and D_i, is significantly positive, then N_{t-1} must

Table 2-5
Regressions of Sales (Value of Shipments) on Sales Anticipations, New Orders,[a] and Seasonal Terms, Four Major Manufacturing Industries, Quarterly, 1959–63

Industry	Constant Term[b] (1)	Regression Coefficients[b] b (2)	Regression Coefficients[b] c (3)	Adjusted Determination Coefficient (4)	Partial Correlation Coefficients[c] (5)	Partial Correlation Coefficients[c] (6)
Primary iron and steel[d]	2.359	−0.216	.616	.618	−.310	.797
	(0.914)	(0.250)	(.177)			
Machinery, except electrical	−0.834	0.457	.641	.961	.726	.866
	(0.699)	(0.137)	(.117)			
Electrical machinery	−0.028	0.423	.609	.818	.486	.690
	(0.968)	(0.241)	(.202)			
Transportation equipment[e]	−4.540	1.177	.224	.800	.698	.297
	(3.435)	(0.402)	(.240)			

[a] Equation (2) is used for the estimate. For the notation, see the text. The coefficients of the dummy variable, $D_t - w_1$, w_2, and w_3—in that order, are: primary iron and steel: 0.052, 0.311*, 0.031; machinery, except electrical: 0.102, 0.274*, −0.525*; electrical machinery: −0.217*, −0.062, −0.404; transportation equipment: −0.636*, 0.570, 0.318. Most of these coefficients are smaller than their standard errors; those that are larger, and possibly statistically significant, are marked with an asterisk.

[b] Column 2 gives the coefficient of S^a. Column 3 gives it for N_{t-1}. The standard errors are in parentheses beneath the coefficients.

[c] Column 5 shows the partial correlation coefficient of S_t with S^a, net of the effects of N_{t-1} and the seasonal factors D_t; column 6, the partial of S_t with N_{t-1}, net of the effects of S^a and D_t.

[d] Excludes three quarters strongly affected by a major steel strike: III-1959, IV-1959, and I-1960.

[e] Total of automotive and nonautomotive.

have some predictive power that was not used in the sales forecast S^a. Where that coefficient is large, as it is for the primary iron and the two machinery industries, the forecast could presumably be much improved by better utilization of the available information on recently received orders.[54]

[54] This paragraph and the following one apply certain concepts developed in Jacob Mincer and Victor Zarnowitz, "The Evaluation of Economic Forecasts," in J. Mincer, ed., *Economic Forecasts and Expectations: Analyses of Forecasting Behavior and Performance*, New York, NBER, 1969.

Measures of direct association between S^a and N_{t-1} give us an idea of how important recent orders are as a codetermining factor or "ingredient" of first sales anticipations. These correlation statistics are shown in Table 2-6. They suggest that the anticipations of primary iron and steel and machinery sales have much in common with new orders, even net of the seasonal influences (first three lines, columns 1–3). The lowest correlations are obtained for transportation equipment, where, it will be recalled, S^a has been relatively efficient as an estimator of S_t, while N_{t-1} has been poor in this role (Table 2-6, last line). It is, of course, sensible for the anticipations to have a weaker association with orders whenever the latter are less helpful in predicting sales.

The addition of orders received in quarter $t-2$ contributes little to the correlations in Table 2-6, except for nonelectrical machinery, where the combined effect of N_{t-1} and N_{t-2} on S^a is strong (third line).

Finally, a *caveat* must be issued: it should be clear that the correlations in Table 2-6 are generally not high enough to yield results con-

Table 2-6

Correlations of Sales Anticipations with New Orders and Seasonal Terms,[a] Four Major Manufacturing Industries, Quarterly, 1959–63

	Correlations[b] of S^a with N_{t-1} and D_i				Correlation[c] of S^a with N_{t-1}, N_{t-2}, and D_i	
Industry	Simple (1)	Partial (2)	Multiple (3)	Adjusted and Squared (4)	Multiple (5)	Adjusted and Squared (6)
Primary iron and steel[d]	.644	.508	.761	.369	.872	.591
Electrical machinery	.598	.554	.632	.199	.686	.231
Machinery, exc. electrical	.442	.562	.601	.149	.879	.668
Transportation equipment	.142	.260	.566	.073	.590	.023

[a] For the notation, see the text accompanying equation (2), above.

[b] The simple correlation is of S^a with N_{t-1}. The partial is of S^a with N_{t-1}, net of the effects of D_i. The multiple is of S^a with N_{t-1} and D_i. Column 4 shows $\bar{R}^2$, the adjusted coefficient of determination.

[c] The multiple correlation coefficient is in column 5. Column 6 shows the adjusted coefficient of determination.

[d] Excludes three quarters affected by the steel strike: III-1959, IV-1959, and I-1960.

ventionally regarded as significant after adjustments have been made for the degrees of freedom. The numbers of observations are small (13 to 16); consequently, the adjustments reduce the coefficients substantially. The values of $\bar{R}^2$ in Table 2-6 are accordingly low, except for the above-mentioned case of nonelectrical machinery (columns 4 and 6).

Summary

The demand for some goods is so differentiated or unstable or sporadic, and consequently the cost of storing them unsold in finished form is so high, that these goods are produced primarily to order rather than to stock. For products that are typically made to order, the average ratios of finished inventories to unfilled orders (Q/U) are relatively low, while for products that are typically made to stock the Q/U ratios are high. Although they tend to fall in prosperous times and rise in sluggish ones, the ratios generally exceed 1 ($Q > U$) in most nondurable goods industries and are generally less than 1 ($Q < U$) in most durable goods industries. Manufacture to order is particularly important in metals, machinery, and nonautomotive transportation equipment—industries producing mainly capital goods.

Cancellations of orders received by manufacturers appear to be on the average relatively small for a variety of products, but they have been large at certain times on military and defense-related contracts. The amount and rate of cancellations increase with, but lag behind, new orders.

New orders (N) and shipments (S) tend to coincide in production to stock. In contrast, N leads S in production to order, with output (Z) intervening. Here changes in unfilled orders that reflect adjustments of delivery periods can absorb much of the variation of incoming business, thus making the course of Z and S considerably smoother than the course of N.

New orders for many manufactured goods are highly variable in the short run and difficult to predict. Sales forecasts are likely to have frequent serious errors and, if the costs of acting on wrong sales forecasts are critically high, production tends to follow advance orders. Forecasts of future sales (new orders) exist even in manufacture to order but they presumably have a less important function than in production to stock and may command less care and attention. Certainly the available evidence indicates that company forecasts of incoming orders tend to have little predictive value.

Advance orders, while themselves poorly predicted, can help businessmen predict their sales more accurately. Thus, sales anticipations appear to be substantially better predictors in the durable goods industries, where production to order is generally important, than in the nondurable goods sector, where this is not the case.

To conclude, in a large segment of the economy orders perform an important role in guiding production. Quantitative evidence on the relationships involved is unfolded in the chapters that follow.