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Inventory Gains and Losses

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Most of the standard inventory control formulas ignore the effect of price fluctuations on carrying costs. These authors suggest a way to calculate economic order quantities with allowance for —

INVENTORY GAINS AND LOSSES

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INVENTORY CONTROL is probably closer to being an exact science than any other area of management. Formulas for calculating economic order quantities, reorder points, and buffer stocks are widely disseminated, and their users often report sizable savings in inventory carrying costs.

One major element of inventory planning, however, has received little attention from the proponents of scientific inventory control. Holding gains and losses as a result of price fluctuations are seldom components of inventory control formulas. Some theorists include a provision in inventory carrying cost for possible price reductions to clear finished goods from inventory, but the possibility of price changes in commodities or materials is rarely taken into account. Yet price fluctuations do occur, sometimes on such a scale as to wipe out most of the advantages of economic order quantity calculation.

In the discussion that follows the reader will be assumed to have at least an elementary understanding of the traditional method for computing optimum economic order quantities. The technique was explained in some detail in an earlier issue of MANAGEMENT SERVICES (see "Inventory Control" by Robert D. Niemeyer, M/S, July-August, 1964, p. 25); it has also been discussed in a number of books and magazines.

This article, accordingly, deals only with the frequently overlooked subject of inventory holding gains and losses caused by price changes. It emphasizes their importance as an element of inventory carrying cost and suggests how to provide for them in computing economic order quantities.

Importance

In several periods of our economic history the severity of price

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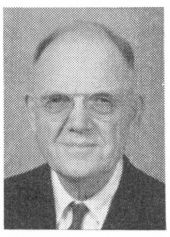

AVERAGE PRICES OF ELECTROLYTIC COPPER — CENTS PER POUND

Year	Average Price	Change from Prev. Year	% Change
1949	19.36		
1950	21.46	2.10	10.85
1951	24.37	2.91	13.56
1952	24.37	—	—
1953	28.92	4.55	18.67
1954	29.82	.90	3.11
1955	37.39	7.57	25.39
1956	41.88	4.49	12.01
1957	29.99	11.89*	28.39*
1958	26.13	3.86*	12.87*
1959	30.82	4.69	17.95
1960	32.16	1.34	4.35
1961	30.15	2.01*	6.25*
1962	30.83	.68	2.26
1963	30.83	—	—

*Decrease

EXHIBIT I

fluctuations has compelled many businessmen to "manage" inventories with consideration of anticipated price changes as a prime factor. Frequently this "inventory management" has merely taken the form of educated guessing about quantities rather than of allowing for anticipated price changes by introducing a factor determined by scientific measurement.

One example is that period extending from the beginning of the Korean War through most of 1957. During this period most companies found that the holding gains in inventory, i.e., the increases in cost prices applicable to inventories on hand, often exceeded the carrying costs of the inventories. It was argued during this period, with some justification, that poor inventory management frequently resulted in increased profits because a position of overstock increased profits.

The magnitude of the year-to-year price variations of industrial raw materials may be established by reference to tabulations of prices applicable to almost any of the basic commodities of consequence in manufacture or conversion of product. Copper is one raw material having extensive application in manufacturing whose price structure shows no extreme patterns of either wide or narrow fluctuation and which therefore may be taken as representative of many basic materials. Average prices for copper from 1949 to 1963 (inclusive) are tabulated in Exhibit 1 on this page.

During this period poor inventory management was most often attributed to those companies using rigid scientific inventory methods. This may be explained by the fact that almost all inventory control formulas in use failed to recognize holding gains and losses, and a rigidly adhered to system that did not include this factor could not be effective in maximizing profits. While exclusion of this element has the effect of concentrating management's efforts and decisions on the nonprojective aspects of the business and of limiting speculative tendencies, in today's economy the feasibility of such a constraint is certainly subject to serious question.

Attempts to avoid the possible consequences of speculation in inventories and to focus on the manufacture or acquisition and marketing of goods have a long, and for the most part unsuccessful, history. These attempts probably resulted in the first use of hedging and certainly were the largest single contributors to the establishment of the commodity market.

Probably a review of the history of this market would indicate that, instead of eliminating or restricting speculation, in many instances it has produced just the opposite effect. Where it is possible to obtain sale and purchase commitments almost simultaneously, or where very clean competitive conditions exist, inventory speculation may be avoided; yet, unfortunately, the number of these situations is limited. More frequently business is presented with a situation where a competitor has stocked in anticipation of a cost increase and is thereby enabled either to hold the resale prices level and build goodwill with customers or to raise resale prices concurrently with the industry adjustments and strengthen its earnings without injuring its competitive standing. Similar adjustments are, of course, possible when costs are dropping if a competitor is in a safety-stock-only position and is able to drop resale prices immediately.

Inventory speculation as a product of managerial whim is not a proper function of the manufacturer and/or distributor of merchandise and is better left to people

EOQ — FIRST EXAMPLE

Number Orders	Value of Each Order	Average Working Inventory	Carrying Costs	Order Costs	Total Costs	Price Change Adjustment	Net Cost
1	$10,000	$5,000	$1,000	$ 10	$1,010	$500	$510
2	5,000	2,500	500	20	520	250	270
3	3,333	1,667	333	30	363	167	196
4	2,500	1,250	250	40	290	125	165
5	2,000	1,000	200	50	250	100	150
6	1,667	834	167	60	227	83	144
7	1,429	715	143	70	213	72	141
8	1,250	625	125	80	205	63	142
9	1,111	556	111	90	201	56	145
10	1,000	500	100	100	200	50	150
11	909	455	91	110	201	46	155
12	833	417	83	120	203	42	161

EXHIBIT 2

in the business of speculation. However, prudent allowance for possible price changes affecting inventories of products regularly marketed is a normal part of business operations in this dynamic economy and is recognized as such by almost all management. It is surprising, therefore, to find that provision is seldom made for this factor in the formula most often recommended for economic reorder quantity calculations:

$$Q = \sqrt{\frac{2CU}{I}}$$

Where Q = Economic order quantity in dollars
Where U = Annual usage in dollars
Where C = Cost of an order in dollars
Where I = Inventory carrying cost as a percentage of working inventory investment

During the period cited earlier — when holding gains in inventories often exceeded carrying costs — application and use of this formula would obviously not have established inventory levels at a point where maximum profits were realized. During other periods price movements have tended downward to the extent that application of the formula would lead to an economic overstock.

Method

Probably in most instances the consideration of holding gains and losses in inventory is best introduced into the calculation of economic reorder quantity by including anticipated, or probable, price increases or decreases, expressed as a percentage of working inventory investment, as a reduction of or addition to carrying costs. On occasion this method will result in a negative carrying cost factor; thus, additional considerations are necessarily involved.

Working inventory investment is specified because in many instances customer service safety stocks are a major factor and should not be diminished for speculative purposes. There are several ways of providing for customer service and/or lost-profit factors in inventory management. One of these methods, establishment of a base stock in units for each item of inventory and limiting calculations of inventory order quantities to the excess over the base stock, is frequently used in practice; because of its simplicity, it is used in the following illustrations. The other methods, while probably more accurate in many instances, involve application of probabilistic techniques that are beyond the scope of this article. The reader is cautioned that there is a need for careful analysis when introducing the factor for holding gains and losses in the more complex models for EOQ calculation.

Example

To illustrate the effect of this factor, assume the following data concerning a class of products:

Annual usage	$10,000
Cost of an order	$10
Carrying costs	20% of working inventory investment
Anticipated price increase	10% of working inventory investment

Application of the formula without a factor for price fluctuation would be as follows:

$$Q = \sqrt{\frac{2(10)\ (10{,}000)}{.20}}$$

$Q = \$1{,}000$

EOQ — SECOND EXAMPLE

Number Orders	Value of Each Order	Average Working Inventory	Carrying Costs	Order Costs	Total Costs	Price Change Arrangements	Net Cost
1	$10,000	$5,000	$500	$ 10	$510	$1,000	$ (490)
2	5,000	2,500	250	20	270	500	(230)
3	3,333	1,667	167	30	197	333	(136)
4	2,500	1,250	125	40	165	250	(85)
5	2,000	1,000	100	50	150	200	(50)
6	1,667	834	83	60	143	167	(24)
7	1,429	715	72	70	142	143	1
8	1,250	625	63	80	143	125	18
9	1,111	556	56	90	146	111	35
10	1,000	500	50	100	150	100	50
11	909	455	46	110	156	91	65
12	833	417	42	120	162	83	79

EXHIBIT 3

Application of the formula including the factor for anticipated price increases as a reduction of carrying costs would be as follows:

$$Q = \sqrt{\frac{2(10)\ (10{,}000)}{.10}}$$

$$Q = \$1{,}414$$

Another method of determining economic reorder point is to tabulate the total costs of inventory acquisition and ownership to the date of sale and then to select the reorder value that results in the lowest total cost. The example just illustrated when solved in this way may assume the tabular form shown in Exhibit 2 on page 54.

Note that the total cost column indicates the same reorder point as previously calculated by use of the formula that did not include a factor for price changes and that the net cost column indicates the same reorder point as calculated by the formula that did include a factor for price changes. Note also that reorder quantity for these selected data would vary more than 40 per cent depending upon whether the factor for holding gains is included in the computation. Carrying costs of 20 per cent may be considered only conservatively high, and annual price fluctuations of 10 per cent or even more are not unusual.

To extend the illustration of this factor to a more extreme, although still a reasonable, situation, assume a company with idle space, ample borrowing capacity, etc., and incremental carrying costs of 10 per cent. Additionally, assume the following:

Annual usage	$10,000
Cost of an order	$10
Anticipated price increases	20% of working inventory investment

Application of the formula without a factor for price fluctuation would yield the following results:

$$Q = \sqrt{\frac{2(10)\ (10{,}000)}{.10}}$$

$$Q = \$1{,}414$$

Application of the formula including a factor for the anticipated price increases as a reduction of carrying costs would be as follows:

$$Q = \sqrt{\frac{2(10)\ (10{,}000)}{-.10}}$$

$$Q = \sqrt{-2{,}000{,}000}$$

(Since the square root of this quantity is a complex number, some other solution method must be applied.)

The tabulation method applied to this illustration is shown in Exhibit 3 above.

Discussion

Both of the methods illustrated indicate that the more inventory owned, the more "profit" realized An examination of some of the items typically included as carrying costs in calculations such as this will show that the indicated conclusion is valid only within calculable limits.

The most frequently illustrated carrying costs include (a) interest on inventory investment, (b) insurance, (c) deterioration and obsolescence, (d) property taxes on inventory, and (e) occupancy costs. Some of these costs must react to changes in inventory owned in the manner of a step function with new cost plateaus reached as limitations of capital, space, time, or other causative factors are approached and passed. Obviously, when additional space is required for inventory storage, new facilities, with associated incidental occupancy costs, will cause a step increase in carrying costs. The same is true

EOQ — THIRD EXAMPLE

Number Orders	Value of Each Order	Average Working Inventory	Carrying Costs	Order Costs	Total Costs	Price Change Adjustments	Net Cost
1	$10,000	$5,000	$1,000	$ 10	$1,010	$500	$1,510
2	5,000	2,500	500	20	520	250	770
3	3,333	1,667	333	30	363	167	530
4	2,500	1,250	250	40	290	125	415
5	2,000	1,000	200	50	250	100	350
6	1,667	834	167	60	227	83	310
7	1,429	715	143	70	213	72	285
8	1,250	625	125	80	205	63	268
9	1,111	556	111	90	201	56	257
10	1,000	500	100	100	200	50	250
11	909	455	91	110	201	46	247
12	833	417	83	120	203	42	245
13	769	385	77	130	207	39	246
14	714	357	72	140	212	36	248
15	667	334	67	150	217	33	250

EXHIBIT 4

of interest on inventory investment as practical borrowing capacity is approached. Property taxes on inventories are most often based upon inventories owned as of a particular date and therefore might well change in significance when speculative purchases cause a large carryover of inventory beyond this date. For any given company then, many of the elements included in carrying cost will remain in stable relationship with inventory owned only within ascertainable limits.

Consequently, it would seem that when a company faces the prospect of rising prices, practicality would dictate, depending upon the circumstances, that one of two courses be adopted:

1. Set reorder quantities at the highest level at which management is willing and able to speculate in market price fluctuations, or
2. Recalculate the incremental carrying costs upward until the amount exceeds the anticipated price fluctuations and then apply the formula including the factor for holding gains and losses.

Price reductions

The effect of this factor where prices are expected to trend downward may be illustrated as follows:

Annual usage	$10,000
Cost of an order	$10
Carrying costs	20% of working inventory investment
Anticipated price decrease	10% of working inventory investment

Application of the formula without a factor for price fluctuation would be as follows:

$$Q = \sqrt{\frac{2(10)\ (10{,}000)}{.20}}$$

$$Q = \$1{,}000$$

Application of the formula including a factor for anticipated price decreases as an additional carrying cost would be as follows:

$$Q = \sqrt{\frac{2(10)\ (10{,}000)}{.30}}$$

$$Q = \$816$$

The tabular method applied to this illustration would yield the results shown in Exhibit 4 on this page.

It should again be pointed out that the costs under consideration will react in the step manner previously discussed. Therefore, as reorder quantity diminishes with application of the formula, a new cost plateau may be reached. Extreme changes in reorder quantity will undoubtedly require a re-examination of carrying costs and order costs.

Conclusion

Holding gains and losses are an important influence in inventory planning and control. Exclusion of such gains and losses from consideration by failure to provide for them in economic reorder quantity calculations tends to negate the usefulness of such calculations. When the size of this element is unusually large, management must be informed of its materiality and also that use of the resulting calculations introduces a major speculative aspect into the business operations. Even if the size of this factor is not unusually large, it still should not be ignored. Price fluctuations are a business reality and usually at least as important as other individual costs in inventory management and control.