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A METHODOLOGY FOR CALCULATING THE COST OF HOLDING INVENTORY: A FOOD INDUSTRY EXAMPLE

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The authors develop methodology to determine inventory carrying costs and substantiate their findings with a case study.

INTRODUCTION

Inventory carrying costs include a number of different cost components and generally represent one of the highest costs in the physical distribution system. This, combined with the fact that inventory levels are affected by almost all of the other elements of the physical distribution system, demonstrates the need for management's careful attention to inventory carrying costs if the appropriate tradeoffs are to be made in the distribution system. Most of the costs of holding inventory that are currently being used are estimates or traditional industry benchmarks. Presently there is not a generally accepted methodology for calculating inventory carrying costs or for that matter even a framework for developing such costs. However, many authors have addressed the types of costs that should be considered and have estimated that these costs range from 12% to 35%.¹

The purpose of this article is to present a methodology, based on existing accounting finance, distribution and production literature, that can be used to develop inventory carrying costs. The results of the application

of the methodology in a live case situation are also reported. The methodology is designed to provide managers with a framework that can be applied in a "real world" setting to determine inventory carrying costs.

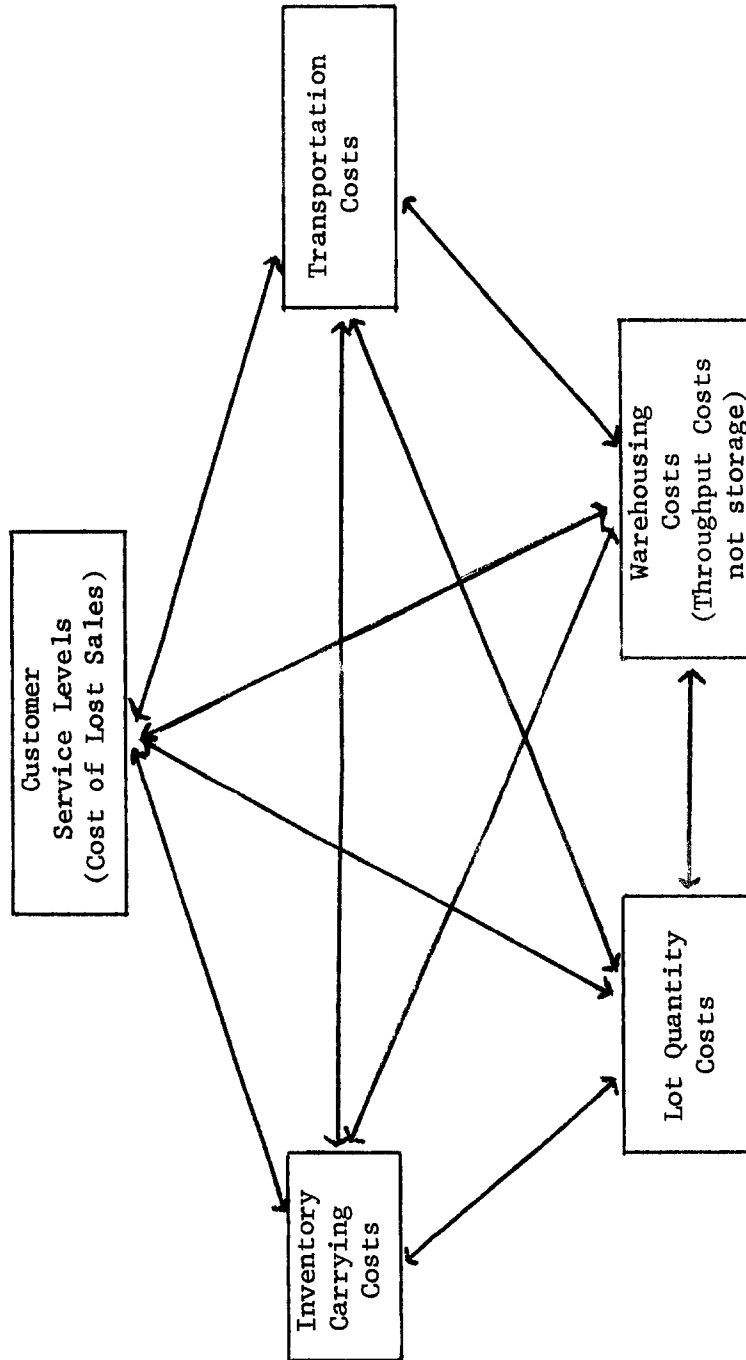
Background

Cost tradeoffs between and among the various elements of the logistics system and among the logistics system and the other functions of a business are basic to the logistics concept. Profits may be increased by reducing inventory and spending more on transportation or by spending more on the logistics system if the improvement in customer service results in more profitable customers. "If cost tradeoffs are at the heart of the logistics concept, then adequate cost information is at the heart of cost tradeoffs."²

Figure 1 illustrates the tradeoffs that are necessary when establishing customer service levels, purchasing policies, transportation policies, and warehousing systems if maximum corporate profitability is to be realized. Given a desired customer service level, low inventory carrying costs lead to multiple warehouses and a slower mode of transportation such as railroads. High inventory carrying costs, on the other hand, result in a limited number of stock locations and require a faster means of transportation, such as motor

FIGURE 1

COST TRADEOFFS REQUIRED IN THE LOGISTICS SYSTEM



Objective: Minimize total costs
Total Costs = Inventory Carrying Costs + Lot Quantity Costs + Warehousing Costs +
Transportation Costs + Cost of Lost Sales.

carrier or perhaps aircraft in order to minimize total costs. Without an accurate assessment of the costs of carrying inventory, it is unlikely that a company would choose the distribution policies that would result in the highest profit.

The cost of carrying inventory is also required to accurately determine economic manufacturing quantities, economic order quantities, and sales discounts,³ all of which are currently calculated on the basis of estimated costs in the majority of companies.

DEVELOPMENT OF THE MODEL

The following four basic costs categories must be considered when calculating inventory carrying costs: 1) Capital Costs; 2) Inventory Service Costs; 3) Storage Space Costs; 4) Inventory Risk Costs.

1. Capital Costs

Holding inventory ties up money that could be used for other types of investments. This reasoning holds for internally generated funds as well as funds obtained from outside sources. Consequently, the company's opportunity cost of capital should be used in order to accurately reflect the true cost involved.

A precise definition of the cost of capital is elusive; however Goodman defined it as follows:

"The cost of capital refers to that amount of money which a company, as a result of accepting a proposal, is expected to pay to and/or reinvest for the suppliers of funds during the life of the proposal, over and above the amount of funds required to initially finance the proposal."⁴

He made the point that it is a fallacy to think of the cost of capital as the interest rate plus financing charges since such a position assumes "that the owner's investment, including retained earnings, is cost free."

The measurement of cost of capital is very complex and much confusion is evident in the minds of academicians and businessmen alike. For example, the coupon rate on bonds is not an accurate measure of the cost of debt capital. Also, to measure the cost of debt capital, the impact of the marginal use of debt on the market price of common stock must be estimated. This issue has not been resolved. Basic financial management texts often employ a device commonly referred to as "weighted average cost of capital." However, the principal deficiency of this device rests on the assumptions regarding the optimum capital structure, debt and preferred stock capacity, the debt-equity mix, and optimum dividend policy.

In most business situations available capital must be rationed to the most attractive investment possibilities. Mao offered the concept of hurdle rate--the rate over which projects will be accepted or the minimum acceptable rate of return--for use in situations where capital is rationed. He defined the hurdle rate in these situations as the rate of return on marginal investments, due to the principle of opportunity cost.

"Consider for example, a firm which pays 10 percent for the funds that it acquires and that, because of capital rationing, is currently turning down marginal investments promising annual returns of 15 percent. For this company the hurdle rate in investment decisions is 15 percent,

although the cost of capital is only 10 percent. This means that the relevant time value of money is measured by the return on the most lucrative investments foregone by the firm, rather than by the price at which the funds were originally acquired. Of course, the 15 percent hurdle rate could also be designated as the cost of capital to the firm if this term is interpreted generically."⁵

Goodman supported Mao's view concerning opportunity cost. For most pragmatic business decisions, he stated that "capital rationing" was a more meaningful concept than "capital budgeting" and that a weighted average cost of capital was inferior to the concept of opportunity cost. "For most decision-making situations, it is the opportunity calculated cost of capital which is far more important for a given decision than an actual calculated cost of capital based upon something which happened yesterday."⁶

The cost of capital used in this research is the hurdle rate concept as presented by Mao. It is used for companies experiencing capital rationing which is the rule rather than the exception. Where capital rationing does not exist, the capital invested in inventory is expected to earn a rate competitive with marketable securities and/or other liquid investments of the firm.

Generally speaking, there are two types of capital costs that should be considered:

Inventory Investment - Many businessmen think that inventory is a relatively liquid and riskless investment. For this reason, they feel that

a somewhat lower return can be justified on inventory investments. However, in most companies inventory investments require capital that could be used in other corporate investments and by having funds invested in inventory a company foregoes the rate of return that could be obtained on such investments. Consequently, the company's opportunity cost of capital should be applied to the investment in inventory. Although most companies use some variation of absorption costing for inventory valuation, only variable manufacturing costs are relevant. That is, the cost of capital (the company's minimum acceptable rate of return) should only be applied to the variable costs directly associated with the inventory.

Investment in Assets - The cost of capital also should be applied to the investment in physical assets such as materials handling equipment if the amount of investment varies directly with the volume of inventory held and not the quantity of inventory shipped.

2. Inventory Service Costs

The inventory service costs are made up of:

Taxes - Taxes vary depending on the state in which inventories are held. The tax rates can range from zero in states where inventories are exempt to 19.8% of the assessed value in Indiana. In general, taxes vary directly with inventory levels.

Insurance - This refers to insurance purchased to cover the loss of inventory. Although insurance rates are not strictly proportional to inventory levels (since insurance is usually purchased for a specified time period), the policy will be revised periodically based on expected inventory

policy changes. Insurance rates vary depending on the materials used in the construction of the building, its age, and considerations such as the type of fire prevention equipment installed.

3. Storage Space Costs

In general there are four types of facilities that should be considered and the treatment is quite different for each one.

Plant Warehouses - The costs associated with plant warehouses are usually fixed in nature, although some variable costs such as the cost of taking inventory and other direct expenses should be included in inventory carrying costs. Fixed charges and allocated costs are not relevant for inventory policy decisions unless the warehouse space could be rented or used for some other productive purpose, if not used for storing inventory. In most cases, this would not be possible since we are dealing with changes in inventory levels and not the possibility of entirely eliminating inventories.

Public Warehouses - Space in public warehouses is usually rented on a dollar per hundredweight or on a volume occupied basis. The use of public warehouses is a policy decision made because it is the most economical way to provide the desired level of customer service without incurring excessive transportation costs. For this reason, the costs associated with public warehouses should be considered as through-put costs and only charges for recurring storage that are explicitly or implicitly included in the rental cost should be considered in carrying costs.

Of course, the capital costs associated with holding inventory in public warehouses must be included in inventory carrying costs. These costs are equal to the variable manufacturing

costs plus variable distribution costs multiplied by the opportunity cost of capital (minimum acceptable rate of return which equals the hurdle rate).

Rented (Leased) Warehouses -

When warehouse space is rented, it is normally contracted for, and the contract is in force for a specified length of time. The amount of space rented is based on the maximum amount needed for the period of the contract. Thus the rate of incurring warehouse rental charges does not fluctuate from day to day with changes in the inventory level, although the rental rates can vary from month to month or year to year when a new contract is negotiated. Most operating costs are fixed although some may vary with inventory level. In any case, they could be eliminated by not renewing the contract and are therefore, a relevant input for decision making. However, these costs should not be included in inventory carrying costs, but rather in the warehousing costs category (see Figure 1). Their inclusion in inventory carrying costs simply clouds the issue and forces an unnecessary recalculation of the inventory carrying cost percentage.

Privately Owned Warehouses - All operating costs that could be eliminated by closing the warehouse or the net savings resulting from a change to public warehouses should be included in warehousing costs and not in inventory carrying costs.

4. Inventory Risk Costs

These vary from company to company, and include charges for obsolescence, damage, pilferage and relocation of inventory.

Obsolescence - The cost of obsolescence is the cost of each unit which must be disposed of at a loss because it becomes obsolete. It is the difference

between the original cost of the unit and its salvage value. This figure may or may not show up on the profit and loss statement as a separate item. Usually obsolescence results in an over-statement as a separate item. Usually obsolescence results in an over-statement of the cost of goods manufactured account or the cost of goods sold account. Consequently, some difficulty may be experienced in arriving at this figure.

Damage - Only the portion of damage that is directly attributable to the volume of inventory held should be included. Damage incurred during shipping should be considered a through-put cost since it will continue regardless of inventory levels. Often this figure is identified as the net amount after claims.

Pilferage - Shrinkage has become an increasingly important problem for American businessmen. Inventory theft in the view of many authorities is a more serious problem than cash embezzlement. It is far more common and involves far more employees and is hard to control. This cost may be more closely related to company security measures than inventory levels, although it will definitely vary with the number of warehouse locations.

Relocation Costs - Relocation costs are the expense incurred by the transshipment of inventory from one stocking location to another to avoid obsolescence. In most cases these costs are the result of tradeoffs between transportation and warehousing costs and are not relevant for inventory holding costs.

THE CASE STUDY

In order to obtain the data to confront the methodology, a case study approach was used with a manufacturer

of food products. The actual accounting records and costs of this firm were investigated in depth in an effort to substantiate the proposed methodology. A number of problems encountered in operationalizing an inventory carrying cost methodology will be common to a number of organizations, and this research could prove useful to other companies who want to implement such a procedure.

The company was chosen because of management's desire to establish a formal procedure for determining inventory holding costs and the willingness to work with the researchers in order to develop an inventory carrying cost figure to be used in future distribution system analysis and planning.

The Company - A Description

The company had annual sales of over \$100 million and maintained an average inventory of approximately \$10 million. Its products were distributed nationally through three plant warehouses and over forty public warehouses. In no instance did the company totally occupy the leased space of a specific field warehouse, and individual field warehouse allocations ranged from 150 to 5,000 tons. The majority of public warehouse rates were negotiated at least every twelve months and rarely did a contract extend beyond two years. In all warehouses a one-shot billing system comprised of a fixed rate for storage and handling was applied to every hundred pounds of product delivered to a warehouse. Charges for such items as damaged goods and telephone expenses were billed separately. In a few cases, a public warehouse would assess a small monthly penalty charge for every hundredweight of product in excess of the contracted maximum storage level. Usually the charge for recurring storage was implicitly or

explicitly included in the negotiated rate and was based on the past experience of the negotiators.

Data Collection

The methodology previously described and the following framework were used as a basis for discussion in the data collection portion of the study.

1. A documented cost of capital figure (an interview with the controller was used to obtain this data).
2. Insurance and taxes on inventory for the past year.
3. Breakdown of warehousing costs both fixed and variable by plant warehouses and field warehouses.
4. Inventory risk costs (expressed in dollars for the past year)
 - obsolescence
 - shrinkage
 - damage
 - relocation costs (if any)
5. Standard manufacturing costs for each product.
6. Average monthly finished goods inventory for each product (either last year's actual or this year's projected).
7. Average annual total finished goods inventory for the past year.
8. Breakdown of where in the system inventory is held, for example:
 - 33% - field warehouses
 - 45% - plant warehouses
 - 22% - in transit
9. Current inventory carrying cost and method of calculation (if used).

10. Another goal of the study was to document the problems encountered in developing the methodology in each company as well as to obtain a measure of the time and effort involved in data collection in order to determine a realistic procedure for collecting these costs relative to the associated benefits and costs.

Inventory Carrying Costs - As Calculated by the Company

The inventory carrying cost percentage that was being quoted was 9.5% after taxes or 19.0% before taxes.

A meeting with the Controller revealed that there was not an established procedure for calculating inventory carrying costs. He said that it had been some time since the original calculation was made and was not aware that the number was still being used. Although he could not remember specifically which costs had been included, he believed that the following expenses had been considered:

1. Taxes (on inventory);
2. Insurance (on inventory);
3. Public Warehouses (about 3% - total public warehousing costs over factory sales through public warehouses valued at full factory cost);
4. Plant Overhead (some fixed items such as taxes and insurance);
5. Cost of Money (10%).

The cost of capital (10%) was applied to inventory valued at full factory cost.

Total 19.0% before taxes
9.5% after taxes

Calculation of Inventory Carrying Costs

1. Capital Costs (Cost of Money Invested in Inventory)

The company's minimum attractive rate of return on new investments was 20% after taxes. This was the return on investment that the company was requiring on new investments due to the shortage of capital. The capital costs should only be applied to "out-of-pocket" investment in inventory. The first step in the analysis of these out-of-pocket costs was to determine the average monthly inventory for each product for 1974 at full factory cost. The next step was to isolate variable costs from standard cost data. The variable manufacturing costs were then expressed as a percent of full factory cost for inventory held in plant warehouses. Variable transportation costs were also included for inventory held in public warehouses.

A weighted average of the variable costs associated with holding inventory throughout the system was calculated in order to find the inventory value to which the cost of capital should be applied. This weighted average amounted to 82.47% of the budgeted average monthly inventory. Since all other expenses were calculated as a percentage of inventory valued at full factory cost, it was necessary to adjust the 20% cost of capital figure to reflect the fact that only 82.47% of the inventory investment was variable (i.e., $20\% \times .8247 = 16.494\%$ after tax or 32.988% pre tax).

2. Inventory Service Costs

These costs are made up of insurance and taxes paid on the inventory investment.

Insurance - The budgeted insurance figures for 1974 were used since they

were the most easily obtained. The budgeted insurance expenses for 1974 were provided by the accounting department and represented approximately 0.07% of the 1974 projected average monthly inventory.

Taxes - The taxes paid in 1973 were provided by the company's tax accountant and represented 1.406% of the average monthly inventory in 1973.

3. Storage Space Costs

There were two types of warehouse facilities that required consideration:

Public Warehouses - Space in public warehouses was rented on a per hundred-weight basis. The use of warehouses was a policy decision made to provide the desired level of customer service without incurring excessive transportation costs. It is one of the cost categories that must be considered when attempting to minimize the total costs within the logistics system. A discussion with the manager of warehouse operations led to the conclusion that in 1973 approximately 2 cents per hundredweight on the average was built into the public warehousing rates in order to cover the costs of recurring storage. As a percentage of 1973 inventory this represented 1.093% of the inventory value.

Plant Warehouses - The costs associated with plant warehouses were fixed in nature with the exception of \$185,162 of direct variable expenses that would vary with changes in inventory levels. The variable costs of plant warehouses for 1974 were projected as 2.057% of 1974 planned inventory levels.

4. Inventory Risk Costs

Obsolescence was not a factor since the product had a shelf life of 18 months and enjoyed 12 turns per

year. Damage and pilferage, net of claims against carriers and public warehouses amounted to \$16,000 in 1973 or 0.22% of that year's average monthly inventory and relocation costs were believed to be negligible.

5. Total Inventory Carrying Costs

The total carrying costs figure to be used for decision making was 37.834% before taxes (Table 1). It was the researcher's belief that the procedure would only require three or four man days of effort per year to keep the inventory carrying cost figure current on an annual basis.

FINDINGS

This section deals with specific findings of the in-depth case study as well as the more general issues related to the basic problem of developing an inventory carrying cost methodology.

The company had been using an inventory carrying cost figure of 19.0% before taxes for distribution system planning. This number did not include some of the necessary costs and specifically excluded an opportunity cost of capital. Some of the costs that had been used were related to throughput or were fixed in nature and were not affected by the amount of inventory held in the system.

In addition, the company was including interest expense in the carrying costs calculation, but when the figure was applied in decision making a return on investment equal to the company's hurdle rate was expected on the additional inventory held. The interest expense as part of inventory carrying costs was multiplied by the full factory cost of the inventory when clearly this was not the out-of-pocket investment in inventory. This implies that even once the inventory carrying

costs have been calculated that managers may appreciate a framework for applying the figure in order to avoid the type of double counting illustrated in Table 2 (interest expense plus R.O.I.).

In terms of the availability of these costs within the current accounting system and the time required to gather these data, the findings in this case were very encouraging. All of the required numbers were available within the current accounting system and it appeared that once the procedure had been established that three or four man-days of effort per year would keep the carrying cost figure current. This, in fact, turned out to be a realistic estimate.

The new carrying cost figure of 37.83% of inventory valued at full factory cost is being used by the company for distribution-related decisions. The company is using the methodology to update the carrying costs on an annual basis and is also using it to determine the carrying costs for raw materials inventory and in-process inventory.

CONCLUSIONS

It would appear that the traditional industry benchmark of approximately 25% may not be an accurate figure. Although this number has been widely quoted in textbooks and in academic and industry publications, it would seem prudent for companies to actually calculate the figure that applies for their specific set of circumstances.

In the case of a company with a relatively homogenous product line and a twelve-month inventory plan, it should be possible to use one figure for all products. This figure would require updating on an annual basis when the new inventory plan, updated standard costs, and the previous year's expenditures for insurance and taxes on

TABLE 1

INVENTORY CARRYING COSTS FOR A FOOD PRODUCT MANUFACTURER

I. CAPITAL COSTS	
(Opportunity cost of capital	
= 40% before taxes; 20% after taxes)	32.988%*
II. INVENTORY SERVICE COSTS	
- Insurance	.070%
- Taxes	1.406
III. WAREHOUSING COSTS	
A. Public Warehouses (recurring storage only)	1.093
B. Plant Warehouses	
- Taxes	--
- Insurance	--
- Investment - Building	--
- Investment - Equipment	--
- Labor	--
- Supervision	--
- Plant Administration	--
- Utilities	--
- Maintenance	--
- Cost of Taking Inventory	--
- Plant Floor Space	--
- Other Direct Expenses	<u>2.057</u>
	<u>3.150</u>
IV. INVENTORY RISK COSTS	
- Obsolescence (Due to Dating)	.220%
- Damage	
- Pilferage	
- Relocation Costs	<u>--</u>
	<u>37.834%</u>
	<u>TOTAL</u>

* Only 82.47% of the inventory value represented variable costs.

TABLE 2

AN INCORRECT APPLICATION OF INVENTORY CARRYING COSTS
(FOOD PRODUCTS MANUFACTURER)

Using Current Inventory Carrying Cost of 19.0%, Should Columbus, Ohio, Warehouse be Closed?¹

	Plant to Warehouse Expense ²	Warehouse Expense	Freight to Customer Expense	Inventory Carrying Costs	Total System Cost
Close	\$34,705	\$22,529	\$93,280	\$ -0-	\$150,514
Leave Open	38,084	18,774	41,469	11,972	110,294
Columbus Saves	-\$ 3,379	\$ 3,755	\$51,816	-\$11,972	\$ <u>40,220</u>

The factory cost of the inventory change (should Columbus warehouse be closed) is \$63,007. The carrying cost is 19.0% or \$11,972.

$$\begin{aligned}
 \text{R.O.I.} &= \frac{\text{Saving by being open}}{\text{Additional inventory required}} \times 100\% \\
 &= \frac{\$40,220}{\$63,007} \times 100\% = 63.84\% \text{ before taxes} \\
 &= 31.92\% \text{ after taxes}
 \end{aligned}$$

Which implies leaving Columbus open (since R.O.I. is greater than 20% after taxes).

¹ Assumes constant Customer Service Levels and Lot Quantity Costs

² Next closest warehouse will be used.

inventory become available. However, for companies with heterogeneous product lines, it can be expected that the inventory carrying cost figure, when determined as a percentage of full manufactured cost, will vary by products because of such factors as the percentage of variable costs to full costs, the type of product (this influences shrinkage), and the method of distribution.

For companies with exceptionally good data, it may be possible to calculate inventory values based on the variable cost delivered to the distribution center and apply the carrying cost percentage to this number.

Inventory carrying costs are not only a critical input for distribution system planning, but are a useful input to a number of marketing, production and management control applications.

FOOTNOTES

¹L. P. Alford and John R. Bangs (eds.), Production Handbook, (The Ronald Press Company, 1955), p. 397. George W. Aljian, Purchasing Handbook, (McGraw-Hill Book Company, Inc., 1958), pp. 9-29. Dean S. Ammer, Materials Management, (Richard D. Irwin, Inc., 1962), p. 137. Gordon T. Crook, "Inventory Management Takes Teamwork", Purchasing, March 26, 1962, p. 70. Thomas W. Hall, "Inventory Carrying Costs; A Case Study", Management Accounting, January 1974, pp. 37-39. J. L. Heskett, N. A. Glaskowsky, Jr. and R. M. Ivie, Business Logistics, Second Edition, (Ronald Press Company, 1973) p. 20. John F. Magee, "The Logistics of Distribution", Harvard Business Review, July-August 1960, p. 99.

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⁴Sam R. Goodman, Financial Manager's Manual and Guide, (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1973), p. 219.

⁵Sam R. Goodman, Financial Manager's Manual and Guide, (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1973), p. 220.

⁶James C. T. Mao, Quantitative Analysis of Financial Decisions, (Toronto, Canada: Collier-Macmillan Canada, Ltd., 1969), p. 373.