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PRICE INCREASE FACTORS

10/18/1963

Special Assistants for Advanced Logistic Research and Development
U.S. Navy Ships Parts Control Center
Mechanicsburg, Pa.

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14. ABSTRACT

Whenever a stock list item has not been procured for several years, it is expected that there will be some increase in the new unit price over the old acquisition price, particularly because of the increased labor and material costs to the manufacturer. Then the question arises: What reasonable increase in costs can the U.S. Navy Ships Parts Control Center (SPCC) expect on material that has not been procured for one year, two years, or several years. Two different approaches, one by historical data and the other by the cost index, have yielded approximately the same average increase: 4.6% vs. 4.9%. It seems reasonable, then, to believe that the real increase is approximately 5%. (Author)

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REPORT 41

PRICE INCREASE FACTORS

Special Assistants for Advanced Logistic Research and Development
U. S. Navy Ships Parts Control Center
Mechanicsburg, Pa.
18 November 1963

PRICE INCREASE FACTORS

ALRAND Report 41

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To correct this situation the Purchase Division has requested that a study be made to provide a new factor for use in determining a reasonable expected increase in costs. To this end the following study is submitted.

II. THE STUDY

A. Data Used

The data used in developing a new price factor was obtained from the Contract Status History record. A random 10% sample of this record was selected, with the condition for selection being that an item had to have at least two contracts in its history. In total there were approximately 11,000 items in the sample.

The contracts used were regular replenishment buys generated by the mathematical decision rules, and did not reflect any increases caused by the purchase order factoring table.

B. Analysis

The contract history of items in the sample was examined to find two successive contracts that were at least a year apart (using the contract document date). In all, 400 items, covering all Federal groups, were selected in this fashion. Then the price ratio in the unit price of an item was found by dividing the old unit price into the unit price of the next sequential purchase. Also, the time between contracts was computed.

Example:

	Contract Date	Unit Price
Item A	12/58	$3.52

Contract Date of Next Purchase	New Unit Price
8/60	$3.85

$$\text{Price Ratio} = \frac{\$3.85}{\$3.52} = 1.09$$

Time between contracts = (8/60) - (12/58) = 20 months

C. Results

A price ratio change (increase or decrease) and the time (in months) between contracts was computed for each of the 400 items. Then the average price ratio change and mean time between contracts was computed resulting in:

Average Price Ratio	Mean Time
1.08	20.8 months

This means that the unit price of an item increased, on the average, 8% over an average time period of 20.8 months. Translating this into a yearly expected increase by solving (.08)(12)/21 = yearly increase, the expected increase is 4.6% per year, or an average per annum price ratio of 1.046.

D. Setting Confidence Limits

The 4.6% increase is an average expected increase. But we would sometimes expect the increase to be more than the average. Thus, it is necessary to compute a statistic which measures the variation from the average, and this statistic is the standard deviation. The standard deviation, symbolized by the Greek letter sigma (σ), averages the deviations of all values around the average or mean.

This value is found by:

1. Squaring the differences between the value and the average,
2. Taking the mean of these squares, and
3. Extracting the square root.

The formula for σ (standard deviation) is:

$$\sigma = \sqrt{\frac{\Sigma(X - \bar{X})^2}{n}}$$

where:

X = the ratio change

$\bar{X}$ = the average ratio

n = 400 (number of values in sample)

The value of σ for the sample items is 29%, for an average time period of 20.8 months. Converting this into a yearly σ, $.29/\sqrt{\frac{21}{12}}$, we have 21.9%.

Now, by knowing the average and standard deviation, we can set confidence limits, i.e., we can say that we are X% certain that the real increase in cost will not be greater than a defined limit. For example, we can say that we are 85% confident that the yearly increase in costs for an item is not greater than the mean + $\alpha(\sigma)$, where the mean is the average ratio, σ is the standard deviation, and α is a variable multiplier which changes for each confidence limit. With a value of 1.04 for the 85% confidence limit the average increase is not greater than

$$1.046 + (1.04)(.219) = 1.27$$

Then the general formula for computing the expected cost increase for any time period is:

$$Y = T(1.046) + \alpha\sqrt{T}\,(.219)$$

where:

Y = total expected increase

T = time in years since last purchase

α = variable multiplier defined by confidence limits

E. <u>Limitations of the Data</u>

There are two possible limitations in the use of contract status history to derive a pricing factor.

1. If the item used in the study is a provisioning item, the unit price on a follow-on buy after the initial purchase is generally lower. The manufacturer charges off his set-up and development costs to the initial buy. If a preponderance of this type of items is used in the analysis, it would tend to pull the average increase down. However, care was taken to insure that this did not happen

frequently. Nevertheless, some of these items are bound to appear in the data.

2. Another possible limitation in the data would result from quantity discounts. If the purchase quantity on the next contract in sequence was significantly higher or lower than the previous quantity, there could be a difference in the unit prices because of the quantity discounts. Items on which this was apparent were not included in the sample data.

III. AN ALTERNATIVE APPROACH

A. Factory Magazine Cost Index

In Section II a price factor was developed by examining the relationship of time between purchases and the price differences. Another approach to this problem is to use economic indicators which show that the cost of manufacturing material does increase over time. If costs do increase over time, then these costs are ultimately passed on to the consumer.

Factory Magazine, a magazine devoted to the problems of the manufacturer, maintains statistics on all aspects of production costs in the form of a cost index. These indices, maintained monthly to arrive at an average cost index for the year, show the increased costs of buildings and facilities, all raw materials, labor, and equipment from a base year of 1947. Then the aggregate cost index should be indicative of the expected increase in costs which the manufacturer will pass on to his customers.

The following figures are the yearly cost index 1955 - 1962 (Base year = 1947). (Factory Magazine, July 1963, page 6.)

Year	Index
0 (1955)	150.1
1 (1956)	159.7
2 (1957)	166.9

Year	Index
3 (1958)	169.7
4 (1959)	175.8
5 (1960)	180.1
6 (1961)	183.1
7 (1962)	186.1

B. Analysis of the Index

Knowing the year and the index for each year, we want to find the relationship between the year and the index; i.e., we want to find if there is a predictable relationship between time and the index. Also we want to know the expected yearly increase in the index.

One of the most widely used techniques to express a relationship between two variables (time and index) is linear regression analysis which utilizes an equation of the form:

$$y = ax + b$$

In regression analysis a straight line, in the above form, is mathematically fitted to data (in our situation the cost index and year). Here "a" and "b" are numerical constants and once they are known we can calculate a predicted value of y(cost index) for any given value of x(year). Also, the value of "a" gives the slope of the line, or the average rise in the index each year.

C. Results

The results of the regression analysis are

$$y = 4.9x + 154.2 \quad \text{(Figure I)}$$

This means that the average increase in the cost index is approximately 5% per year (value of "a" = 4.9%). Then the overall average increased costs of the manufacturer, which are passed on through increased prices, is 5% per year.

D. Reliability of the Analysis

Having developed a linear relationship in the form of an equation it remains to be seen whether or not it is reasonable to say that there exists some correlation between two variables, x (time) and y (cost index). The statistic to measure the strength of linear relationship between two variables is the coefficient of correlation (r). If the relationship is good, r will be close to + 1 or - 1. The coefficient of correlation, (r), for the cost index = 98.22. This value of r, close to + 1, indicates a high degree of positive correlation.

A companion statistic to the coefficient of correlation is the coefficient of determination (r^2). This statistic expresses what percent of the variation of y's (cost index) may be accounted for by the relationship with the variable x (time).

In this situation (r^2 = 96.5) a large degree of the variation of the y's is accounted for (presumed caused) by differences in the variable x.

COST INDEX OF MATERIAL AND LABOR

Source: Factory Magazine

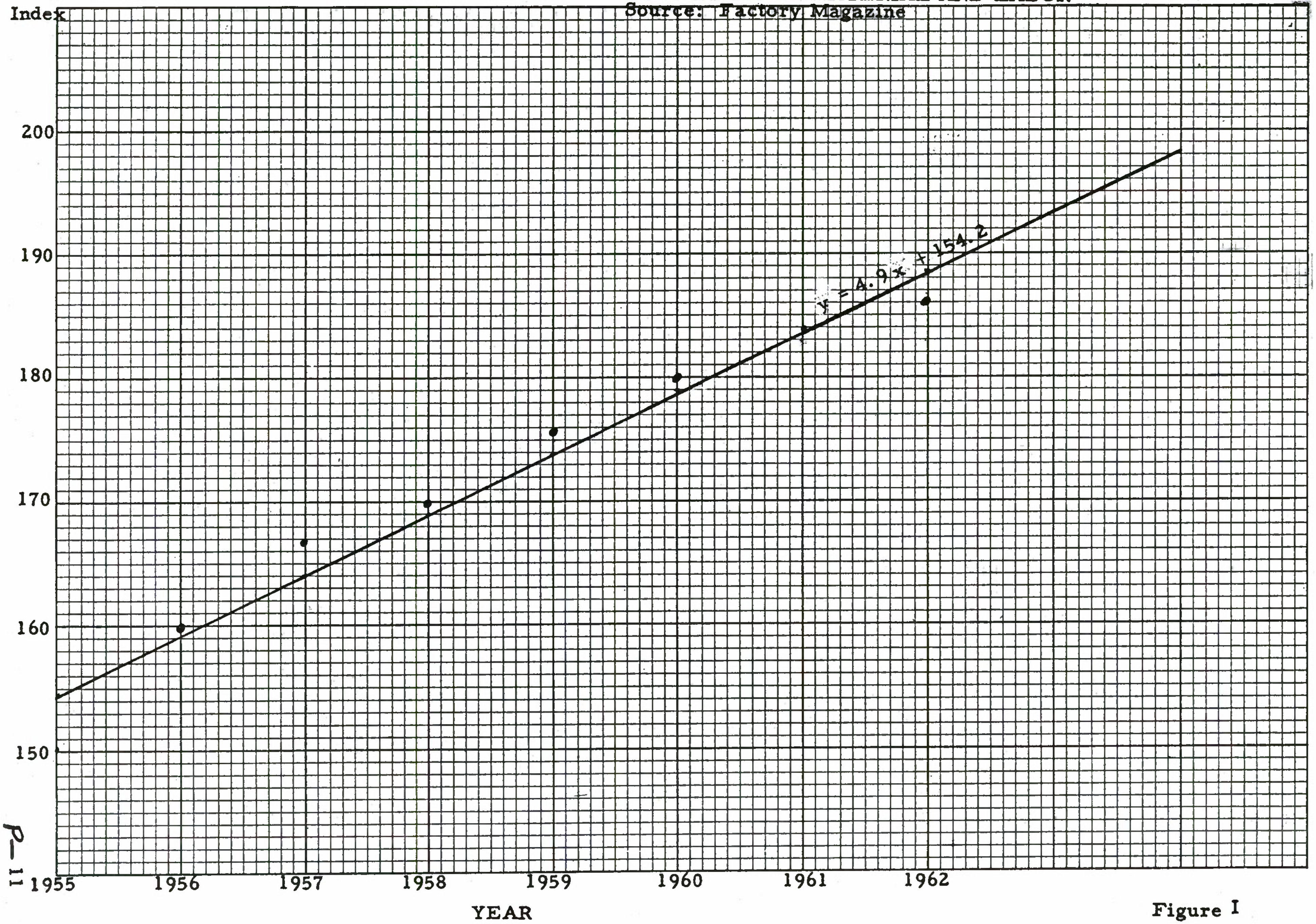

Figure I

IV. CONCLUSION

Two different approaches, one by historical data and the other by the cost index, have yielded approximately the same average increase: 4.6% vs. 4.9%. It seems reasonable, then, to believe that the real increase is approximately 5%.

It can be seen on Figure II that the higher the confidence level used the larger is the allowable increase in costs. Thus there is a trade-off between increased costs in the material purchased and the costs incurred in reprocessing the document returned by the manufacturer. For example, at the 95% confidence level we would expect that 5% of the time the manufacturer would return the document. However, we pay for this by assuming larger increases in unit price. Therefore, we suggest a relatively low setting at the outset, perhaps at the 75% level, and then to monitor the results. If the savings in commitment money are significant compared to the cost of reprocessing the expected 25% return of documents, this would be a satisfactory setting. If the facts prove otherwise, a new setting and corresponding increased costs can be easily obtained from Figure II. Perhaps the O & M budget will limit the settings available for our purposes. Three examples (Appendix C) illustrate the fact that there will be a reduction in commitment dollars which will permit more accurate utilization of budgeted dollars.

It is intended that the figures presented in this study be applied to "not-in-stock" items as opposed to "not-carried" items. "Not-carried" items have no previous history on which to compute an expected increase in costs. The technician estimates the current item price based on his experience with similar items "not carried." Therefore it is unnecessary to adjust the estimated cost.

Confidence Levels for Determining
Percentage Increase in Costs

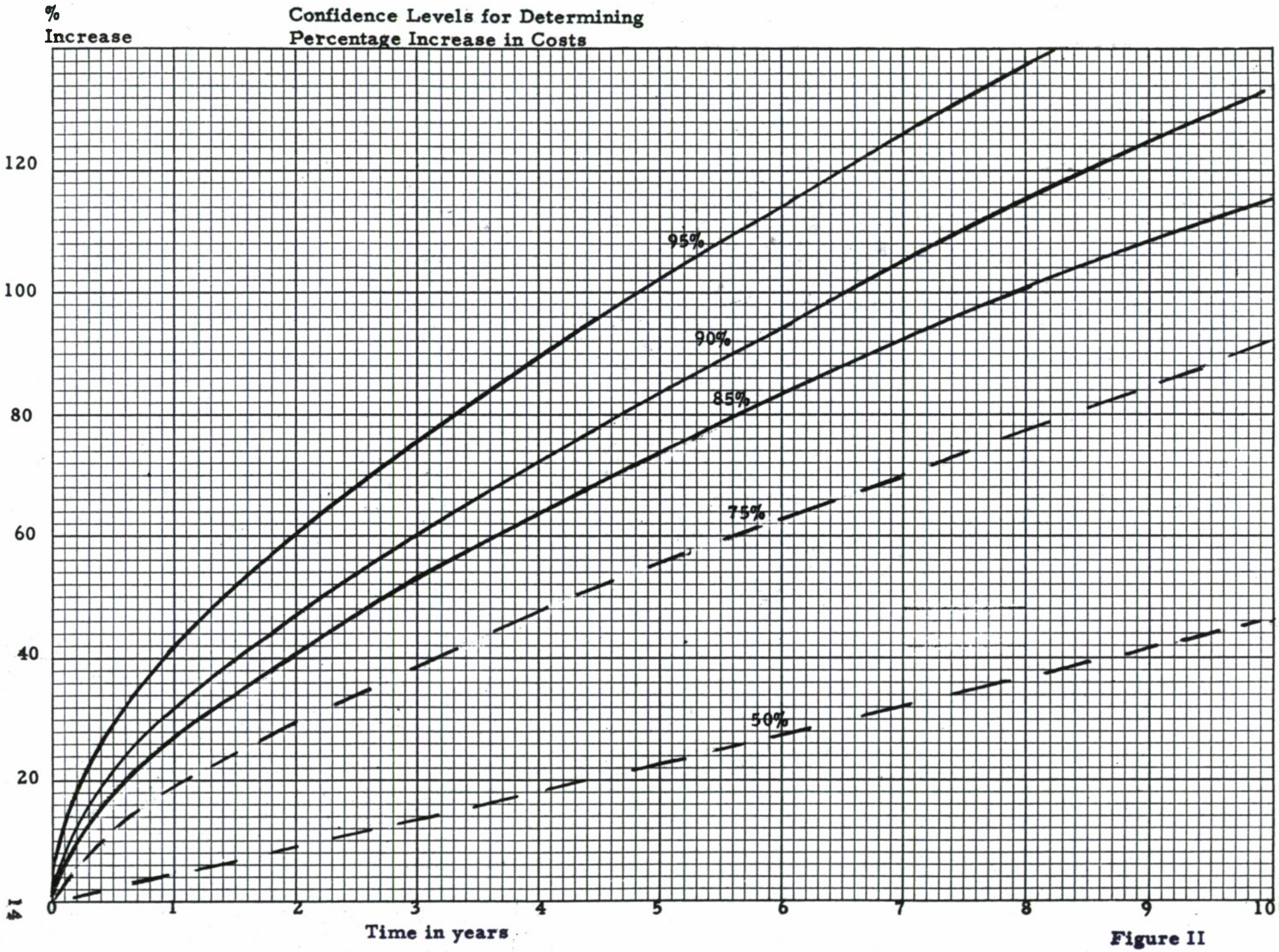

Figure II

APPENDIX A. PURCHASE ORDER FACTORING TABLE

Last Known Unit Price	Do Not Exceed Unit Price
0 - $ 5.00	$ 10.00
5.01 - 10.00	25.00
10.01 - 20.00	40.00
20.01 - 30.00	60.00
30.01 - 40.00	70.00
40.01 - 50.00	100.00
50.01 - 100.00	200.00
100.01 - 200.00	400.00
200.01 - 400.00	600.00
400.01 - 500.00	700.00
500.01 - 600.00	800.00
600.01 - 700.00	850.00
700.01 - 800.00	900.00
800.01 - 900.00	950.00
900.01 - 1000.00	1000.00

APPENDIX B. TABLE OF SUGGESTED PRICES (75% CONFIDENCE LEVEL)

2 EXAMPLES

Last Price	Years Since Last Buy									
	1	2	3	4	5	6	7	8	9	10
$1.00	1.19	1.29	1.38	1.47	1.55	1.63	1.73	1.78	1.85	1.92
5.00	5.95	6.45	6.90	7.35	7.75	8.15	8.65	8.90	9.25	9.60

For year 1 the $5.00 unit price item increased to $5.95 or five times the increase in the $1.00 unit price item: 5($1.19) = $5.95. Then for each year the expected increase is:

Contract Price = (Buy Quantity)(Old Unit Price)(% Increase)

Year	
1	Contract Price = (Buy Quantity)(Unit Price)(1.19)
2	Contract Price = (Buy Quantity)(Unit Price)(1.29)
3	Contract Price = (Buy Quantity)(Unit Price)(1.38)
4	Contract Price = (Buy Quantity)(Unit Price)(1.47)
5	Contract Price = (Buy Quantity)(Unit Price)(1.55)
6	Contract Price = (Buy Quantity)(Unit Price)(1.63)
7	Contract Price = (Buy Quantity)(Unit Price)(1.73)
8	Contract Price = (Buy Quantity)(Unit Price)(1.78)
9	Contract Price = (Buy Quantity)(Unit Price)(1.85)
10	Contract Price = (Buy Quantity)(Unit Price)(1.92)

APPENDIX C. COMPARISON OF CURRENT PROCEDURE VS. PROPOSED PROCEDURE

(1) Item	(2) Contract Number	(3) FSN	(4) Number Required	(5) Stock List Price	(6) Years Since Last Buy	(7) Value of Contract at Stock List Price
1	SPCC 3-27255	H4820-036-0878	6	$85.00	2.6	6 x 85 = $510.00
2	SPCC 3-27743	H2815-469-9276	16	$16.50	1.8	16 x 16.50 = $264.00
3	SPCC 3-27740	H2815-218-6776	64	$18.30	.2	64 x 18.20 = $1171.20

(8) Do Not Exceed Price from Appendix A	(9) Do Not Exceed Price from 75% Curve	(10) Savings in Commitment Money	(11) Unit Price Column (8)	(12) Unit Price Column (9)	(13) Actual Contractors Unit Price
$800.00	$689.00	$111.00	$133.33 (800 ÷ 6)	$114.75 (689 ÷ 6)	$90.25
$600.00	$335.00	$265.00	$37.50 (600 ÷ 16)	$20.93 (335 ÷ 16)	$19.00
$1300.00	$1241.00	$59.00	$20.31 (1300 ÷ 64)	$19.40 (1241 ÷ 64)	$18.70