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# Financial Planning and Control

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*Most financial plans are based on single-value estimates —the best possible, granted, but still assumptions. The author suggests using an entire range of figures for each variable to improve —*

# FINANCIAL PLANNING AND CONTROL

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An important ingredient in the mix of factors that leads to continued business success is the preparation of pro forma financial statements. These statements are the basis for management's performance of planning and control.

Financial planners have been turning recently to simulation as a method for preparing financial statements.[1] While those who use simulation find that they are required to take more care in thinking about the future, they are rewarded with more information for decision-making purposes.[2] This article details and illustrates how probabilistic simulation can be used to provide improved information for financial planning and control. The preparation of a pro forma income statement is used as an example.

Most financial planning is deterministic. This means that only single-valued estimates are made for each variable in the model. For example, the estimate for next year's total sales might be $740,000, even though the analyst does not believe that total sales will be exactly this amount. Shown in Exhibit 1, on page 44, is a typical deterministic pro forma statement for 197__.

Based upon this financial analysis the estimate for net income after taxes for 197__ would be $77,000. Of course it is exceedingly unlikely that it will be exactly this amount, but this is the best available figure for planning and control purposes.

Unfortunately, the deterministic analysis does not provide any information as to how widely the net income figure might vary. There are a number of planning and control situations that cry out for this type of information; as illustrated by the following examples.

Let's assume that management would go ahead with a proposed plant expansion if it was 95 per cent certain that net income after taxes in 197__ would be $55,000 or more. However, this information is not available from the deterministic analysis; thus, management is uncertain whether or not to undertake the plant expansion.

At the conclusion of 197__ net income after taxes turns out to be $35,000 instead of the budgeted amount. Should this variation from the expected be viewed with surprised alarm or, rather, resignation that the possible did indeed happen? The deterministic analysis provides no answer to this question.

What management needs in many instances is information about how

## EXHIBIT I

**Budgeted Income Statement**
**For the Year Ending December 31, 197—**

| | | |
|---|---|---|
| Total Sales | | $740,000 |
| Cost of Goods Sold | 230,000 | |
| Selling Expense | 170,000 | |
| General and Administrative Expense | 165,000 | |
| Research and Development Expense | 14,000 | |
| Interest Expense | 7,000 | |
| Total Expenses | | 586,000 |
| Net Income Before Taxes | | 154,000 |
| Income Taxes | | 77,000 |
| Net Income After Taxes | | $ 77,000 |

widely the budget estimate might vary and with what likelihood. This type of information is available only through a probabilistic analysis.

In order to generate a probabilistic estimate of net income after taxes, management must provide this type of information for the variables. Exhibit 2 on page 45 shows this type of information for a variable frequently encountered in financial analysis, total sales. The cumulative probability curve was generated by management's responses to the following question:[3] "In line with your best judgment, what chance would you assign to total sales being equal to or less than X dollars?"

| X | *Probability (Total Sales≤X)* |
|---|---|
| $ 300,000 | 0.05 |
| 400,000 | 0.10 |
| 500,000 | 0.20 |
| 600,000 | 0.38 |
| 700,000 | 0.60 |
| 800,000 | 0.71 |
| 900,000 | 0.80 |
| 1,000,000 | 0.86 |
| 1,100,000 | 0.92 |
| 1,200,000 | 0.95 |
| 1,300,000 | 0.98 |

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In a similar manner probabilistic estimates can be generated for the other variables. One would simply be talking about selling expense, interest expense, etc., instead of total sales.

In order to have a probabilistic estimate of net income, the data inputs for the budget variables must be algebraically combined. Two approaches to this problem are available—(1) analytic or (2) numeric. The analytic approach is the most precise but requires considerable mathematical and statistical training to understand and apply.[4] The requisite skills are not possessed by most practicing managers. The numeric approach, the one presented here, requires little background in mathematics and statistics. It usually does demand, however, access to a digital computer. Once the basic program is developed, though, the probabilistic analysis can be performed repeatedly at minimal cost.

Fortunately, all of the probability distributions can be combined to provide a probabilistic estimate of net income after taxes—but through the use of simulation, not by analytical methods.

### *Simulation analysis*

A simulation approach to the problem replaces the difficult mathematical and statistical operations with a large number of relatively easy computations.[5] The manager needs to specify the relationships between the variables in the budget, express his intended actions if certain conditions arise (e.g., what will be done to research and development expenditures if total sales are dropping below $300,000?), and generate probability distributions for the variables (as was done for total sales).

Assume that management has established a model for the pro forma income statement, as shown in Exhibit 3 on page 45.[6]

In the model presented in Exhibit 3 two variables, total sales and research and development expense, are treated independently of the other variables. Certainly, this treatment involves at least a slight oversimplification. However, as a first approximation it may be satisfactory. Total sales are influenced more by variables outside of the model, e.g., the general level of the economy, than by budget variables. Research and development expenditures are primarily at management's discretion and need not be related to any other variable.[7]

### *Variables-sales relationship*

There are a number of variables in the model that are probabilistically related to total sales. For example, the cost of goods sold is equal to a probabilistic estimate of fixed costs, plus a probabilistic estimate of variable costs, multiplied by total sales ($TC = FC + VC \times S$). The analyst must provide probabilistic estimates for the fixed and variable components of total cost unless such costs are known with certainty.[8]

Some variables may not always require probabilistic estimates. If the analyst is certain about the amount of debt outstanding and the interest rate(s) on that debt, only a single-valued estimate is needed for interest expense. In the illustrated simulation the estimates for the interest rate, outstanding debt, and tax rate are assumed to be known with certainty.

And finally, some of the variables

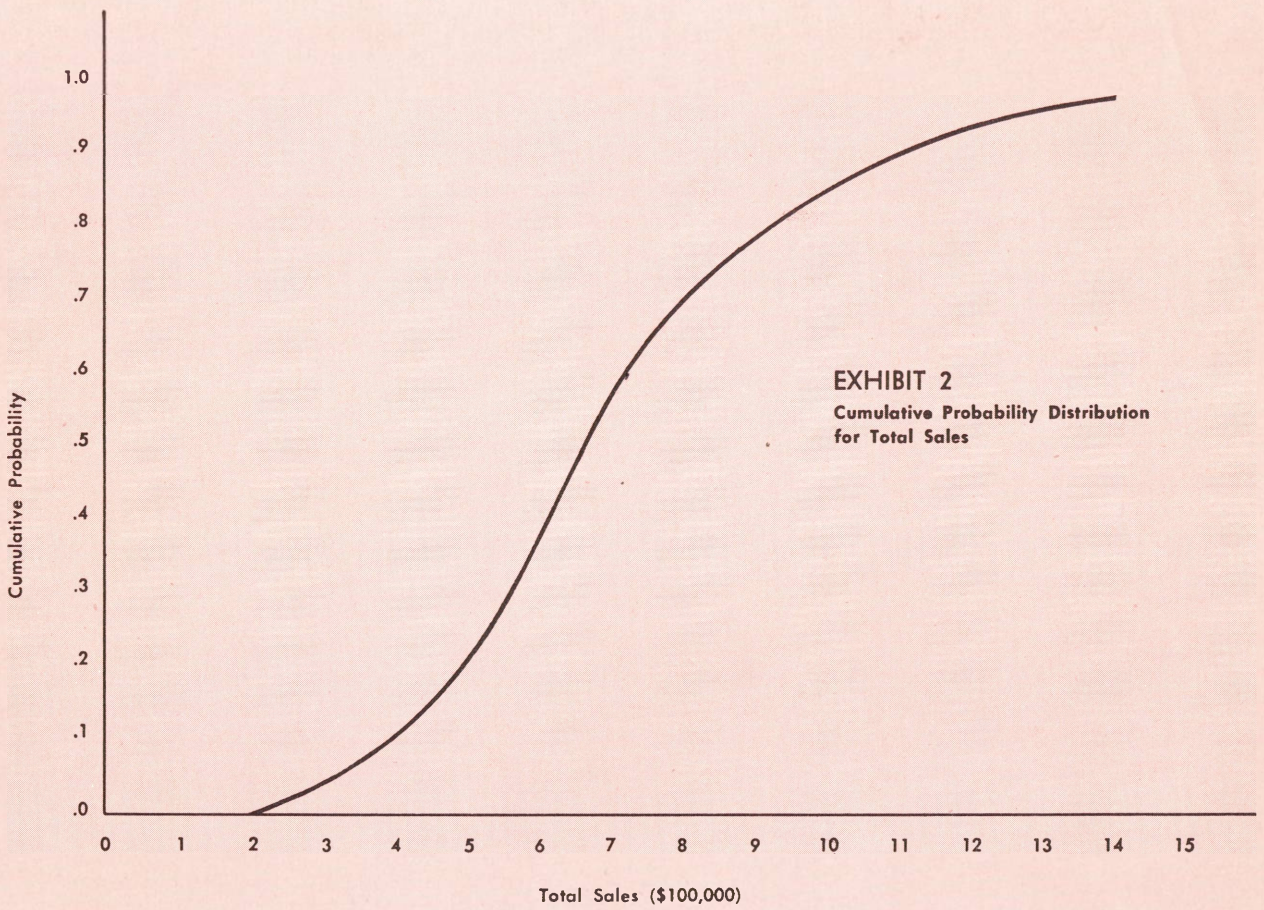



EXHIBIT 2
**Cumulative Probability Distribution for Total Sales**

in the model do not require estimates at all since their values are completely derived from the values of the other variables. For example, total expenses is simply the summation of all the other expense variables.

Once the model and necessary estimates are prepared, a table of uniform random numbers and a work sheet are all that is needed to begin the simulation.[9] The analyst begins by randomly selecting a starting point in the random number table and recording the selected number on the work sheet (see Table 1 on page 46). The number drawn (59 in this case) is then associated with a value for total sales. The association is made by interpreting the random number as a cumulative probability (with an implied decimal point in front of the random number), and by noting the value for total sales that relates to the cumulative probability. For example, from Exhibit 2 it can be seen that $695,000 of sales is associated with the random number 59.

The procedure is repeated for the next variable, cost of goods sold. The cumulative probability distribution for fixed cost of goods sold (only the probability distribution for total sales is shown in this article) indicates that the next random number, 09, relates to $41,000. For the variable component of cost of goods sold, a cost of $0.20 is associated with the random number 20. The total variable cost of goods sold is then computed.

$$\$0.20 \times \$695,000 = \$139,000$$

The total cost of goods sold is the sum of the fixed and variable components.

$$\$41,000 + \$139,000 = \$180,000$$

The next two variables in the

### EXHIBIT 3

Total Sales = Total Sales

Cost of Goods Sold = Fixed Cost of Goods Sold + Variable Cost of Goods Sold x Total Sales

Selling Expense = Fixed Selling Expense + Variable Selling Expense x Total Sales

General and Administrative Expense = Fixed General and Administrative Expense + Variable General and Administrative Expense x Total Sales

Research and Development Expense = Research and Development Expense
Interest Expense = Interest Rate x Outstanding Debt
Total Expenses = Summation of All Expenses
Net Income Before Taxes = Total Sales — Total Expenses
Income Taxes = Tax Rate x Net Income Before Taxes
Net Income After Taxes = Net Income Before Taxes — Income Taxes

## TABLE I

| | 1st Iteration | | 2nd Iteration | | • • • | 200th Iteration | |
|---|---|---|---|---|---|---|---|
| | Random Number | Simulated Activity | Random Number | Simulated Activity | | Random Number | Simulated Activity |
| Total Sales | 59 | $695,000 | 54 | $676,000 | | 42 | $620,000 |
| Cost of Goods Sold — Fixed | 09 | 41,000 | 60 | 63,000 | | 88 | 81,500 |
| Cost of Goods Sold — Variable | 20 | 139,000 | 69 | 167,000 | | 08 | 126,000 |
| Selling Expense — Fixed | 33 | 50,500 | 76 | 86,300 | | 91 | 110,000 |
| Selling Expense — Variable | 49 | 69,500 | 62 | 92,500 | | 28 | 35,000 |
| General & Administrative Expense — Fixed | 95 | 152,000 | 27 | 110,200 | | 29 | 112,500 |
| General & Administrative Expense — Variable | 56 | 22,000 | 34 | 16,000 | | 84 | 38,000 |
| Research & Development Expense | 41 | 15,000 | 48 | 16,000 | | 13 | 10,000 |
| Interest Expense | | 7,000 | | 7,000 | | | 7,000 |
| Total Expenses | | 496,000 | | 558,000 | | | 520,000 |
| Net Income Before Taxes | | 199,000 | | 118,000 | | | 100,000 |
| Income Taxes | | 99,500 | | 59,000 | | | 50,000 |
| Net Income After Taxes | | $ 99,500 | | 59,000 | | | 50,000 |

Net Income After Taxes

Arithmetic Mean $= \overline{I} = \frac{\Sigma I}{n} =$ \$66,050

Standard Deviation $= S = \sqrt{\frac{\Sigma(I - 66{,}050)^2}{n - 1}} =$ \$29,450

| Net Income After Taxes | Frequency | Relative Frequency |
|---|---|---|
| −$5,000 — 15,000 | 4 | 0.020 |
| 15,000 — 35,000 | 23 | 0.115 |
| 35,000 — 55,000 | 46 | 0.230 |
| 55,000 — 75,000 | 71 | 0.355 |
| 75,000 — 95,000 | 28 | 0.140 |
| 95,000 — 115,000 | 14 | 0.070 |
| 115,000 — 135,000 | 8 | 0.040 |
| 135,000 — 155,000 | 3 | 0.015 |
| 155,000 — 175,000 | 2 | 0.010 |
| 175,000 — 195,000 | 1 | 0.005 |
| | 200 | 1.000 |

budget are selling expense and general and administrative expense. Each of these expenses is similar to the cost of goods sold in that it has fixed and variable components. Their values in the first iteration are obtained in a manner analogous to that for the cost of goods sold.

In the model, research and development expense is independent of any other variable. Its value is obtained by generating a random number (41) and relating it to a cost ($15,000).

The remaining variables in the budget do not require random numbers. Their values are either known with certainty or are completely derived from the values of the other variables. All of the values are recorded on the worksheet.

The first repetition through the model provides an estimate of $99,500 for net income after taxes. In order to generate the entire probability distribution for net income it is necessary to perform many repeat runs. The greater the number of repetitions, the greater the precision of the probability distribution for income.[10] Once all the iterations are completed, the output of the simulation can be analyzed. The illustrated analysis of net income includes computing its mean and standard deviation, placing the simulated values in a frequency distribution, and preparing a probability histogram (see Table 1 and Exhibit 4 on page 47). The completed analysis permits the expression of probability statements for net income after taxes in 197–.

Now recall the two situations that were encountered earlier but could not be analyzed by deterministic methods. Each example required probabilistic information to perform the analysis.

The planning example was concerned with the likelihood that net income after taxes in 197– will be equal to or greater than $55,000. Management has stated that it will go ahead with the proposed plant expansion if this likelihood is 95 per cent or more. The probabilistic analysis reveals, however, that there is only a 63.5 per cent probability that net income after taxes will exceed $55,000. This probability is obtained by summing the relative frequencies in those classes that are equal to or greater than $55,000 ($0.355 + 0.140 + 0.070 + 0.040 + 0.015 + 0.010 + 0.005 = 0.635 = 63.5$ per cent) or by noting the area under the probability histogram from $55,000 on up. Since the actual probability is considerably below the 95 per cent level, management will probably not plan on expansion activities in 197—.

The control example involved interpreting the actual net income after taxes figure at the close of 197—. Specifically, how should management respond to a net income figure of $35,000? While a definite answer cannot be made for management, it can be noted that the probabilistic analysis indicated a 13.5 per cent chance ($0.020 + 0.115 = 0.135 = 13.5$ per cent) that net income would be equal to or less than $35,000. Management probably is not pleased with the 197— effort, but it should not be too surprised to find net income this low.

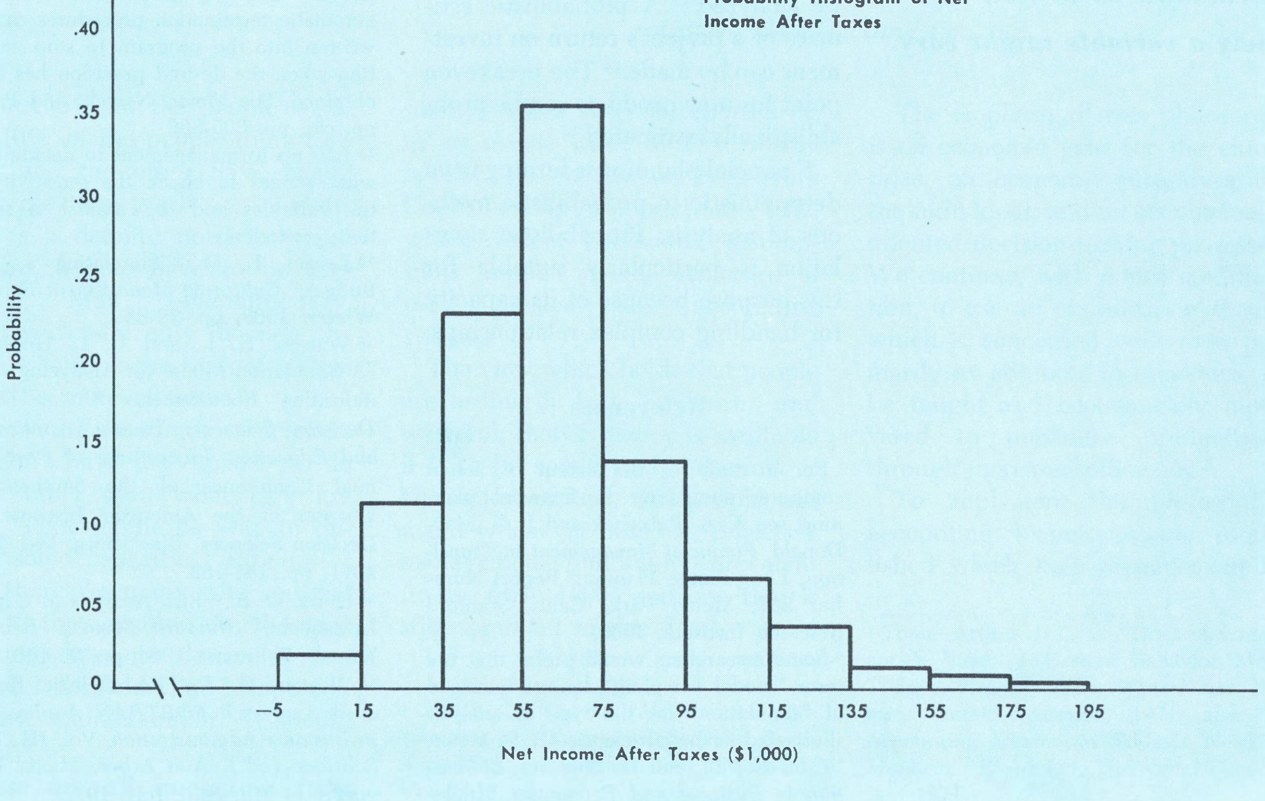
Performing sensitivity analysis on a model, including the pro forma income statement, generates valuable information for management. "Sensitivity analysis" is a term used to describe the process of varying a model's data inputs over certain ranges and noting the effect on the model's output. Those data inputs which have little effect on the model's output are described as being relatively insensitive while those that significantly affect the model's output are considered to be sensitive.[11]

There are a number of reasons why sensitivity analysis should be performed. First, management can determine the effect on the model's output if the estimates for the data inputs are in error. For example, what is the effect on net income after taxes if the estimate for total sales is overstated by, say, 10 per cent? This information can be obtained by rerunning the simulation with a new probability distribution for total sales.

Knowing which variables in a model are most sensitive allows management to key its control system to those sensitive variables. For example, if total sales is a sensitive variable and begins to drop below expected levels, management should have pre-planned responses in mind.

Sensitivity analysis also indicates when the gathering of additional information might be most beneficial. The potential impact of more information is to change the estimates for some of the variables. However, the only changes in the

EXHIBIT 4
Probability Histogram of Net Income After Taxes



data inputs that affect the model's output are for the sensitive variables. For this reason, additional information-gathering efforts should be slight for an insensitive variable.

***Conclusion***

This article has attempted to demonstrate through the preparation of a pro forma income statement that probabilistic financial statements can be prepared without encountering prohibitively difficult mathematical operations.

A probabilistic method of analysis is superior to deterministic methods because of the increased amount of information that is provided for decision-making purposes. The manager has available to him information as to how widely a variable might vary. This additional information can lead to the formulation of probability statements that are useful in performing the planning-control process.

***A probabilistic method of analysis is superior to deterministic methods because of the increased amount of information that is provided for decision-making purposes. The manager has available to him information as to how widely a variable might vary.***

The probabilistic simulation technique can be applied to many financial planning situations. Probabilistic cash budgets can be prepared.[12] Capitalization requirements for new and expanding firms can be analyzed.[13] A probabilistic estimate of a project's return on investment can be made.[14] The breakeven point for new products can be probabilistically estimated.[15]

Financial planning is turning from deterministic to probabilistic methods of analysis. Probabilistic simulation is particularly suitable for this purpose because of its capacity for handling complex relationships.

**References**

[1] For a study of the extent of actual computer simulation in financial planning, see A. A. Robichek and J. G. MacDonald, *Financial Management in Transition,* Long-Range Planning Report Number 267, Menlo Park, Calif., Stanford Research Institute, 1966.

[2] Some researchers would prefer that the term "model sampling" be used instead of "simulation" for the type of analysis illustrated in this article. See R. C. Meier, W. T. Newell, and H. L. Pazer, *Simulation in Business and Economics,* Englewood Cliffs, N.J., Prentice-Hall, Inc., 1969, pp. 2-5.

[3] A discussion of different methods for specifying subjective probability distributions is provided by L. H. Smith, "Ranking Procedures and Subjective Probability Distributions," *Management Science,* December, 1967, pp. 236-249.

[4] Analytical methods of analysis are discussed in C. H. Springer, *et al., Probabilistic Models,* Homewood, Ill., Irwin, Inc., 1968, pp. 101-134.

[5] For a general discussion of simulation, see G. di Roccaferrera, *Operations Research Models,* Cincinnati, South-Western Publishing Company, 1964, pp. 681-942.

[6] An analysis of an actual firm would probably require a more complex model. For example, the cost of goods sold would be broken down into more variables. In addition, the model would probably be simulated on a computer rather than by hand.

[7] Management might want to link research and development expenditures to a variable such as total sales; in this case research and development expense would no longer be handled independently.

[8] All variable costs are assumed to have been specified on a per dollar basis.

[9] In a uniform random number table each and every number has an equal probability of being drawn. Most large-scale computers have callable random number subroutines as part of their software.

[10] The computer running time for the type of analysis presented here is minimal. For this reason the number of iterations can usually be set arbitrarily high without incurring great costs. However, automatic termination procedures can be written into the program to stop execution when the desired precision has been obtained. See Meier, Newell, and Pazer, *op. cit.,* pp. 305-306.

[11] It is up to management to decide over what ranges to check the sensitivity of the variables and to establish a sensitivity criterion.

[12] Lerner, E. M., "Simulating a Cash Budget," *California Management Review,* Winter, 1968, pp. 79-86.

[13] Watson, H. J., and C. L. Hubbard, "A Simulation Model for Analyzing Capitalization Requirements Under Risk," *Decision Sciences: Theory, Application and Education,* Proceedings of First Annual Conference of the Southeastern Chapter of the American Institute for Decision Sciences, Blacksburg, Va., July, 1971, pp. 153-162.

[14] Hertz, O. B., "Risk Analysis in Capital Investment," *Harvard Business Review,* January-February, 1964, pp. 95-106.

[15] Watson, H. J., "Probabilistic Breakeven Analysis," *FORTRAN Applications in Business Administration,* Vol. III, T. J. Schriber (ed.), Ann Arbor, Mich., University of Michigan, July, 1972.