

Metrics Meet Monte Carlo

By **Jerome Scherer** - November 15, 2016



Hiding within gross profit lurks a quiet antagonist. An enemy that many may be secretly unaware of and could potentially be killing their business. That enemy is embedded fixed costs within the Cost of Goods Sold (COGS) line item of the income statement. COGS, frequently also called Cost of Sales, is an important component of any financial report, but it is a subjective measure and its components vary greatly between organizations.

Intuitively one may think that Cost of Goods Sold (COGS) varies in direct proportion to sales. For example, if sales go up by 10%, COGS should go up a corresponding 10%. In reality, that is rarely the case. The COGS income statement line item may incorporate a series of fixed costs including allocated utility costs, rent, machinery maintenance and other fixed expense that are related to the cost of goods sold but are not variable in nature.

Direct-Basis Income Statement – A Better Way

Subtracting direct variable costs from sales equals Profit Contribution. Profit Contribution minus fixed costs equals pre-tax profits.

- Direct variable costs are those costs that vary directly with sales and production activity.
- Fixed costs are those costs that exist whether an organization has sales or production activity. Fixed costs exist simply because of the passage of time, for example, rent.

SINGLE POINT ESTIMATE MODEL			
		\$	%
1	SALES [SLS]	\$ 1,500,000	100.0%
2	Material Costs [MAT]	\$ 600,000	40.0%
3	Direct Labor Costs [LAB]	\$ 180,000	12.0%
4	Direct Factory Overhead [FAC]	\$ 75,000	5.0%
5	Direct Sales Costs [SAC]	\$ 90,000	6.0%
6	TOTAL DIRECT COSTS [TDC]	\$ 945,000	63.0%
7	PROFIT CONTRIBUTION [TPC]	\$ 555,000	37.0%
8	Fixed Factory Expense [FAX]	\$ 205,000	
9	Fixed Sales Expense [SAX]	\$ 115,000	
10	Fixed Admin Expense [ADX]	\$ 94,000	
11	TOTAL FIXED EXPENSES [TFX]	\$ 414,000	27.6%
12	PRE-TAX PROFIT [PTP]	\$ 141,000	9.4%

Figure 1

With Pre-Tax Profits (PTP) being the true measure of a company's success, it makes sense to create a separate management report outside of the standard Generally Accepted Accounting Standards (GAAP) financial statements presentation to show management a much clearer path as to how a company's operations are succeeding or failing.

A direct format Income Statement can be easily created by (See Figure 1 for example):

1. Separating costs into direct and fixed costs
2. Deducting direct variable costs from sales to derive Profit Contribution
3. And finally deducting fixed costs from Profit Contribution to get Pre-Tax Profit.

A Direct-Basis Income Statement is ideal as an effective operations management tool and can provide management with a better view of the business to manage costs and improve efficiencies.

Direct-Basis Income Statement – Key Metrics

A Direct-Basis Income Statement allows for the application of several key metrics to be quickly and easily calculated that will help identify areas of operational improvement. Use the direct basis income statement in Figure 1 above and the descriptions of each ratio below as you follow along and calculate each ratio on your own. At the bottom of the section, you can check your work.

Return on Labor (ROL)

$$\text{Return on Labor} = \frac{\text{Profit Contribution}}{\text{Direct Labor Costs}}$$

This metric represents the Profit Contribution earned per dollar of Direct Labor. It provides a useful way to compare the profitability of different products which may be more or less labor intensive. You may wish to discontinue a product line if you are not satisfied with the return being achieved. You can

set goals for acceptable ROL performance or even compare your results with those of your competitors or your industry (if the information is available).

Return on Materials (ROM)

This metric represents the Profit Contribution earned per dollar of Material Cost. Here again, it is useful in comparing performance for products having different Bill of Materials requirements.

$$\text{Return on Materials} = \frac{\text{Profit Contribution}}{\text{Material Costs}}$$

Return on Prime Costs

$$\text{Return on Prime Costs} = \frac{\text{Profit Contribution}}{\text{Material Costs} + \text{Direct Labor Costs}}$$

This metric simply combines the ROL and the ROM measures.

Breakeven on Labor

This metric essentially measures the ROL that must be achieved to simply cover Fixed Expenses. If we assume that we are getting no ROM, then this metric establishes the minimum ROL required to break even.

$$\text{Breakeven on Labor} = \frac{\text{Fixed Expenses}}{\text{Direct Labor Costs}}$$

Fixed Cost Turnover

$$\text{Fixed Cost Turnover} = \frac{\text{Sales}}{\text{Total Fixed Expenses}}$$

This metric measures the number of times that Sales cover Total Fixed Expenses. It is a broad measurement of the turnover of Fixed Costs.

Profit Contribution Margin Percentage

$$\text{Profit Contribution \%} = \frac{\text{Profit Contribution}}{\text{Sales}}$$

This metric is one of the most useful measures as you will be able to compare Profit Contribution Margins between various SKU's or Product Lines. It could

be instrumental in helping you decide whether to continue producing and selling particular SKU's or whether to discontinue a Product Line.

Margin of Safety

How many times does Profit Contribution cover Total Fixed Costs? Margin of safety can be calculated multiple ways:

$$\text{Margin of Safety} = \left[\frac{\text{Return on Labor}}{\text{Breakeven on Labor}} \right] \text{ OR } \left[\frac{\text{Profit Contribution \$}}{\text{Total Fixed Expenses \$}} \right]$$

$$\text{Margin of Safety} = \left[\frac{\text{Profit Contribution \%}}{\text{Total Fixed Expenses \%}} \right] \text{ OR } \left[\text{Fixed Expense Turnover} \times \text{Profit Contribution \%} \right]$$

Finally, this metric helps you sleep at night. If your Margin of Safety computes to 1.00, it means that your Profit Contribution is merely covering your Fixed Expenses. If it computes to less than 1.00, it means that your Profit Contribution is not covering your Fixed Expenses. Any number greater than 1.00 indicates that you have a Margin of Safety. Obviously, the greater that number, the better you will sleep.

Example Company Data with Ratios

THE OSBORNE COMPANY
 OPERATING STATEMENT (DIRECT COST PRESENTATION)
 YEAR ENDED DECEMBER 31, 20__

MODEL DRIVERS	
UNITS TO BE SOLD	750,000
UNIT SELLING PRICE	\$ 2.00
MATERIAL COST %	40%
DIRECT LABOR COST %	12%
DIRECT FACTORY OVERHEAD %	5%
DIRECT SALES COST %	6%
MODEL METRICS	
PERFORMANCE MEASURES	
RETURN ON LABOR	3.08
RETURN ON PRIME COST	0.71
BREAKEVEN ON LABOR	2.30
FIXED EXPENSE TURNOVER	3.62
PROFIT CONTRIBUTION %	37.0%
MARGIN OF SAFETY	
RETURN ON LABOR DIV BY BREAKEVEN ON LABOR	1.34
FIXED EXPENSE TURNOVER TIMES PC%	1.34
PROFIT CONTRIBUTION \$ DIV BY FIXED EXPENSES	1.34
PROFIT CONTRIBUTION % DIV BY TFX %	1.34

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No Hard and Fast Rules in Finance

Utilizing a Direct Basis Income Statement allows another benefit in regards to financial modeling. Assume that the above numbers are not actual but forecasted sales and expenses. Then they represent only a "best guess" as to how results may materialize.

The world is filled with uncertainty and any perspective that finance can provide as to how likely it is that a certain scenario will materialize will add a tremendous value to senior management. But how does one do that? Typically, a financial planning and analysis (FP&A) team may put together a sensitivity analysis with a plus or minus 10-20% up and downside scenario to help provide guidance as to potential outcomes of future results. But what if there was a better way? In fact, there is!

Performing a Monte Carlo Simulation

A Monte Carlo simulation is a statistical method that runs a series of scenarios using different variables based on different inputs and their assigned distributions that you designate to ascertain a probabilistic outcome. The first step in the process of running a Monte Carlo simulation is to gather parameters. You might look to your Sales, Marketing and Manufacturing Departments to provide minimum, most likely and maximum values for key model drivers which is what has been done for the sample model and placed in the table below.

Driver	Minimum Value	Most Likely Value	Maximum Value
Units Sold	695,000	750,000	775,000
Unit Price	\$1.95	-	\$2.05
Direct Material Cost	37.50%	40.00%	48.00%
Direct Labor Cost	11.50%	12.00%	14.00%
Direct Factory Overhead	4.00%	5.00%	7.00%
Direct Sales Cost	5.00%	6.00%	8.00%

In addition to the above parameters, there may be other internal or external events that you would like to consider in the model. In this case, management feels that there is a 30% chance they will add a fixed cost employee on July 1 at an annual salary of \$40,000. Using specialty purchased software which works in an Excel® spreadsheet environment, one can input the variables and perform a Monte Carlo simulation which will provide a range of possible outcomes (as well as their likelihood of occurrence) for the newly defined metrics. By reviewing available historical information, one may be able to determine the appropriate probability distributions to replace these uncertain single point estimates.

The output of the Monte Carlo simulation is in Figure 2 below.

The Osborne Company
Comparison of Results (Unless Otherwise Stated, Figures are in Thousands of Dollars)

	Single Point Estimate Model		Model With Probabilities		
	Mean	Minimum	Maximum		
Profit Contribution	\$ 555	\$ 418	\$ 635		
Variance from Single Point Estimate		-4.68%	14.41%		
Pre-Tax Profit	\$ 141	\$ (7)	\$ 221		
Variance from Single Point Estimate		-22.70%	56.74%		
Return on Labor (Times)	3.08	2.13	3.52		
Variance from Single Point Estimate		-5.84%	14.29%		
Margin of Safety (Times)	1.34	0.98	1.53		
Variance from Single Point Estimate		-5.97%	14.18%		

Figure 2

In the table to the left, we see that Profit Contribution, which was forecasted to be at \$555 might be as low as \$418 or as high as \$635. The mean result, or the average of all the results, is \$529 or 4.68% below the forecast. After analyzing the statistics (not shown here), I can tell you that 77% of the results will be lower than the \$555 forecast.

You can interpret the other outputs (Pre-Tax Profit, Return on Labor and Margin of Safety) in the same fashion. From the statistical analysis, I can tell you how the results for the other outputs compared to the forecast:

Pre-Tax Profit.....82% of the results will be lower than the \$141 forecasted

Return on Labor.....78% of the results will be lower than the 3.08 forecasted

Margin of Safety.....82% of the results will be lower than the 1.34 forecasted

In addition, the analysis of Profit Contribution represented by the following Tornado Chart (Figure 3) indicates the sensitivity of the model's drivers. Other Tornado Charts run for the other outputs displayed the same general findings.

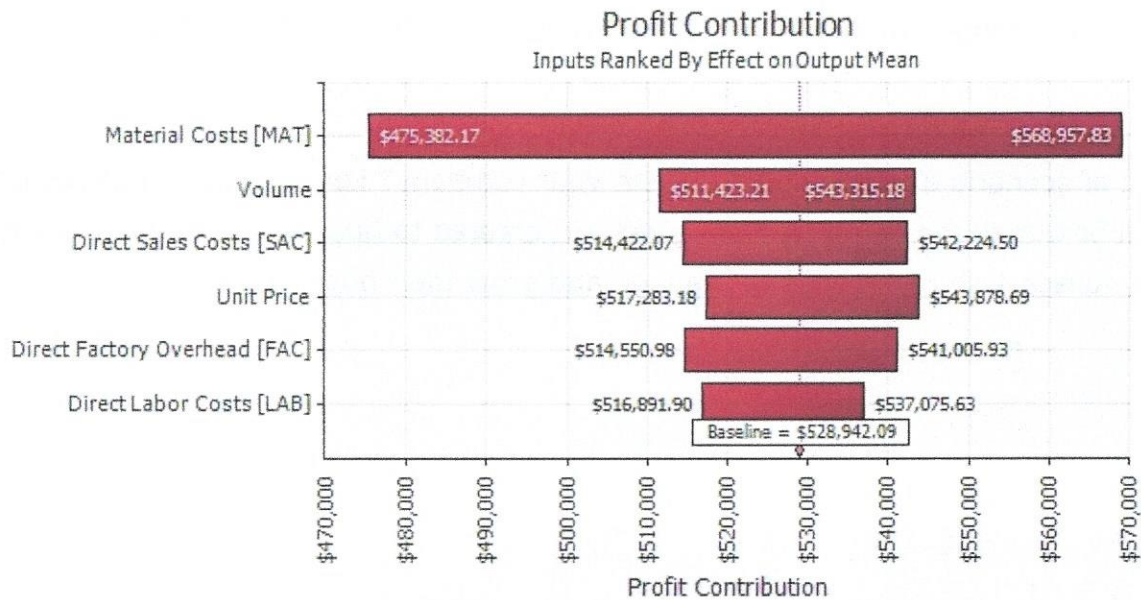


Figure 3

The center line in the chart above represents the mean of Profit Contribution (\$528,942). As the simulation is run, the results for each driver are captured. The values to the left of the center line are below the mean, while the values to the right are above the mean. The wider the variations above and below the mean give tangible evidence as to the sensitivity of each of the drivers. For management purposes, those having greater impacts deserve greater attention.

Conclusion

So, what have we accomplished here? First, we separated all fixed and variable costs such that only variable costs are deducted from sales to arrive at a profit contribution. Fixed costs are deducted from profit contribution to arrive at pretax profit.

Second, we created several new metrics that management can use to better manage the business. Return on Labor will enable an evaluation of product or product line profitability based on the intensity of the direct labor component. Margin of Safety will provide a measurement for management to sleep better.

Finally, we subjected all of these metrics to a simulation to determine the likelihood that the forecasted results would occur as well as the sensitivity of the drivers.

The only conclusion one can reasonably arrive at is that single point estimate forecasting does not give you the range and depth of insight into your numbers that Monte Carlo simulation does.

What type of scenario analysis do you use in your company? Let me know in the comments below, call or e-mail me below as I am always interested to hear how others are learning and using new forecasting techniques to manage and grow their businesses.

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Jerome Scherer

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"You can't control it unless you measure it or model it!" Jerry Scherer is a former financial officer of Northwest Industries, a Fortune 200 leader in planning, control and data systems, where he pioneered the development of mainframe computer solutions utilizing optimization and Monte Carlo simulation tools to facilitate management decision making. Mr. Scherer has also been a CFO and Controller of several manufacturing firms and was the Managing Partner of a consulting firm engaged in providing decision support solutions. JB Scherer Consulting Group provides assistance and training to companies in PC-based strategic, tactical and financial decision models enabling them to bring "what-if" analysis into the 21st century.