

# Accounting for Uncertainty in Cost-Volume-Profit Analysis

By Tom Downen, Ph.D., CPA

## EXECUTIVE SUMMARY

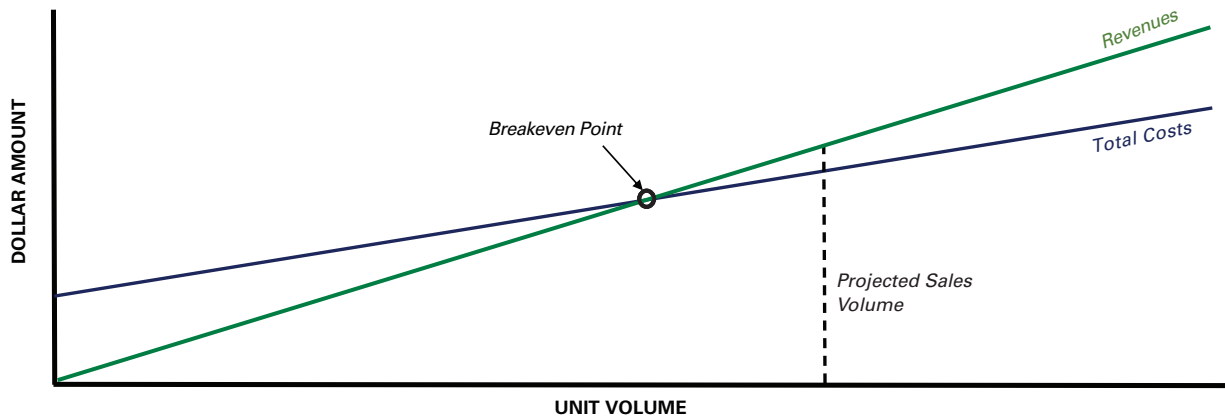
Decision makers need to know how judgment and estimation in managerial accounting data lead to uncertainty. One approach to reflect the uncertainty in financial reporting and various analysis methods involves using ranges, such as confidence intervals, rather than just point estimates. Doing so will introduce additional possible outcomes for decision makers to consider, but it could also induce judgment dysfunctions.

**A**s many accounting and finance professionals know, judgment and estimation often influence amounts included in financial statements and other reports. Judgment (choosing between different accounting methods) and estimation (predicting a future event or amount) result in uncertainty in accounting data, ultimately affecting financial accounting and managerial accounting. Because managerial accounting can include forecasted data, it is more likely to be subject to estimation and, therefore, likely to include greater degrees of uncertainty.

Most managerial accounting decisions involve uncertainty. Consider, for example, a cost-volume-profit (CVP) analysis. Figure 1 shows a standard CVP graph, assuming that relevant values, such as revenue per unit, fixed costs in total, and variable costs per unit are either known with certainty or estimated as a specific single amount. In many cases, a company would estimate total fixed costs and variable costs per unit based on an analysis of amounts from prior periods using a method such as high-low, scattergraph, or the preferred statistical regression.

In this standard CVP scenario, the breakeven point is where estimated revenues equal estimated total costs. A company would expect sales volumes below the breakeven point to result in a loss and sales volumes above the breakeven

**Figure 1: A Standard Example of CVP Analysis**



point to result in a profit. Assume this CVP analysis pertains to a new product that the company is considering. Based on the projected sales volume in Figure 1, the standard decision would be to pursue the product opportunity. In other words, the projected sales volume is above the breakeven point and, therefore, should be profitable.

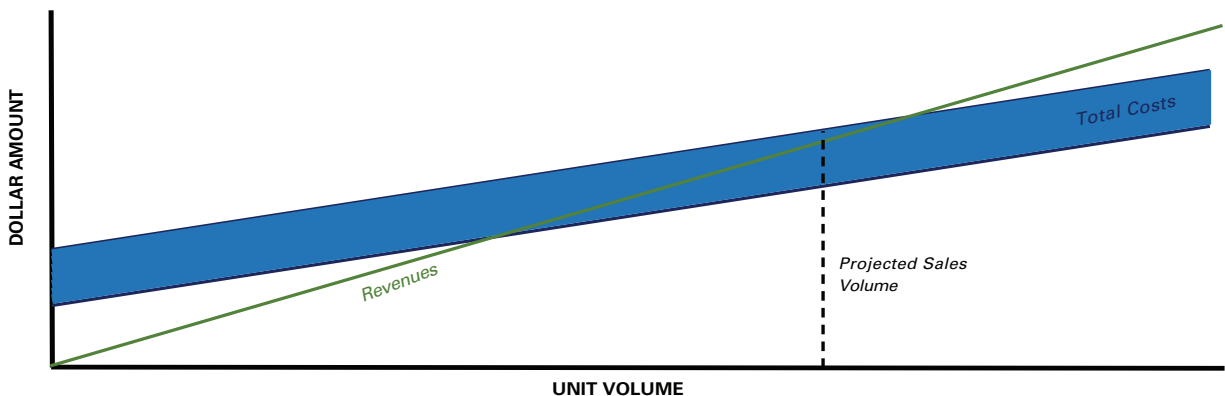
**UNCERTAINTY IN ESTIMATED FIXED COSTS**

In a CVP graph, the y-intercept is where the total costs line intersects the vertical axis. The y-intercept represents the estimated fixed costs—the amount of total costs the company would expect to incur if it produced

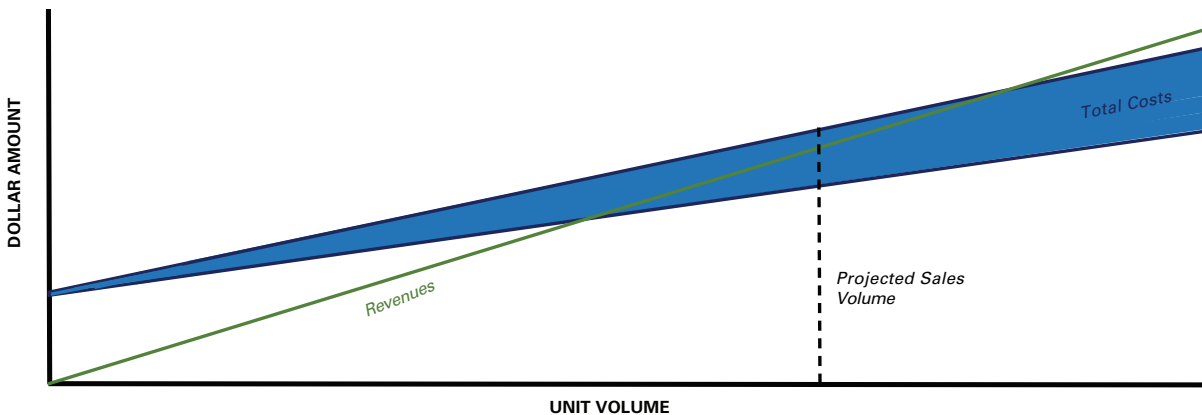
zero units. Fixed costs, however, could vary at extreme volumes considering relevant ranges. To reflect uncertainty in estimated fixed costs, the intercept would likely be a range, not a single point. The overall effect on the CVP graph would be a total costs band, rather than a total costs line (see Figure 2). The total costs band would be wider (or narrower) with a greater (or lesser) degree of uncertainty in the estimated fixed costs.

In this CVP graph, the decision at the projected level of sales volume is not quite so obvious. Although more of the possible outcomes in the total costs range for this expected sales volume are below the expected revenue

**Figure 2: CVP Analysis Reflecting Uncertainty in Fixed Costs**



**Figure 3: CVP Analysis Reflecting Uncertainty in Variable Costs per Unit**



amount and, therefore, should be profit-producing, the possibility of a loss at the expected sales volume is now evident. The loss-avoidance aspect of Prospect Theory suggests that some decision makers would choose not to pursue the opportunity for fear of that possible loss, particularly in an otherwise profitable context.<sup>1</sup>

#### **UNCERTAINTY IN ESTIMATED VARIABLE COSTS PER UNIT**

In a CVP graph, the slope of the total costs line reflects estimated variable costs per unit—the amount the company expects total costs to increase or decrease with each unit change in the volume they produce. To reflect uncertainty in estimated variable costs per unit, this slope would likely include a range of values rather than a single value. As Figure 3 shows, the effect on the CVP graph would be a total costs cone rather than a total costs line. The shape and width of the cone will depend on the degree of uncertainty in the estimated variable costs per unit.

Again, in this CVP graph, the decision for the company to make at the projected level of sales volume is less clear. At the projected sales volume, most of the possible outcomes for total costs would be below revenues. Therefore, it is most likely that the scenario would be profitable at that sales volume. Yet some possibility of a loss again exists, where total costs could exceed total revenues. This

could again result in loss-avoidance behaviors.

#### **UNCERTAINTY IN BOTH FIXED COSTS AND VARIABLE COSTS PER UNIT**

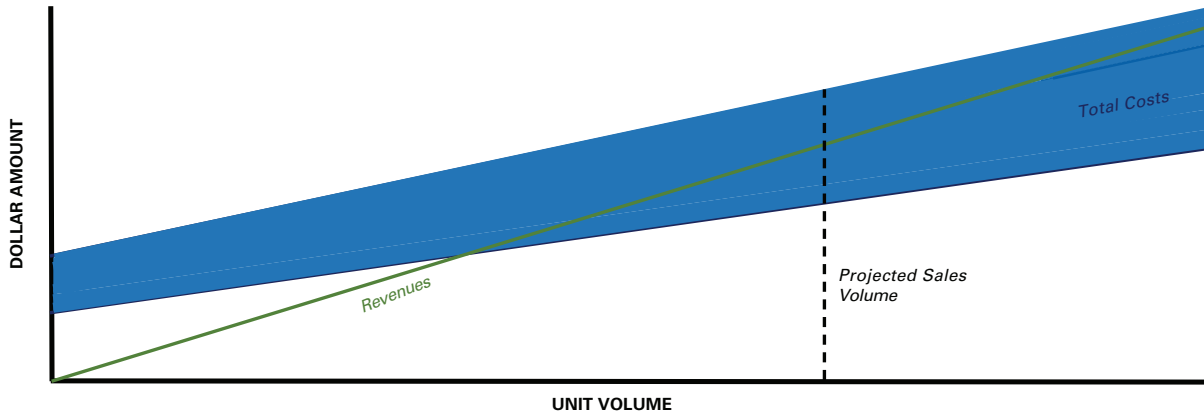
Of course, some degree of uncertainty in both estimated fixed costs and estimated variable costs per unit is possible. While uncertainty could exist in the amount of revenue per unit, company management would likely have more control over that element because it decides the product's selling price. A total costs band that gets progressively wider represents uncertainty in both fixed costs and variable costs per unit (see Figure 4).

It would be possible in a scenario such as this to underestimate fixed costs while overestimating variable costs per unit, or vice versa, with these two estimation errors essentially offsetting each other in part or in full. In that case, the actual result might not vary much from the point estimate of total costs based on a standard total costs line. But it is also possible to either underestimate or overestimate both, resulting in a total cost amount toward one of the band's edges. This possibility could result in a big shift in the opportunity's profitability. Lastly, uncertainty could affect the expected sales volume (a wide dashed band not shown in the figure), expanding the range of possible outcomes even further.

#### **QUANTIFYING THE UNCERTAINTY**

When a company considers a new product opportunity

**Figure 4: CVP Analysis Reflecting Uncertainty in Both Fixed Costs and Variable Costs per Unit**



or a new geographic region, one common starting point for CVP analysis might be to examine prior performance data for a similar product or region. Consider the data in Table 1 for a similar product or region for the most recent 12 months.

Figure 5 shows these data graphed in Microsoft Excel as a scatterplot. Several methods to analyze fixed costs and variable costs per unit are readily available, including the high-low method and the scattergraph method. The most accurate approach, however, is based on regression analysis to minimize the squared distance between the line and the observations.

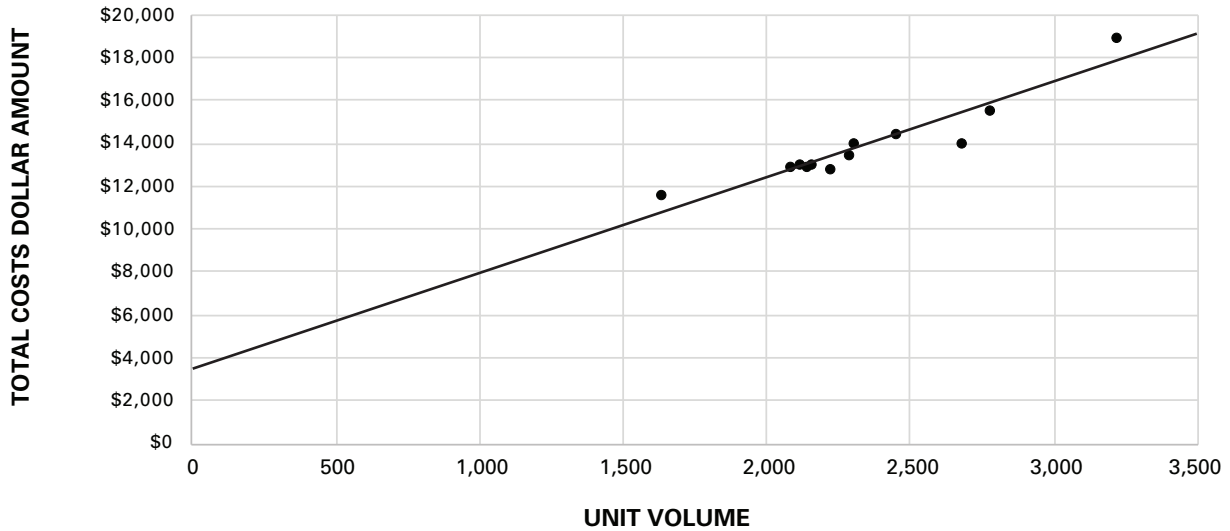
The predicted total costs line in Figure 5 reflects the

regression results. This analysis process uses the regression tool in the Analysis ToolPak, a free add-on to the standard Excel installation. The results are in Table 2. Based on these data, the best point estimate for fixed costs is \$3,585.21, and the best point estimate for variable costs is \$4.33 per unit. This regression analysis, however, also provides 95% confidence intervals for each estimate. Because the sample data do not fall perfectly on a line, there is some variation or uncertainty in the observations. Thus, the regression analysis also suggests that with high confidence the company can expect the fixed costs to range between \$925.96 and \$6,244.47. The analysis also indicates that with

**Table 1: Sample Sales Volume and Total Costs Data for Recent Periods**

Month	Sales Volume	Total Costs	Month	Sales Volume	Total Costs
January	1,640 units	\$11,464	July	2,142 units	\$12,704
February	2,119 units	12,905	August	2,290 units	13,297
March	2,224 units	12,598	September	2,308 units	13,875
April	2,687 units	13,865	October	2,455 units	14,309
May	2,088 units	12,776	November	2,780 units	15,387
June	2,160 units	12,848	December	3,221 units	18,733

**Figure 5: Scatterplot of Recent Data for a Similar Product or Region**



high likelihood the variable costs per unit will range between \$3.21 and \$5.45. Using these confidence interval estimates, Figure 6 shows a CVP analysis that includes the uncertainty band for total costs.

**UNCERTAINTY IN OTHER MANAGERIAL ACCOUNTING CONTEXTS**

The uncertainty associated with judgment and estimation would affect a variety of other managerial accounting contexts. For example, a company budgeting for direct labor normally would estimate how many units it will produce, how many direct labor hours each unit will require, and the labor rate per hour. If the company considers a range of possible production levels, perhaps based on both uncertain product demand and a range of possible direct labor hours per unit, managers can be

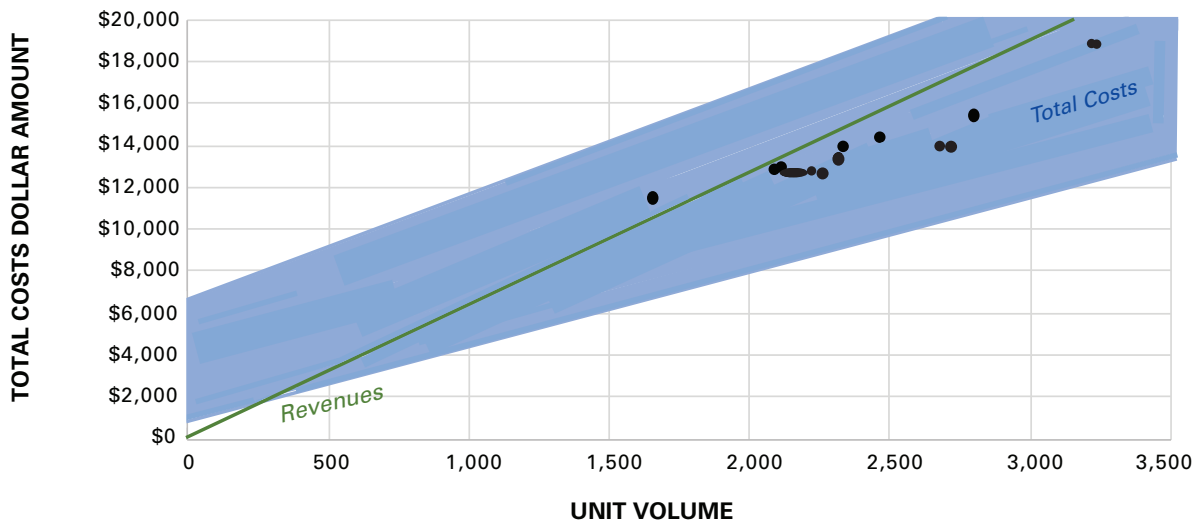
more prepared to hire and schedule employees. Similarly, when preparing a cash budget, generally after the company has prepared all other relevant budgets, it predicts the likelihood of a negative cash position with a need to borrow funds or a positive cash position to possibly repay on prior borrowings. If the company includes uncertainty levels in the various budget components, it can be more prepared for a range of possible ending cash positions to better anticipate lender interactions.

Other possible applications of uncertainty reporting in common managerial accounting contexts could include estimates of overhead costs and cost-driver volumes for activity-based costing methods, standard costs for variance analysis, and capital investment analysis.

**Table 2: Regression Analysis Results for Sample Data**

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Fixed costs	\$3,585.21	\$1,193.49	3.004	0.013	\$925.96	\$6,244.47
Variable costs per unit	\$4.33	\$0.503	8.615	0.000	\$3.21	\$5.45

**Figure 6: Regression Prediction of Fixed and Variables Costs with Uncertainty**



**DISCLOSING UNCERTAINTY FOR DECISION MAKERS**

This article is not suggesting that common analysis tools in managerial accounting are unhelpful. To the contrary, it can be critical to perform CVP analysis when a company considers a new product or expansion into a new location. But it is important to recognize that most—if not all—amounts in that analysis are subject to uncertainty. If decision makers rely on analyses that do not reflect uncertainty and if they do not know uncertainty exists, they may be surprised when actual results vary (perhaps substantially) from expected results. The surprise could be unpleasant. Instead, my suggestion is to, when possible, disclose the existence and level of uncertainty, so decision makers have as much relevant information as possible. It is, however, also important to

avoid inducing any dysfunctional psychological reactions. ■

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**ENDNOTE**

1 Daniel Kahneman and Amos Tversky, “Prospect Theory: An Analysis of Decision Under Risk,” *Econometrica*, March 1979, pp. 263-292.