

**TEACHING AFTER-TAX COST-VOLUME-PROFIT ANALYSIS
– PROBLEMS AND GRAPHS –
IN INTRODUCTORY MANAGERIAL ACCOUNTING:
NO EQUATIONS REQUIRED**

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Introduction

Cost-volume-profit (CVP) analysis is generally defined as a planning tool by which managers can evaluate the effect of a change(s) in price, volume, variable cost, or fixed costs on profit. Additionally, CVP analysis is the basis for understanding contribution margin pricing, related short-run decisions, target costing, and transfer pricing. As one of managerial accounting's most basic analytical tools, CVP analysis is covered in all introductory managerial accounting texts.

Traditionally, equations are used to teach CVP analysis and to solve CVP problems. Because the equations method requires a before-tax set of equations and an after-tax set of equations, CVP analysis is frequently classified as before-tax and after-tax. While the before-tax equations are relatively straightforward, the after-tax equations are relatively complex and difficult for introductory managerial accounting students to understand and use. As a result, introductory managerial accounting textbooks either omit after-tax income CVP analysis or treat it separately, usually in an appendix, such that it can be easily omitted. Yet, income after taxes is the measure of wealth created by operations which managers cannot ignore and should not be omitted from introductory managerial accounting when a better method of teaching the topic is available.

This paper discusses an alternative method that is used in introductory managerial accounting classes to teach CVP analysis and to solve CVP problems – the contribution margin income statement. As the paper demonstrates, including income after-taxes using the contribution margin income statement for CVP analysis is straightforward, logical and is accomplished without additional effort or confusion. The equations are unnecessary and do not add value. They are eliminated.

The Contribution Margin Income Statement Model

Exhibit 1 shows the contribution margin income statement (CMIS) as a model to teach CVP analysis and to solve CVP problems. For comparative purposes, exhibit 1 also shows the typical before-tax and after-tax sets of equations. All of the equations are derived from the CMIS. In fact, many instructors, as we have, may use the CMIS to explain and derive the equations. Since the equations are derived from the CMIS and the CMIS is easily used to solve CVP problems, the equations are unnecessary. Thus, unless the equations add value they are nonvalue-added and should be eliminated. Whether or not the equations add value is considered later. How the CMIS model is introduced and used in the classroom for CVP analysis is discussed below.

The textbook teaches the equations method, which students will be instructed to ignore. Consequently, the related chapter is assigned after they have used and understand the CMIS method. Prior to a classroom discussion, students are given a short handout to study. It includes: (1) a brief discussion of variable costs, contribution margin, fixed costs, calculation of income tax expense, and related assumptions; (2) the CMIS model as shown in exhibit 1; and (3) a

relatively complex after-tax income CVP problem and a solution using the CMIS.

The classroom discussion is particularly important. Students learn how to use the CMIS for after-tax income CVP problems, firmly establishing both the CMIS method and after-tax income CVP analysis. Our experience indicates that with this accomplished, students can ignore the textbook's equations without concerns or reservations. Additionally, although the textbook does not cover after-tax income CVP analysis, students have not questioned its inclusion.

The following example focuses on income after-tax and illustrates how students learn to use the CMIS in one 50-minute class period.

Given Information:		Required:	
Expected unit selling price	\$40.00	Target unit variable cost	?
Estimated sales in units	10,000	Breakeven sales in units	?
Total fixed costs	\$150,000	Breakeven sales in dollars	?
Income tax rate	40%	(The breakeven questions are posed	
Target after-tax income	\$60,000	after the unit variable cost is found.)	

As discussed in the handout and emphasized in class, students are urged to follow a three-step approach when solving CVP problems: (1) write the model, (2) "plug in" the given information, and (3) solve for the unknown. Writing the model for each problem promotes recall and provides a visible solution "roadmap" when the given information is substituted for letters. To illustrate the "roadmap" for the example problem, the unit values column is written on the board and the given information is "plugged in" an adjacent column as below.

Unit Values	
pq	\$40*10,000
(vq)	(v10,000)
mq	m10,000
(F)	(\$150,000)
B	B
(tB)	(.4B)

$$A \qquad \$60,000$$

Some students see a solution and will begin solving the problem, some see the first step, and others see three unknowns. After a few moments of silence and the class appears ready, posing the question – What is the target unit variable cost? – prompts a response. Students must work from the “bottom up,” using the CMIS as a model rather than as an income statement, and make two simple calculations. Students are encouraged to write each “vertical” calculation “horizontally” as below.

$B - tB = A$	$mq - F = B$
$B - .4B = \$60,000$	$m10,000 - \$150,000 = \$100,000$
$.6B = \$60,000$	$m10,000 = \$250,000$
$B = \$60,000 / .6$	$m = \$250,000 / 10,000$
$B = \$100,000$	$m = \$25$

Since the unit price was given (\$40), the target unit variable cost of \$15 is obvious. The CMIS solution may appear to require more calculations and more time than an equation. In fact, the calculations are virtually identical to the calculations required to solve an equation and with a little practice the time required to solve a problem using the CMIS is comparable to an equation. Readers may, and are encouraged to, test the assertion by performing the calculations using the CMIS and any of the applicable equations.

With the unit variable cost known, the breakeven sales in units question is asked. Again, the process of writing the model, plugging in the given information, and converting vertical calculations into horizontal calculations is emphasized. The result is shown below.

	Unit Values	Horizontal Calculation
pq	\$40q	
(vq)	(\$15q)	
mq	\$25q	$mq - F = B$
(F)	(\$150,000)	$\$25q - \$150,000 = 0$
B	0	$\$25q = \$150,000 + 0$
(tB)	(0)	$q = (\$150,000 + 0) / \25

$$A \qquad 0 \qquad q = 6,000$$

To illustrate CVP analysis with ratios, the final question – What is breakeven sales in dollars? – is posed with the requirement of using the ratios. As before, the model is written on the board, given information is substituted for letters in the adjacent column, and the horizontal calculation is shown to the side.

Ratios/Percents		Horizontal Calculation
S	S	
(v%S)	37.5%S	$v\% = V/S = vq/pq = v/p = \$15 / \$40$
m%S	62.5%S	$m\% = M/S = mq/pq = m/p = \$25 / \$40$
(F)	(\$150,000)	$m\%S - F = B$
B	0	$62.5\%S - \$150,000 = 0$
(tB)	(0)	$62.5\%S = \$150,000 + 0$
A	0	$S = (\$150,000 + 0) / 62.5\%$
		$S = \$240,000$

Classroom Adjustments

At the end of the classroom demonstration, the related textbook chapter is assigned. Students are informed that the textbook uses equations that are derived from the CMIS, that all CVP problems can be solved using the CMIS, that the CMIS is easier to use and requires less memorization, and that for these reasons the equations will not be used for problem solving. Students are instructed to ignore the equations, they will not be expected to use or in any way be held responsible for the equations. Our students have not expressed reservations or concerns (complaints) about either the CMIS approach or being held responsible for after-tax income CVP analysis, which is not covered in the chapter assignment. The handout combined with the classroom demonstration allays their reservations and concerns (fears). In fact, when students were exposed to both methods, their comments about the CMIS were positive.

Using the CMIS may require two adjustments for instructors. One, because students are using the CMIS, instructors should also use the CMIS. Introducing some of the equations or short-cuts by an equation is unnecessary and may cause confusion. Because this can happen unintentionally, instructors should be sure to use the CMIS initially. The second adjustment involves income taxes. Using the CMIS, income tax expense is easily and explicitly included in CVP analysis. Consequently, instructors can easily include income tax expense in CVP

problems and CVP graphs as shown in exhibit 2. In fact, if income tax expense is not included in a CVP graph, students are likely to question why.

Effect On Accounting Majors

Using the CMIS, accounting majors are not exposed to the specific equations that they may be required to use in advanced cost/managerial accounting courses. They are, however, thoroughly exposed to after-tax CVP analysis – problems and graphically – and extensively used the CMIS which is necessary to derive and understand the equations. Our experience indicates that accounting majors who have used the CMIS are not at a disadvantage. In fact, they may be better prepared.

Comparative Analysis

Experience with both methods has proven that CVP analysis is easier to teach and learn using the CMIS because it is structured, requires less memorization, and directly includes income tax expense. As presented, the CMIS model consists of three columns of “letters.” The total values column is an easily remembered sequence of income statement steps that relates directly to the unit values column and the ratios/percents column. To solve a CVP problem, students use either the unit values column or the ratios/percents column, depending on the given information, and make one, two, or three simple calculations. Each calculation and each cost are explicitly stated in the CMIS. Because each cost of operations – variable cost, fixed cost, and income-tax expense – and their “behavior” are explicitly stated in the CMIS, after-tax income CVP analysis is straightforward. Additionally, since the costs and their behavior are obvious, they can be easily and logically presented graphically. That is, CVP analysis can be expanded to include an after-tax income graph without additional effort.

In contrast, after-tax income CVP analysis using the equations method is more difficult to teach and learn because it is relatively unstructured, requires more memorization, and includes the “effect of income taxes.” The degree of structure depends on the mix of “algebra” and memorization. With an “algebraic” emphasis instructors must decide which equation(s) should be memorized and then demonstrate and explain the substitution and manipulation of terms – algebra – to obtain the equations appropriate for the specific problem. Most CVP problems can be solved with at least two equations. For example, to find the target unit variable cost in the illustrative problem above instructors may explain the basic after-tax unit values equation and the after-tax contribution margin equations, respectively (from exhibit 1) “ $pq - vq - F = A/(1 - t)$ ” and “ $q = (F + (A/(1 - t)))/m$.” Students’ questions such as “How do I know which equation to derive?” “Which equation should be used?” and “Which equation should be memorized?” are likely to follow. Using the CMIS, this dilemma is avoided.

As for memorization, a comparison of the CMIS model and the sets of equations from the students’ perspective leads to three conclusions. From the students’ perspective: (1) the equations require more memorization, (2) the after-tax equations are relatively complex, and (3) the after-tax equations are difficult to understand especially the after-tax conversion term [from exhibit 1, “ $A/(1 - t)$ ”]. This term is the “effect of income taxes.” To understand the effect of income taxes and thus the after-tax conversion term, students must consciously recall its

derivation (using terms from exhibit 1):

$$B - tB = A$$

$$B(1 - t) = A$$

$$B = A/(1 - t).$$

Additionally, constructing an after-tax CVP graph with the equations as the foundation is complex and difficult to understand. (The end note discusses how income tax expense can be included directly in the equations. This approach, however, may be more complex than the traditional equations approach. It is not recommended.)

Summary and Conclusions

This paper has two objectives. The first objective is to discuss how the contribution margin income statement (CMIS) is used in introductory managerial accounting classes as the model to teach cost-volume-profit (CVP) analysis, solve CVP problems and construct an after-tax CVP graph. It shows that the benefits of covering after-tax CVP analysis can be achieved without additional effort or confusion. Thus, the paper raises a serious question for introductory managerial accounting education. Is the learning objective to understand and perform CVP analysis using equations or to understand and perform CVP analysis? By posing the question we hope to achieve the paper's second objective, to initiate a discussion leading to the question's resolution.

End Note

Technically, income tax expense can be included in the equations. This is illustrated below for unit values using the terms from exhibit 1 and two means of deriving the traditional after-tax equation.

Unit Values Equation	$pq - vq - F - tB = A$
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Since	$pq - vq - F = B$
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By Substitution	$pq - vq - F - t(pq - vq - F) = A$
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Then	$pq - vq - F(1 - t) = A$
------	--------------------------

$$pq - vq - F = A / (1 - t)$$

Unit Values Equation	$pq - vq - F - tB = A$
----------------------	------------------------

Since $pq - vq - F = B$

By Substitution $B - tB = A$

Then $B(1 - t) = A$

$B = A / (1 - t)$

By Substitution $pq - vq - F = A / (1 - t)$

Exhibit 1

Methods Of Cost-Volume Profit Analysis

Contribution Margin Income Statement Method

	Total	Unit	Ratios/	
	Dollars	Values	Percent	
Sales	S	pq	S	
- Variable costs	(V)	(vq)	(v%S)	$v\% = V/S = vq/pq = v/p$
= Contribution margin	M	mq	m%S	$m\% = M/S = mq/pq = m/p$
- Fixed costs	(F)	(F)	(F)	
= Before-tax income	B	B	B	
- Income taxes	(T)	(tB)	(tB)	
= After-tax income	A	A	A	

p = unit selling price

t = income tax rate

q = quantity of units sold

v% = variable cost ratio

v = unit variable cost

m% = contribution margin ratio

m = unit contribution margin

The Equations Method

Basic Equations

Total dollars

$$S - V - F = B$$

$$S - V - F = A/(1 - t)$$

Unit values

$$pq - vq - F = B$$

$$pq - vq - F = A/(1 - t)$$

Ratios/Percent

$$S - v\%S - F = B$$

$$S - v\% - F = A/(1 - t)$$

Contribution Margin Equations

Unit Values

$$q = (F + B)/m$$

$$q = (F + (A/(1 - t)))/m$$

Ratios/Percent

$$S = (F + B)/m\%$$

$$S = (F + (A/(1 - t)))/m\%$$

