Research Note

A New Framework for Capacity Costing and Inventory Variance Analysis

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Abstract

The proposed framework in this article presents a new framework for capacity costing and inventory variance analysis by introducing linear programming (LP) into variance analysis to allow for optimal budgeting in a firm with two production departments and two products. In addition, the proposed framework replaces the traditional concept of ex ante flexible budget, with the concept of ex post flexible budget, which allows management to optimally revise the budget in response to changes in market and operational conditions. Additionally, an inventory variable is added to the linear programming model to capture management's planned and actual inventory decisions.

The proposed framework further distinguishes between practical and budgeted capacity in each department and explicitly identifies the planned and unplanned changes in inventory levels and in capacity utilization. Collectively, these modifications to traditional flexible budgeting and variance analysis enhance their managerial and pedagogical applications.

Keywords:

Inventory Variance Analysis
Linear Programming (LP)
Ex Ante Flexible Budgets
Ex Post Flexible Budgets
Practical and Budgeted Capacity

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Introduction

This paper extends Yahya-Zadeh (2002) to integrate inventory variances into flexible budgeting and profit variance analysis. While traditional profit variance analysis "flexes" the static budget to *actual* sales volume, Yahya-Zadeh (2002) argued that a more appropriate benchmark for measuring the performance of a firm or its profit centres would be an ex post optimal budget. An ex post optimal budget, it was argued, was the result of an optimization program using the latest data available by the end of the budget period. Using linear programming as the optimization tool, the study showed that changes in market conditions, such as a change in the firm's relative output and input prices, could render a traditional flexible budget misleading. Measuring and rewarding responsibility centre managers for achieving outdated budget targets could lead some profit centre managers to increase production of the wrong department or the wrong product. Additionally, it would penalize profit centre managers making strategic and timely decisions to change course to respond to changing market conditions. The present paper complements Yahya-Zadeh (2002) by incorporating inventory and cost of capacity variances to it.

In the accounting literature, the concept of an ex post budget based on an optimized linear program was introduced by Demski (1967). Hulbert and Toy (1977) initiated a similar discussion in the marketing literature. They suggested using the ex post data, information available to marketing manager at the end of the budget period, for analysing marketing variances. The ex post information enabled them to isolate the planning component of marketing variance from its performance component. Consequently, poor performance due to inadequate planning could be separated from variances due to substandard performance. Hulbert and Toy further introduced the concepts of market size variance and market share variance. Market share variance was treated as controllable, while market size variance was considered uncontrollable for marketing managers. Hulbert and Toy's study was extended by several other studies in the marketing literature (Weber, et al., 1997; Sharma and Achabal, 1982; Jaworski, 1988; Mitchell and Olsen, 2003).

The incentive to overproduce under absorption costing has been the subject of much debate in management accounting. The incentive to overproduce under absorption costing and thereby capitalize higher portions of fixed manufacturing overhead has been well known. Overproducing inventory defers current manufacturing costs to future periods through inventory account. Interpreting fixed manufacturing overhead cost as “cost of capacity” implies that increased inventory is equivalent to moving capacity costs into future periods.

Cooper and Kaplan (1992) argued that companies should specifically examine the cost of resources supplied (i.e., cost of available capacity) and differentiate it from cost of resources (capacity) used. While periodic financial statement reporting is based on cost of resources supplied, activity-based costing provides information of cost of resources used. Cooper and Kaplan (1992) argue that cost of unused capacity is useful for managerial decisions and should be reported for each activity. They made a distinction between budgeted and practical capacity and argued in favour of using practical capacity for computation of activity rates in activity-based costing. Kaplan (1994) extended this idea. Kaplan suggested decomposing activity rates to their *committed* (i.e., fixed) and *flexible* (i.e., variable) components. He used these rates to determine *budgeted unused capacity costs* and *capacity utilization variances* for each activity and to integrate ABC and flexible budgeting.

Balakrishnan and Sprinkle (2002) presented a new framework for profit variance analysis that specifically identified and reported *the cost of planned unused capacity* and *the cost of unplanned use of idle capacity*. In addition, they specifically determined *inventory change variance* as an integral part of profit variance computations. The key features of their improved variance analysis framework was using practical capacity for computing fixed overhead costs and introducing a flexible budget that was adjusted for actual sales volume and budgeted changes in inventory.

The present study uses the linear programming framework, as in Yahya-Zadeh (2002), to incorporate inventory variance and cost of unused capacity into traditional profit variance analysis. The use of the linear programming method makes it possible to view annual budgeting as an optimization exercise in the context of multi-department and multi-product companies. In addition, it redefines flexible budget, as an ex post, instead of an ex ante, concept. In determining inventory and cost of capacity variances, the current study follows the methodology of Balakrishnan and Sprinkle (2002). Additionally, it extends their study by integrating ex post flexible budget into their model.

Pedagogically, the present study offers a new way of thinking about variances and capacity costing. Cost accounting textbooks (e.g., Horngren, et al.) often present variances for individual products, and individual departments. Further, they tend to ignore inventory variance except in the discussion of product costing. Budgeted capacity is routinely used to determine fixed overhead rate and the significance of using practical capacity in activity-based costing and in overhead variance analysis is downplayed or completely overlooked. Traditional textbooks provide limited coverage of the linear programming tool in the discussion of short-term product-mix decisions. At the same time, the present study extends the work of the earlier studies by emphasizing the need for an optimal budgeting concept and by integrating linear programming into the discussion of inventory and capacity cost variances.

The practical value of present study stems from its ability to view variance analysis in the context of overall optimization decisions. Management’s midyear decision to adjust production levels of different departments or products is discussed relative to overall profit maximization decision. Consequently, unplanned changes in production levels of a department, treated as unfavourable moves under the traditional approach, may be treated as a positive step by the framework proposed in this study. Management may have to change its production plans midway through the budget period and cause “unfavourable” capacity variances in some departments. Unless such decisions are examined through the lens of a global optimization plan, it would be hard to make sense of recurring or shifting changes in inventory and capacity variances. By integrating variance analysis and profit optimization decisions, the present study demonstrates an approach for improving measurement and interpretation of inventory, capacity, and profit variances.

The present paper illustrates the new inventory and capacity variances using a numerical example. First, the limitations of textbook variance analysis in dealing with multi-product and multi-department situations are discussed. In subsequent sections, an improved framework for computation of inventory and capacity variances and for evaluating management's production decisions is presented.

Hypothetical Example

Consider a firm with two production departments and two products, X and Y. The firm's production, price, and inventory information are shown in Table 1.

The static budget indicates that during the upcoming year the firm plans to sell 4,143 and 3,457 units of products X and Y, respectively. Manufacturing one unit of product X requires 0.96 labour hours in Department 1 and 0.24 labour hours in Department 2. Product X has a budgeted selling price of $88 and a budgeted unit variable manufacturing cost of $66. Beginning inventory for Product X is 200 units and the desired ending inventory is 414 units (set at 10% of budgeted sales volume for the current period). The corresponding quantities and prices for product Y (Table 1) should be interpreted in a similar manner. The *practical* capacity of Departments 1 and 2, measured in labour hours, are 5,000 and 4,000 labour hours, respectively. The current year's *budgeted* capacity of Departments 1 and 2 are 5,000 and 3,594 hours, respectively. Departments 1 and 2, respectively, have budgeted fixed annual manufacturing overhead costs of $35,000 and $25,875.

Budgeted (and actual) total demand for the two products is 7,600 units. Buyers can easily substitute one product for another because of similarity of their features and functions.

By the end of the budget year, the firm had sold 3,814 units of product X and 3,786 of product Y at average prices of $86.50 and $75, respectively. Actual inventory levels increased far beyond the budgeted levels to 572 and 568 units of X and Y, respectively. Actual fixed overhead cost in Department 1 was $37,500 and actual fixed overhead in Department 2 was $30,000.

Observe that in this example Department 1 is planned to operate at its full practical capacity (5,000 hours), whereas Department 2 is budgeted to operate under capacity (4,143 × 0.2 + 3,457 × 0.8 = 3,594). This feature is the outcome of optimizing production and inventory plans using the linear programming method (see Table 5 for optimization procedure). This feature enables the study to examine mid-year changes in actual or budgeted production and sales levels differently than under the traditional approach. Specifically, it charts the consequences of market changes beyond limits foreseen in the static budget. A brief review of Balakrishnan and Sprinkle's (2002) helps set the stage for the description of our numerical example.

Traditional Approach to Flexible Budgeting

Table 2 (Panel A) presents alternative computations of overhead rates using budgeted and practical capacities. Panel B of Table 2 determines unit product costs using an overhead rate based on budgeted capacity and Panel C calculates unit product costs using practical capacity as the denominator. The planned increase in the firm's inventories (10% increase) implies the need to determine unit costs in the beginning inventory and the need to use a cost flow assumption. LIFO is the assumed inventory flow[1]. Also, observe that practical capacity is used in computation of unit costs in the beginning inventories (see Table 2, Panel C).

Table 3 demonstrates the traditional flexible budgeting approach applied to the current example. Budgeted gross profit for the period is $100,791.

[1] These assumptions are consistent with Balakrishnan and Sprinkle (2002). The use of practical capacity for determination of unit costs in the beginning inventory is for consistency and comparability of Tables 3, 4, and 6.

Table 1: Production and Inventory Levels Under Actual, Budgeted and Traditional Definition of Flexible Budget

Item	Actual (AR) (based on actual sales and inventory levels)		Flexible Budget (based on actual sales and inventory levels)		Static Budget (SB) (based on ex ante optimal sales and inventory levels)	
	X	Y	X	Y	X	Y
Sales volume [a] (units)	3,814	3,786	3,814	3,786	4,143	3,457
Unit price ($)	$86.50	$75.00	$88.00	$74.00	$88.00	$74.00
Unit variable cost ($)	66.00	54.00	66.00	54.00	66.00	54.00
Unit contribution margin ($)	20.50	21.00	22.00	20.00	22.00	20.00
Beginning inventory (units)	200	400	200	400	200	400
Desired ending inventory (units)	572	568	572	568	414	346
Production volume (units)	4,186	3,954	4,186	3,954	4,357	3,403
Labour hours required in Dept. 1 per unit	0.96	0.24	0.96	0.24	0.96	0.24
Labour hours required in Dept. 2 per unit	0.2	0.8	0.2	0.8	0.2	0.8

Additional information:

Total market demand for products X and Y: 7,600 units

	Department 1	Department 2
Current year budgeted capacity (labour hours)	5,000	3,594
Current year practical capacity (labour hours)	5,000	4,000
Last year's practical capacity (labour hours)	5,000	4,000
Budgeted fixed manufacturing overhead (years 1, 2)	$35,000	$25,875
Actual fixed manufacturing overhead—current year	37,500	30,000
Overhead rate based on budgeted capacity	$7.00	$7.20
Overhead rate based on practical capacity	7.00	6.74

	Product X	Product Y
Budgeted increase in inventory level for current year	10%	10%
Actual increase in inventory level for current year	15%	15%

Table 2: Computation of Unit Costs in Beginning Inventory and Current Period

Panel A: Overhead Rate Computations

	Department 1	**Department 2**
Overhead rate based on budgeted capacity ($35,000 ÷ (4,357 × 0.96 + 3,403 × 0.24)) ($25,875 ÷ (4,357 × 0.20 + 3,403 × 0.80))	$7.00	$7.20
Overhead rate based on practical capacity ($35,000 ÷ 5,000); ($25,875 ÷ 4,000)	$7.00	$6.47

Panel B: Unit Cost Computations: Budgeted Capacity as the Denominator

	Product X	**Product Y**
Unit variable costs	$66.00	$54.00
Overhead in units produced in current period (0.96 × $7 + 0.20 × $7.20); (0.24 × $7 + 0.80 × $7.20)	8.16	7.44
Current period unit costs	$74.16	$61.44

Panel C: Unit Cost Computations: Practical Capacity as the Denominator

	Product X	**Product Y**
Unit variable costs	$66.00	$54.00
Overhead in beginning inventory units (0.96 × $7 + 0.20 × $6.47); (0.24 × $7 + 0.80 × $6.47)	8.01	6.86
Beginning inventory unit costs	$74.01	$60.86

Table 3: Variance Computation with Traditional Approach (Using Ex Ante Flexible Budget) with Budgeted Capacity as the Denominator

Item	Actual (actual sales and inventory levels)	Flexible Budget (actual sales and inventory levels)	Static Budget (budgeted sales and inventory levels)
Sales Revenue [a]	$613,861	$615,796	$620,402
Less Cost of goods sold:			
Beginning inventory [b]	39,146	39,146	39,146
+ Cost of goods manufactured [c]	553,368	553,368	532,195
− Ending inventory [d]	77,055	77,055	51,730
Unadjusted cost of goods sold	515,459	515,459	519,611
+ Fixed overhead spending variance [e]	6,625	0	0
− Fixed overhead volume variance [f]	2,701	2,701	0
Adjusted cost of goods sold	519,383	512,758	519,611
Gross Margin	$94,478	$103,038	$100,791

$ 8,560 U — **Flexible-Budget Variance**

$ 2,247 F — **Sales Volume & Inventory Variance**

Notes for Table 3:
Inventory assumption used for computation of inventory and cost of goods sold is LIFO. Further, for consistency and comparability of Tables 5, 6, and 7, it is assumed that overhead rate per direct labour hour for the units in beginning inventory are based on practical capacity.

[a] Actual sales revenue = (3,814 × $86.50 + 3,786 × $75); Flexible budget revenue = (3,814 × $88 + 3,786 × $74); Static budget revenue = (4,143 × $88 + 3,457 × $74);
[b] Beginning inventory = (200 × $74.01 + 400 × $60.86)
[c] Cost of goods manufactured:
Actual = (4,186 × $74.16 + 3,954 × $61.44); Flexible budget = (4,186 × $74.16 + 3,954 × $61.44); Static budget = (4,357 × $74.16 + 3,403 × $61.44)
[d] Actual (and flexible budget) ending inventory (LIFO) = (200 × $74.01 + 372 × $74.16 + 400 × $60.86 + 168 × $61.44) = $77,055
Ending inventory under the static budget (LIFO) = (200 × $74.01 + 214 × $74.16 + 346 × $60.86) = $51,730
[e] Fixed overhead spending variance = $37,500 + $30,000 – $35,000 – $25,875 = $6,625 U
[f] Fixed overhead production-volume variance = Applied fixed overhead –Budgeted fixed overhead = ((4,186 × 0.96 + 3,954 × 0.24) × $7.00 + (4,186 × 0.20 + 3,954 × 0.80) × $7.20) – ($35,000 + $25,875) = $2,701

The flexible budget is obtained by substituting budgeted sales and production levels with actual sales and actual production levels. All other parameters of the static budget are maintained in the flexible budget. In particular, product X and Y's prices are $88 and $74, respectively.

The increased overall production volume under the flexible budget results in a favourable production-volume variance of $2,701. The flexible budget generates a gross margin of $103,038. It adjusts gross margin under the static budget by $2,247. This variance results from flexible budget's departure from planned sales, production and inventory levels under the static budget. In particular, placing excess fixed overhead in inventory contributes to this favourable variance. According to Balakrishnan and Sprinkle (2002) the traditional approach fails to explicitly report the components of this variance. To overcome this limitation, they propose a framework based on the use of practical capacity and the introduction of a new flexible budget framework.

Variance Computations Proposed by Balakrishnan and Sprinkle

Balakrishnan and Sprinkle (2002) dealt with the limitations of the traditional model (1) by using practical capacity instead of budgeted capacity, and (2) by adding an additional flexible budget column, and (3) by separately reporting the cost of planned unused capacity and unplanned use of idle capacity. Table 4 illustrates their approach using the current example.

Two features of Table 4 distinguish it from the traditional approach of Table 3. First, notice the addition of an intermediate flexible budget (Column 3) to the table that enables them to split the sales-volume-inventory variance of Table 3 into a sales-volume variance and an inventory variance. Further, observe how the use of practical capacity enables their study to replace the traditional fixed overhead volume variance with two new variances, namely, the cost of planned unused capacity and the cost of unplanned use of idle capacity.

Balakrishnan and Sprinkle (2002) modify the traditional approach by clearly separating the income impact of change in the sales volume from the income impact of unplanned change in the inventory levels. According to this approach, the difference between gross margin for static budget and gross margin for flexible budget (Column 2) is comprised of sales-volume variance ($123 F) and inventory-change variance ($2,004 F).

Next, observe the two specific advantages of using practical capacity in Table 4. First, by using practical capacity (assumed to be constant over 4 to 5 years) as the denominator, overhead rates across periods will remain constant. This property creates cost stability across periods such that unit costs of products X and Y for the current period are the same as those in the beginning inventory. Consequently, the use of LIFO assumption is no longer necessary. Second, the use of practical capacity allows for the introduction of a new concept, namely, the cost of planned unused capacity. In the present example, practical capacity is 9,000 labour hours compared to budgeted capacity of 8,594 hours (5,000 hours in Department 1 and 3,594 in Department 2). When budgeted capacity is the denominator for the computation of overhead rate, the cost of fixed overhead is fully absorbed into cost of goods manufactured. With practical capacity as the denominator, the cost of unused capacity in Department 2 ((4,000 – 3594) × $6.47 = $2,627) can be reported separately. Their proposed modifications to the traditional approach make it harder for management to hide the cost of unused capacity in inventory.

Ex Post Flexible Budget

The starting point of traditional variance analysis is the definition of the flexible budget, as the static budget revised for actual production and actual sales. This is an *ex ante* definition of flexible budget since input and output prices and other budget assumptions remain identical to that of the static budget. Yahya-Zadeh (2002) viewed budgeting as an optimization procedure. In particular, the static budget is viewed as the outcome of an explicit (or implicit) optimization exercise undertaken by management at the *start* of the budget period. Likewise, ex post flexible budget is an optimal plan. It refers to a thorough revision and re-optimization of the static budget based on the latest market and manufacturing conditions as made available to management at the *end* of the budget period. As market and production conditions change, they may render the static budget suboptimal. Therefore, instead of a mere rescaling of the static budget at the end of the year and using it for flexible budgeting, management undertakes a thorough revision of it. At the end of the year every assumption of the static budget, such as sales volumes, input and output prices and productivity rates, will be scrutinized and revised if necessary. A limited revision of the static budget by simply replacing budgeted sales volumes with actual sales volumes does not provide a benchmark for measuring actual performance. Indeed, the use of actual sales volumes in the ex ante flexible budget implies that management (or profit centre managers) need not be held accountable for (even) large declines in budgeted sales volumes. Yahya-Zadeh (2002) argued that measuring managerial and profit performance based on outdated standards has little informational value.

Table 5 summarizes the procedure for determining the ex post flexible budget. First, observe that the sales and production figures of the static budget in Table 5 are the results of an optimization problem. Optimal sales levels of products X and Y are the solutions to the following linear programming problem (LP 1):[2]

Maximize total contribution margin:
$22 X + $20 Y

Subject to:
Department 1 production constraint:
0.96 (1.10 X – 200) + 0.24 (1.10 Y – 400) ≤ 5,000
Department 2 production constraint:
0.2 (1.10 X – 200) + 0.8 (1.10 Y – 400) ≤ 4,000
Demand constraint: X + Y ≤ 7,600

The objective function of this problem is the total contribution margin of the firm from the sales of its two products. The firm has an inventory policy of setting ending inventory of each product to 10% of its current sales level.

Therefore, with 200 units of X in the beginning inventory, the expression (1.10 X – 200) represents the production volume of product X for the current year. Likewise, the expression (1.10 Y – 400) represents the production volume of product Y. The first production constraint states that total labour hours required to meet the production targets of the two products should not exceed the capacity of Department 1 (5,000 hours). Interpretation of the second constraint is similar.

The optimal solutions to this problem (after rounding) are: X= 4,143 and Y=3,457.

The budgeted ending inventories of the two products are:

Ending inventory of product X = 10% × 4,143 = 414

Ending inventory of product X = 10% × 3,457 = 346

To understand the remaining columns of Table 5 and the process of determining the *ex post flexible budget*, consider the timeline described below.

January 2:
The budget year starts. *Static budget* goes into effect. The static budget represents an optimal annual plan—a solution to the LP1 problem based on the latest sales forecasts and production information available at the start of the year.

December 31:
The LP optimization problem is solved a second time at the end of the year based on *actual* market and production conditions for the budget period just completed. This solution will be referred to as the *ex post flexible budget* (Table 5, solution to LP2). It represents the "*best course of action that management could have taken*" given the *actual* development of market and production conditions during the budget period.

[2] In practice, management of the firm may not explicitly solve a formal optimal problem as is shown here. But the outcome of the budgeting process is in some sense an optimal plan for the firm.

Table 4: Variance Computation: Balakrishnan and Sprinkle (2002) Approach

Item	Actual (actual sales and Actual inventory) (1)	Flexible Budget (actual sales and actual inventory) (2)	Flexible Budget (actual sales and budgeted inventory) (3)	Static Budget (budgeted sales and inventory levels) (4)
Sales Revenue [a]	$613,861	$615,796	$615,796	$620,402
Less Cost of goods sold:				
Beginning inventory [b]	39,146	39,146	39,146	39,146
+ Cost of goods manufactured [c]	550,446	550,446	525,242	529,568
− Ending inventory [d]	76,902	76,902	51,698	51,698
Unadjusted cost of goods sold	512,690	512,690	512,690	517,016
+ Fixed overhead spending variance	6,625	0	0	0
+ Cost of planned unused capacity [e]	2,627	2,627	2,627	2,627
+ Unplanned use of idle capacity [f]	2,407	2,407	403	0
Adjusted cost of goods sold	519,535	512,910	514,914	519,643
Gross Margin	$94,326	$102,886	$100,882	$100,759

$8,560 U — **Flexible-Budget Variance** (between columns 1 and 2)

$2,004 F — **Inventory-Change Variance** (between columns 2 and 3)

$123 F — **Sales-Volume Variance** (between columns 3 and 4)

Notes for Table 4 are on the following page

Table 4 Explanations

In this table, the LIFO inventory assumption is dropped as the unit costs in the beginning inventory and current period are identical. Overhead rate used in computation of both costs are based on practical capacity.

[a] Actual sales revenue = (3,814 × $86.50 + 3,786 × $75); Flexible budget revenue = (3,814 × $88 + 3,786 × $74); Static budget revenue = (4,143 × $88 + 3,457 × $74)

[b] Beginning inventory = (200 × $74.01 + 400 × $60.86)

[c] Cost of goods manufactured: Actual = (4,186 × $74.01 + 3,954 × $60.86); Flexible budget = (4,186 × $74.01 + 3,954 × $60.86); Flexible budget = (4,028 × $74.01 + 3,732 × $60.86); Static budget = (4,357 × $74.01 + 3,403× $60.86)

[d] Actual (and flexible budget) ending inventory = (572 × $74.01 + 568 × $60.86) = $76,902
Ending inventory under the static budget = (414× $74.01 + 346 × $60.86) = $51,698

[e] The computation of cost of planned unused capacity involves two steps:

- Cost of available (practical capacity) = $35,000 + $25,875 = $60,875
- Cost of planned used capacity under static budget = ((4,357 × 0.96 + 3,403 × 0.24) × $7.00 + (4,357 × 0.20 + 3,403 × 0.80) × $6.47) = $58,248

Planned cost of unused capacity = cost of available capacity – cost of used capacity under static budget = $60,875 – $58,248 = $2,627
This is an unfavourable variance, and should therefore be added to the unadjusted cost of goods sold.

[f] The computation of cost of unplanned over-utilization (or under-utilization) of idle capacity involves the following steps:

- Cost of used capacity for actual results (and flexible budget with actual sales and actual inventory) = (4,186 × 0.96 + 3,954 × 0.24) × $7.00 + (4,186 × 0.20 + 3,954 × 0.80) × $6.47 = $60,655
- Cost of unplanned use of idle capacity = Cost f used capacity – Cost of planned used capacity = $60,655 – $58,248 = $2,407 F.
- Cost of used capacity under flexible budget with actual sales and budgeted inventory = (4,028 × 0.96 + 3,732 × 0.24) × $7.00 + (4,028 × 0.20 + 3,732 × 0.80) × $6.47 = $58,651
- Cost of unplanned use of idle capacity = Cost f used capacity – Cost of planned used capacity = $58,651 – $58,248 = $403 F.
- Unplanned use of idle capacity is favourable for actual and flexible budget columns and, therefore, should be subtracted from the unadjusted cost of goods sold.

Table 5: Production and Inventory Levels under Budgeted, Actual, and Ex Post Flexible Budgets

Item	**Actual (AR)** (actual sales and inventory levels)		**Modified FB** (**ex post optimal** sales and **actual** inventory)		**Ex Post FB** **Ex Post Flexible Budget** (**optimal** sales and **optimal** inventory)		**Static Budget (SB)** (**ex ante optimal** sales and inventory levels)	
	X	**Y**	**X**	**Y**	**X**	**Y**	**X**	**Y**
Sales volume [a] (units)	3,814	3,786	3,527	4,073	3,527	4,073	4,143	3,457
Unit price ($)	$86.50	$75.00	$86.50	$75.00	$86.50	$75.00	$88.00	$74.00
Unit variable cost ($)	66.00	54.00	66.00	54.00	66.00	54.00	66.00	54.00
Unit throughput (or cont. margin) ($)	20.50	21.00	20.50	21.00	20.50	21.00	22.00	20.00
Beginning inventory (units)	200	400	200	400	200	400	200	400
Desired ending inventory (units)	572	568	572	568	353	407	414	346
Production volume (units)	4,186	3,954	3,899	4,241	3,680	4,080	4,357	3,403
Labour hours required in Dept. 1 per	0.96	0.24	0.96	0.24	0.96	0.24	0.96	0.24
Labour hours required in Dept. 2 per	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8

[a] Sales volumes under the Static Budget, Actual Results, and Ex Post Flexible Budget are, respectively, the solutions to the following three LP problems.

Let X and Y represent sales volume for Products X and Y:

LP 1. (SB)
Maximize total contribution margin: $22 X + $20 Y (Solution X=4,143; Y=3,457, Total contribution margin = $160,287)
Subject to:
Department 1 production constraint: $0.96\,(1.10\,X - 200) + 0.24\,(1.10\,Y - 400) \leq 5{,}000$
Department 2 production constraint: $0.2\,(1.10\,X - 200) + 0.8\,(1.10\,Y - 400) \leq 4{,}000$
Demand constraint: $X + Y \leq 7{,}600$

LP 2. (Ex Post FB)
Maximize total contribution margin: $20.50 X + $21 Y (Solution X=3,527; Y=4,073 Total contribution margin = $157,836)
Department 1 production constraint: $0.96\,(1.10\,X - 200) + 0.24\,(1.10\,Y - 400) \leq 5{,}000$
Department 2 production constraint: $0.2\,(1.10\,X - 200) + 0.8\,(1.10\,Y - 400) \leq 4{,}000$
Demand constraint: $X + Y \leq 7{,}600$

LP 3. (AR)
Maximize total contribution margin: $20.50 X + $21 Y (Solution X=3,814; Y=3,786, Total contribution margin = $157,693)

Subject to:
Department 1 production constraint: $0.96\,(1.15\,X - 200) + 0.24\,(1.15\,Y - 400) \leq 5{,}000$
Department 2 production constraint: $0.2\,(1.15\,X - 200) + 0.8\,(1.15\,Y - 400) \leq 4{,}000$
Demand constraint: $X + Y \leq 7{,}600$

Figure 1: Ex ante and Ex post Optimal Budget Targets

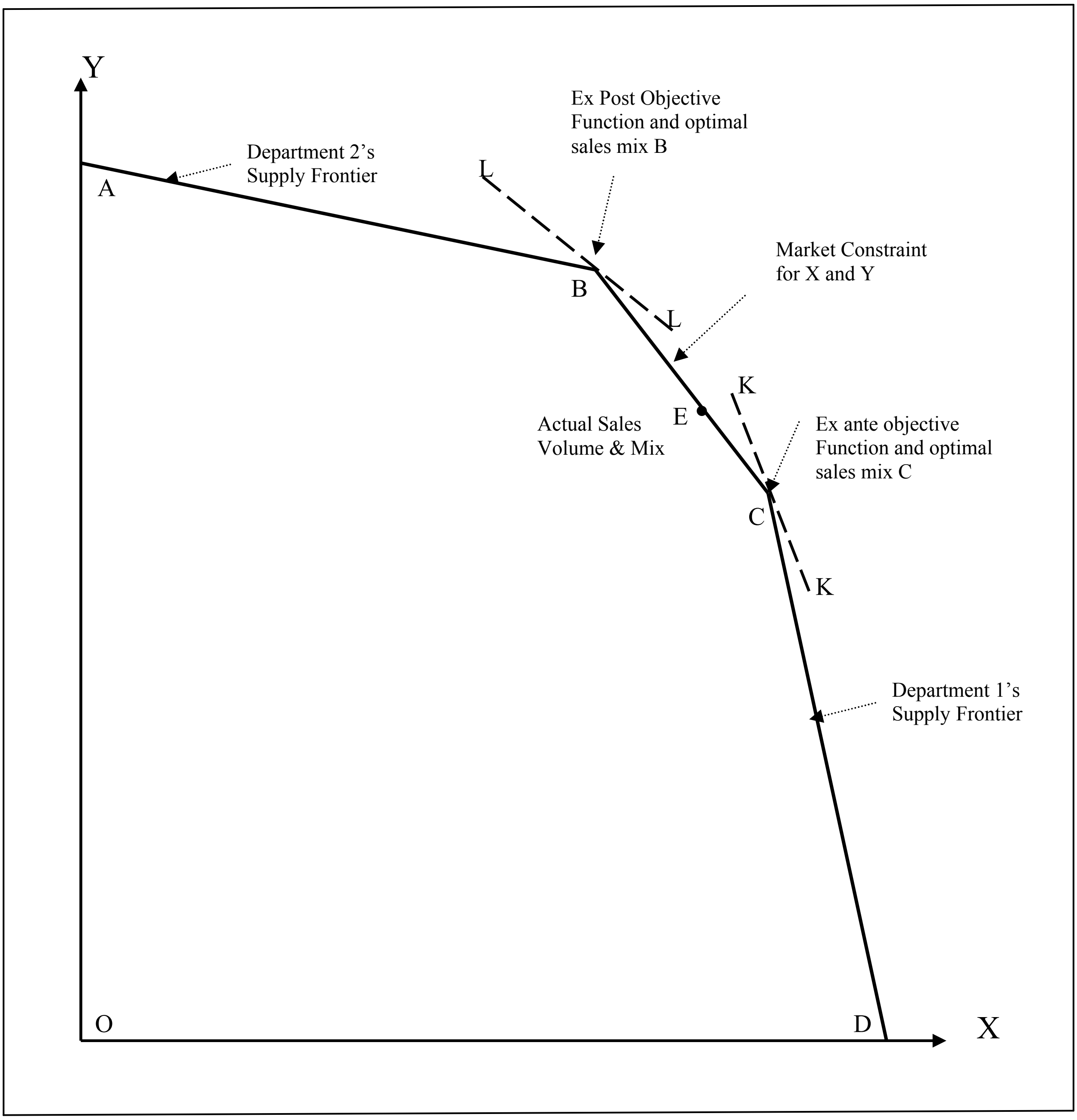


Figure 1 illustrates the solution to the above problem. Variables X and Y represent sales volumes of products X and Y. Lines CD and AB exhibit *budgeted supply frontiers* of Departments 1 and 2, respectively. Points along the line CD or below that represent the set of all possible sales volumes of the two products that can be produced and supplied to the market while observing production capacity limits and desirable ending inventory targets. Similar interpretation applies to line AB. The market constraint is represented by line BC. The linearity and continuity of lines AB and CD indicate that the two departments can process both products at any desired proportion and can switch from production of X to production of Y at no additional cost.

The firm starts the year by targeting sales levels represented by point C. Point C is the solution to LP 1 and represents the budgeted sales levels of products X and Y at the start of the year. Graphically, it is the intersection of (i) market constraint and (ii) Department 1's supply frontier. It also represents the point of tangency of equal-contribution-margin line, KK[3] to the feasibility area OABCD. Targeting point C as the optimal sales levels for the budget period implies that Department 1 operates at full capacity and Department 2 operates under capacity. At point C demand for company's products is met fully.

As the budget year progresses, market conditions change in favour of product Y. Assume that the best achievable prices for products X and Y were $86.50 and $75, respectively. Consequently they are chosen as the ex post budget prices relevant for profit variance analysis. As a result of this change in product prices, unit contribution margin of product X declines and that of Y increases. As relative unit contributions margins change, the slope of the line KK decreases. Running the linear programming problem a second time using the revised prices yields a new optimal solution represented by point B (see LP 2 in Table 5). The revised objective function in problem LP 2 is represented by line LL. Observe from Figure 1 that this change in optimal plan makes it necessary for Department 2 to operate at full capacity and for Department 1 to operate below capacity. Operating at point B maximizes the firm's total contribution margin under the new market and production conditions. Henceforth, point B will be referred to as the ex post optimal target and will be used as the basis for preparing the *ex post flexible budget*. Selling at any other point, including point A and all interior points of the area OABCD, would generate a lower contribution margin than operating at point B.

Observe in Figure 1 that the actual result (AR) is shown by point E. Point E is the solution to linear programming number 3 (Table 5, LP 3). The only purpose for setting up and for solving LP 3 is to ensure that point E is a feasible outcome. In practice, actual results could be any point in the interior of the area OABCD or on its boundaries. LP 3 assumes that actual prices obtained for products X and Y equal $86.50 and $75, respectively. These happen to be the ex post flexible budget prices for the two products, but they could be any other set of prices. Further, it assumes that management has intentionally raised its inventory percentage from 10% to 15%. Management made this change solely to boost reported earnings and had no legitimate business purpose for raising inventories beyond the budgeted 10%.

Profit Variance Analysis Using Ex Post Flexible Budget

The present study integrates the concept of ex post flexible budget developed by Yahya-Zadeh (2002) into the variance analysis framework developed by Balakrishnan and Sprinkle (2002). Table 6 details the proposed procedure using the present example. Let us examine the differences between the present study's approach and that of earlier studies by reviewing Table 6.

The actual results exhibited in Table 6 (Column 1) report a profit of $94,326. The static budget, shown in Column 4, reports a profit of $107,759. These amounts equal the respective amounts of Table 4. The ex post flexible budget is viewed in this study as the central budget for measuring all variances. Contrast this with the traditional approach and

[3] Equal-contribution-margin line represents the set of points (X,Y) resulting in equal contribution margin, given the budgeted output and input prices for the firm. One can replace the objective function to that of maximizing *throughput* to accommodate firms that follow Eli Godratt's *Theory of Constraints*.

Balakrishnan and Sprinkle (2002), both of which view the static budget as the key budget. The ex post flexible budget shown in Table 6 (Column 3) is a thorough revision of the static budget. Specifically, it revises the static budget sales volumes and prices to reflect the latest changes in market and production conditions. The revised sales volumes (3,527 units of X and 4,073 units of Y) are *optimal* in the sense that they are the solutions to the linear programming problem LP 2. Flexible budget's ending inventories (353 units of X and 407 units of Y) are also different from static budget ending inventories, yet they continue to be 10% of the respective flexible budget sales volumes. While the flexible budget of Table 4 reports a gross margin of $100,882, the ex post flexible budget of Table 6 reports a gross margin of $98,233.

The difference between the gross margin under ex post flexible budget and the gross margin of static budget is $2,525. This variance will be referred to as the *planning variance.* The planning variance measures the decline in budgeted gross margin resulting from a planning error. Top management should carefully examine and understand the causes of this variance to be able to control it in the future.

Column 2 is a modified version of ex post flexible budget. It retains the *optimal* sales volumes and mix, yet it adjusts the ending inventories of products X and Y to *actual* ending inventory levels. Column 2 reports a gross margin of $101,092. This represents an increase in gross margin over the ex post flexible budget by $2,859. This variance, named inventory-change variance, is the result of increasing production beyond optimal levels of the ex post flexible budget and creating excess inventory. It measures the unplanned use of idle capacity to increase production and inventory levels. Observe that inventory-change variance equals the cost of unplanned use of idle capacity in Column 2. The variance is favourable since it increases gross margin. Unplanned increase in inventory levels may be a deliberate management policy to boost earnings.

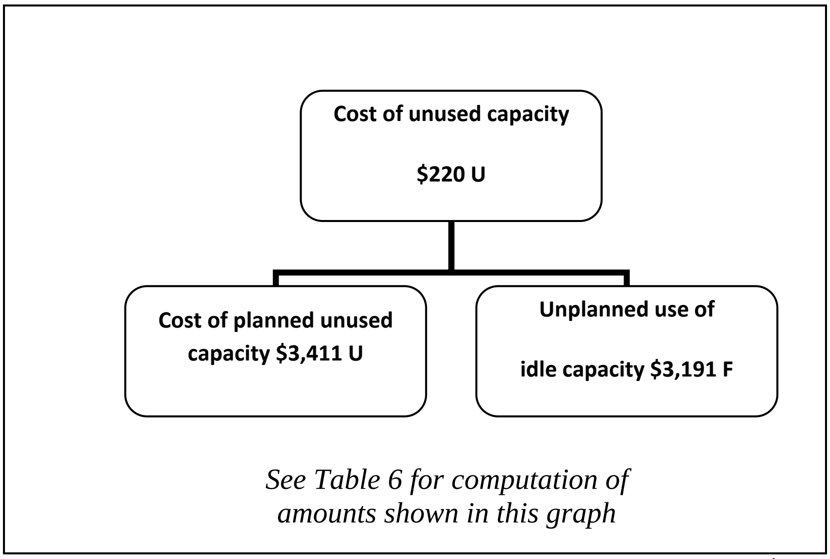
In fact, $2,859 equals the cost of fixed overhead placed into inventory account by increasing inventory levels beyond the ex post budgeted levels.[4]

As in Balakrishnan and Sprinkle (2002), the use of practical capacity to compute overhead rates allows the computation of cost of capacity variances. The firm's cost of capacity is the cost of making practical capacity of the two departments available for production. It is the sum of fixed overhead costs in the two production departments ($60,875). Cost of planned unused capacity occurs when budgeted capacity is less than practical capacity. Observe that the budgeted unused capacity under static budget is 407 hours (all in Department 2) and the related cost of planned unused capacity is $2,627 (407 × $6.47). In contrast, planned unused capacity under the ex post flexible budget is 488 hours (all in Department 1) with a cost of $3,411 (488 × $7.00). While Balakrishnan and Sprinkle (2002) report the cost of planned unused capacity on the basis of unused capacity incorporated into the static budget ($2,627), the present study reports the cost of unused capacity provided for in the ex post flexible budget ($3,411).

An increase in ending inventory levels beyond levels planned in the ex post flexible budget gives rise to a favourable *unplanned use of idle capacity*. If production and ending inventory fall short of budgeted levels, the unplanned use of idle variance would be unfavourable. To illustrate this concept, note that the cost of planned capacity usage under the ex post budget is $57,464 ((3,680× 0.96 + 4,080 × 0.24) × $7.00 + (3,680 × 0.20 + 4,080 × 0.80) × $6.47). On the other hand, the cost of actual capacity usage is $60,655 (4,186 × 0.96 + 3,954 × 0.24) × $7.00 + (4,186 × 0.20 + 3,954 × 0.80) × $6.47). Therefore, unplanned use of idle capacity shown in Column 1 is $3,191 ($60,655 – $57,464).

[4] To see this, subtract the cost of fixed overhead in ending inventory of Column 2 from the cost of fixed overhead in the ending inventory of Column 3. Cost of fixed overhead in ending inventory of Column 2 is $8,478 (572 × $8.01 + 568 × $6.86). Cost of fixed overhead in the ending inventory of Column 3 is $5,619 (353 × $8.01 + 407 × $6.86). Inventory-change variance equals the difference between these amounts ($2,859 = $8,478 - $5,619).

Figure 2: Cost of Capacity Variances



Management and the divisional manager can boost earnings by increasing production and ending inventory levels. Doing so would lead to a favourable unplanned use of idle capacity and reduces the adjusted cost of goods sold. Under the traditional approach, the profit impact of planned unused capacity and that of unplanned use of idle capacity are netted against each other making it hard for management to uncover unplanned buildup of inventories at the divisional or company level. The proposed method reports these variances separately and facilitates management's decision making.

Comparing Tables 4 and 6, it is difficult to highlight optimality of the ex post flexible budget. The traditional flexible budget of Table 4 produces $615,796 of sales revenue and $100,882 of gross margin whereas the ex post flexible budget delivers only $610,561 of sales revenue and $98,233 of gross margin. Tables 4 and 6 cannot be directly compared directly because they make different assumptions about product prices. Table 7 presents figures that are comparable and help differentiate between the traditional and the ex post flexible budgets. Two features of Table 7 are worth noticing. First, it focuses on contribution margin rather than on gross margin. Second, it uses the ex post optimal prices of $86.50 and $75 to compute comparable sales revenue for all four columns. Table 7 clearly demonstrates that the ex post flexible budget, shown in Column 2, generates the greatest contribution margin and net income and is, therefore, the optimal budget.

Measuring Capacity Costs at the Departmental Level

So far the analysis of capacity costs (planned and unplanned usages) has been limited to the company as a whole. With the introduction of ex post flexible budget, examining capacity costs at departmental level can add insight to the analysis. Table 8 details capacity cost computations. In both panels of Table 8, practical capacity is the key concept. If planned production and inventory levels utilize 100% of existing practical capacity, then the cost of planned unused capacity is zero. In Panel A, Department 1 is planned to operate at full capacity (5,000 hours) and Department 2 is budgeted to operate under capacity ((3,593 hours). Consequently costs of planned unused capacity in Departments 1 and 2 are, respectively, $0 and $2,626. In Department 1, the unplanned use of idle capacity is 32 hours. This indicates that actual capacity usage was less than budgeted capacity usage. Unplanned use of idle capacity in Department 2, on the other hand, is 406 hours. Thus, while the static budget provides for Department 2 to operate under capacity, actual outcome indicates that it operated at full capacity. In Department 2, the cost of unplanned use of idle capacity ($2,627) fully offsets the cost of planned unused capacity.

Table 6: Variance Computations Based on Ex Post Flexible Budget and Practical Capacity as the Denominator

Item	Actual (actual sales and inventory levels) (1)	Modified Flexible Budget (optimal sales and actual inventory) (2)	Ex Post Flexible Budget (optimal sales and optimal inventory) (3)	Static Budget (budgeted sales and budgeted inventory) (4)
Sales Revenue [a]	$613,861	$610,561	$610,561	$620,402
Less Cost of goods sold:				
Beginning inventory [b]	39,146	39,146	39,146	39,146
+ Cost of goods manufactured [c]	550,446	546,672	520,666	529,568
− Ending inventory [d]	76,902	76,902	50,896	51,698
Unadjusted cost of goods sold	512,690	508,916	508,916	517,016
+ Fixed overhead spending variance [e]	6,625	0	0	0
+ Cost of planned unused capacity [f]	3,411	3,411	3,411	3,411
− Unplanned use of idle capacity [g]	3,191	2,859	0	784
Adjusted cost of goods sold	519,535	509,468	512,327	519,643
Gross Margin	$94,326	$101,092	$98,233	$100,759

Flexible Budget Variance (1)–(2): $ 6,766 U

Inventory Change Variance (2)–(3): $2,859 F

Planning Variance (3)–(4): $2,525 U

Notes for Table 6 are on the following page.

Table 6 Explanations

[a] Actual sales revenue = (3,814 × \$86.50 + 3,786 × \$75); Flexible budget revenue = (3,527 × \$86.50 + 4,073 × \$75); Static budget revenue = (4,143 × \$88 + 3,457 × \$74)

[b] Beginning inventory = (200 × \$74.01 + 400 × \$60.86)

[c] COGM: Actual = (4,186 × \$74.01 + 3,954 × \$60.86); Flexible budget = (3,527 × \$74.01 + 4,072 × \$60.86); Static budget = (4,357 × \$74.01 + 3,403 × \$60.86)

[d] Ending inventory: Actual = (572 × \$74.01 + 568 × \$60.86) ; Modified flexible budget = (572 × \$74.01 + 568 × \$60.86)
Ex post flexible budget = (353 × \$74.01 + 407 × \$60.86); Static budget = (414× \$74.01 + 346 × \$60.86)

[e] Fixed overhead spending variance = \$37,500 + \$30,000 – \$35,000 – \$25,875 = \$6,625 U

[f] The computation of cost of planned unused capacity involves two steps:

- Cost of planned used capacity under ex post flexible budget = ((3,680 × 0.96 + 4,080 × 0.24) × \$7.00 + (3,680 × 0.20 + 4,080 × 0.80) × \$6.47) = \$57,464
- Planned cost of unused capacity =cost of available capacity – cost of used capacity under static budget = \$60,875 – \$57,464 = \$3,411 This amount remains unchanged under the other columns.

[g] The computation of cost of unplanned over-utilization (or under-utilization) of idle capacity involves the following steps:

- Actual cost of used capacity = (4,186 × 0.96 + 3,954 × 0.24) × \$7.00 + (4,186 × 0.20 + 3,954 × 0.80) × \$6.47 = \$60,655
- Cost of unplanned use of idle capacity = Cost f used capacity – Cost of planned used capacity = \$60,655 – \$57,464 = \$3,191 F.
- Cost of used capacity under modified flexible budget = (3,899 × 0.96 + 4,241 × 0.24) × \$7.00 + (3,899 × 0.20 + 4,241 × 0.80) × \$6.47 = \$60,323
- Cost of unplanned use of idle capacity = Cost f used capacity – Cost of planned used capacity = \$60,323 – \$57,464 = \$2,859 F.
- Cost of used capacity under static budget = ((4,357 × 0.96 + 3,403 × 0.24) × \$7.00 + (4,357 × 0.20 + 3,403 × 0.80) × \$6.47) = \$58,248
- Cost of unplanned use of idle capacity = Cost f used capacity – Cost of planned used capacity = \$58,248 – \$57,464 = \$784 F.

Table 7: Comparison of Contribution Margins Indicating the Optimality of Ex Post Flexible Budget

	Actual (actual sales and actual inventory and actual prices)	Ex Post Flexible Budget (optimal sales and optimal Inventory and actual prices)	Ex Ante Flexible Budget (actual sales and actual inventory and actual price)	Static Budget (budgeted sales and inventory and actual prices)
Item	**(1)**	**(2)**	**(3)**	**(4)**
Sales Revenue [a]	$613,861	$610,561	$613,861	$617,644
Less: Variable Cost of goods sold [b]	456,168	452,724	456,168	460,116
Total Contribution Margin	157,693	157,836	157,693	157,528
Less: Total Fixed Overhead [c]	67,500	60,875	60,875	60,875
Net Income	$90,193	$96,961	$96,818	$96,653

[a] Actual sales revenue = (3,814 × $86.50 + 3,786 × $75); ex ante flexible budget revenue = (3,814 × $86.50 + 3,786 × $75); ex post flexible budget revenue (3,527 × $86.50 + 4,073 × $75); static budget revenue = (4,143 × $86.50 + 3,457 × $75).
[b] Actual COGS = (3,814 × $66 + 3,786 × $54); ex ante flexible budget COGS = (3,814 × $66 + 3,786 × $54); ex post flexible budget COGS (3,527 × $66 + 4,073 × $54); static budget COGS = (4,143 × $66 + 3,457 × $54).
[c] Actual total fixed costs = $37,500 + 30,000); Budgeted total fixed overhead costs = ($35,000 + $25,875).

JAMAR 78 Vol. 9 · No. 2 · 2011

Table 8: Capacity Costs at Departmental Levels

Panel A: Capacity Costs Using Static Budget

	Department 1		Department 2		Company
	Hours	***Dollars***	***Hours***	***Dollars***	***Totals***
Practical capacity	5,000	$35,000	4,000	$25,875	$60,875
Planned unused capacity (hours)	0	$0	(406)	(2,626)	(2,626)
Budgeted capacity usage (static budget)	5,000	35,000	3,594	23,249	58,249
Unplanned use of idle capacity	(32)	(224)	406	2,626	2,402
Actual capacity utilization	4,968	34,776	4,000	25,875	60,651

Panel B: Capacity Costs Using Ex Post Flexible Budget

	Department 1		Department 2		Company
	Hours	***Dollars***	***Hours***	***Dollars***	***Totals***
Practical capacity	5,000	$35,000	4,000	$25,875	$60,875
Planned unused capacity (hours)	(488)	(3,416)	0	0	(3,416)
Budgeted capacity usage (ex post flexible budget)	4,512	31,584	4,000	25,875	57,459
Unplanned use of idle capacity	456	3,192	0	0	3,192
Actual capacity utilization	4,968	34,776	4,000	25,875	60,651

JAMAR Vol. 9 · No. 2 · 2011

In Panel B, ex post flexible budget is the base line for computation of capacity variances and costs. If market prices change during the year by a sufficiently large amount, it is possible for the *optimal* sales volume and mix to change so that static budget sales targets are no longer optimal (see Figure 1). Panel B has the capability to highlight such target changes via capacity cost computations. In Panel B, budgeted capacity usage refers to planned usage of capacity under the ex post budget. It indicates that under the ex post flexible budget management should operate Department 2 at full capacity and Department 1 under capacity. The Balakrishnan and Sprinkle (2002) approach focuses on capacity costs at the company level and by doing so overlooks the extensive repositioning of the optimal departmental plans.

Discussion and Conclusion

This study extends earlier studies from management accounting and marketing literature and offers a new framework for analysing inventory variances and capacity costs in a firm with several products and several departments. It integrates the concept of ex post flexible budget into a well-developed technique for inventory variance and capacity cost analysis. The concept of ex post flexible has been adopted directly from Yahya-Zadeh (2002) and the methodology used for computation of inventory variances and capacity costs is an extension of Balakrishnan and Sprinkle (2002). This study's proposed framework, however offers the following distinct advantages:

1. Traditional (ex ante) flexible budget is replaced with ex post flexible budget, which plays a central role in profit variance analysis. It introduces an element of optimization into the budgeting procedure and enables management to see the cost of inadequate planning. Comparing Columns 3 and 4 of Table 6, it is clear that of the $6,433 ($100,759 – $94,326) unfavourable variance in gross margin, $2,525 resulted from the untenable assumptions of the static budget under changing market conditions.

2. The proposed framework for variance analysis also highlights the cost of management's failure to swiftly respond to the changing environment by changing its production plans. In Table 6, of the total unfavourable variance of $6,433, an amount of $3,907 ($98,233 – $94,326) is the direct result of the failure to swiftly change actual production plans in the direction of the ex post optimal budget.

3. The profit impact of unplanned changes in inventory levels is also highlighted. Management's decision to boost income by increasing ending inventories beyond planned levels resulted in a favourable inventory-change variance of $2,859. Stated differently, the unfavourable flexible budget gross margin variance would have been $2,859 greater, had management not increased inventory levels.

4. As in earlier studies, the cost of unused capacity and the cost of unplanned use of idle capacity are highlighted on the income statement. Additionally, these costs are reported at the department level. Under this approach, a planned reduction in production in one department (Department 1) must not be viewed as an unfavourable variance. Likewise, a planned increase in production of another department (Department 2) should not be viewed as an effort to unjustifiably build up inventory. Such reporting should be helpful to management in identifying if departmental managers have reacted properly in response to market changes. It may also facilitate management of capacity costs by highlighting departments that frequently report large costs under the heading of planned unused capacity.

5. The new framework makes it possible to integrate the widely practiced operational tool of linear programming into equally widely used financial control tool of variance analysis. It enables management to better understand the cost impact of their operational decisions. It enables accountants to better interpret variances in light of operational necessities.

6. Pedagogically, the proposed framework enables instructors and students to integrate apparently unrelated

management functions such as accounting marketing, and operations. Additionally, it provides a comprehensive exercise dealing with variances, absorption costing, variable costing, and the interrelationship between income statement and balance sheet accounts.

The model presented in this study can be set up in a spreadsheet format for teaching purposes and small-scale practice projects. Large-scale application of this model too, is possible, given the power of today's computing technology and the demand for more dynamic budgeting and control procedures. Linear programming is widely used by operations departments and its integration into the budgeting procedures can only benefit management accountants by making their work relevant and timely for operations and marketing decisions. Recent applied accounting literature indicates an interest in measuring variances relative to industry performance standards. Mudde and Sopariwala (2008) and (2011) measure variances for Southwest Airlines and American Airlines relative to U.S. airline industry with *ex post information.* Among other variances, they measure productivity and capacity underutilization variances. Such studies demonstrate a promising outlook for the application of the approach proposed in the current study.

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