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THREE-WAY ANALYSIS OF LABOR COST VARIANCE

Rosita S. Chen

INTRODUCTION

In the accounting literature, much has been written about variance analysis. Variance is generally thought of as the deviation of the actual results from the budget which, in turn, is a quantified plan for future business activities. The budget can be a useful tool only if it is properly applied. Otherwise, it can turn out to be a deterrent to the efficiency of production.

In practice, many managers would be satisfied with a performance report in which actual costs are compared with the static budget for a pre-determined single level of business activity. It is contended, however, that variance analysis based on the static budget has limited value in that it reveals only the difference between the observed and the *ex ante* results, and tends to combine deviations due to various factors into a single variance. As a remedy, the concept of flexible budgeting has been introduced and is gaining popularity. The main contribution of the flexible budgeting concept is the recognition of *ex post* results reflecting what the firm should have planned to do with perfect information about the actual level of activity. Incorporating *ex post* results into the system, cost variances are determined on the basis of three sets of data: the *ex ante*, the observed, and the *ex post*. Demske noted [3, p. 702]:

> The difference between *ex ante* and *ex post* results is a crude measure of the firm's forecasting ability. It is the difference between what the firm planned to do during the particular period and what it should have planned to do. Similarly, the difference between *ex post* and observed results is the difference between what the firm should have accomplished during the period and what it actually did accomplish.

The traditional method to obtain *ex post* results is to apply the predetermined standard cost per unit to the units actually produced. This approach implies that, while the activity levels are considered flexible, the standard cost is still static. This paper attempts to (1) point out the deficiency of the use of the static standard cost, and (2) explore the desirability of conducting variance analysis on the basis of flexible standard costs. For simplicity, the present discussion is limited to direct labor cost. The same logic, however, is also applicable to other cost elements, such as direct materials and variable overhead expenses.

THE TRADITIONAL METHOD OF VARIANCE ANALYSIS

The traditional method of variance analysis starts from the establishment of cost standards as well as the identification of expected levels of activity. Once the actual activity level is known, a flexible budget can be prepared accordingly to serve as a benchmark for labor performance measurement. The difference between the actual cost and the flexible budget is usually dichotomized into wage rate and efficiency variances as follows:

$V_w = H_a(r - R)$ .... (1)
$V_e = R(H_a - H_s)$ .... (2)

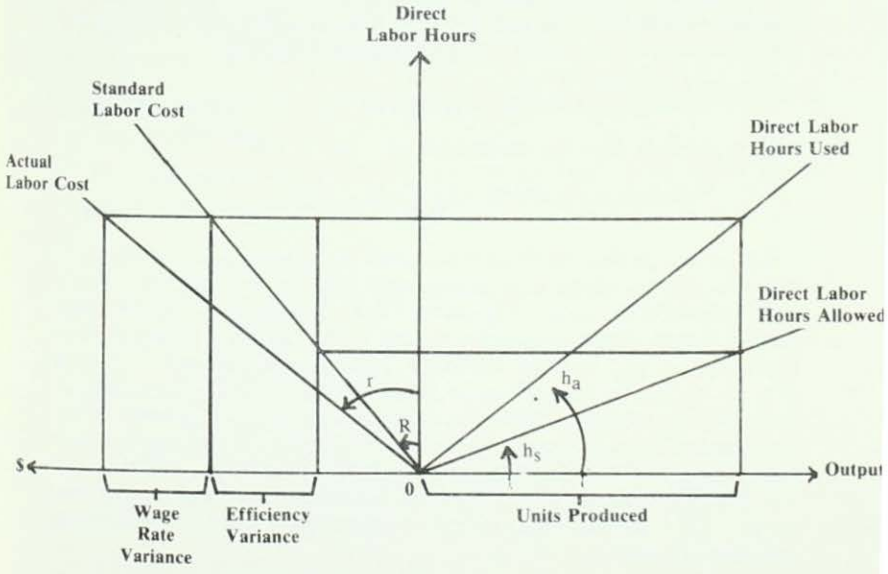
Where: V_w = wage rate variance
V_e = efficiency variance
H_a = direct labor hours used
H_s = direct labor hours allowed for actual level of output
R = standard wage rate per hour
r = actual wage rate per hour

These two variances are depicted graphically in Figure 1.

It should be noted that the efficiency variance is a function of the predetermined standard. Underlying this method is the assumption that there is no learning effect contributing to the variance so that the predetermined static standard can be invariably applied. This implicit assumption, however, is challenged by a series of empirical reports indicating the occurrence of a significant learning effect in certain labor intensive industries. [1], [2], [4]. Given the significant effect of learning, the traditional method of performance evaluation is unsatisfactory, because learning effect is largely beyond the control of workmen.

Figure 1

The Traditional Method of Variance Analysis



where h_s = standard hours per unit of output

h_a = direct labor hours used per unit of output

THE LEARNING CURVE APPROACH TO VARIANCE ANALYSIS

T. P. Wright was apparently the first writer to formulate into theory the principle of decreasing labor hours as the number of airframes produced is increased. He is still the most frequently quoted authority on the subject. According to him, the relationship between average labor hours and cumulative number of airframes produced could be expressed by the function: [1, pp. 15-20], [4].

$$\bar{Y} = ax^{-b} \quad (3)$$

where:

$\bar{Y}$ = cumulative average direct labor hours

x = cumulative units of output

a = direct labor hours for the first unit of output

b = absolute value of the slope of the learning curve, indicating the ratio of the average labor hours at two different cumulative outputs

In addition to equation (3), there is another expression of the learning curve theory relating cumulative total labor hours with cumulative output:

$$Y = \bar{Y}x = ax^{1-b} \quad (4)$$

where:

Y = total labor hours

Assume that the total labor time for the first ten units is 10,000 hours and that for the first nine units is 9,000 hours, the time for the tenth unit must be 10,000 - 9,000 = 1,000 hours. If Y_B represents the total hours for a cumulative output of x_B, and Y_{A-1} is the total labor hours for a cumulative output of x_{A-1}, with B>A, then the labor hours for the output from A to B, inclusive, must be: [2, pp. 178-182]

$$Y_{A \to B} = ax_B^{1-b} - a(x_A - 1)^{1-b}$$
$$= a[x_B^{1-b} - (x_A - 1)^{1-b}] \quad (5)$$

and the average time for the output $x_B - x_A + 1$ is

$$\bar{Y}_{A \to B} = Y_{A \to B}/(x_B - x_A + 1)$$
$$= [a/(x_B - x_A + 1)]\,[x_B^{1-b} - (x_A - 1)^{1-b}] \quad (6)$$

Equations (5) and (6) show that, given a, b, and x_A, a change in x_B will result in a change in both the total and the average labor hours, reflecting different levels of learning effect. Assume that, for the budget period, the expected cumulative output is x_B, the total budgeted labor time ($\bar{Y}_{A \to B}$), and the standard labor hours per unit of output ($\bar{Y}_{A \to B}$) will be determined by equations (5) and (6), respectively. If, however, the actually achieved cumulative output is $x_{B'}$, instead of x_B, the learning curve approach would suggest that the labor time standard should be modified in light of the actually achieved output and the resultant expected learning effect. The difference between the *ex ante* and the *ex post* labor time standards should be identified as a measure of learning variance as follows:

$$\text{Learning Variance (in hours)} = (\bar{Y}_{A \to B'} - \bar{Y}_{A \to B})\,(x_{B'} - x_A + 1) \quad (7)$$

Where $\bar{Y}_{A \to B'}$ is the cumulative average direct labor hours for the output $x_{B'} - x_A + 1$. It is essentially the *ex post* labor time standard, in contrast with $\bar{Y}_{A \to B'}$ the *ex ante* labor time standard.

Following the accounting tradition, the learning variance in hours can be transformed into learning variance in dollars by incorporating the standard wage rate into the equation:

$$V_1 = R(\overline{Y}_{A \to B'} - \overline{Y}_{A \to B})(x_{B'} - x_A + 1) \quad (8)$$

Where:

V_1 = learning variance (in dollars).

After identifying the effect of learning, a 2-way variance analysis can be applied on the basis of $\overline{Y}_{A \to B'}$, the flexibly budgeted labor hours for the actual level of output:

$$V_W = \hat{Y}_{A \to B'}(r - R) \quad (9)$$

$$V_P = R(\hat{Y}_{A \to B'} - Y_{A \to B}) \quad (10)$$

Where:

$\hat{Y}_{A \to B'}$ = actual labor hours for the output of $x_{B'} - x_A + 1$

$Y_{A \to B'}$ = flexibly budgeted labor hours for the actual output (see Eq. (5)).

r = actual wage rate per hour

R = standard wage rate per hour

V_W = wage rate variance

V_P = labor performance variance

The above three variances are depicted graphically in Figure 2. A comparison between Figures 1 and 2 shows that the suggested three-way variance analysis differs from the traditional method in that the traditional efficiency variance is dichotomized into learning and performance variances in order to recognize the effect of learning. The performance variance under the learning curve approach is thus a measure of the deviation of the actual labor hours from that allowed based on both the flexible output and the flexible standard.

THE LEARNING CURVE APPROACH TO VARIANCE ANALYSIS — AN EXAMPLE

To demonstrate the feasibility of the learning curve approach to variance analysis, the following hypothetical data are given:

a = 10,000 hours

b = 0.32 (indicating an 80 percent learning curve)

x_A = 6 units

x_B = 25 units

$x_{B'}$ = 15 units

R = \$2.0

r = \$2.1

$\hat{Y}_{A \to B'}$ = 32,000 hours

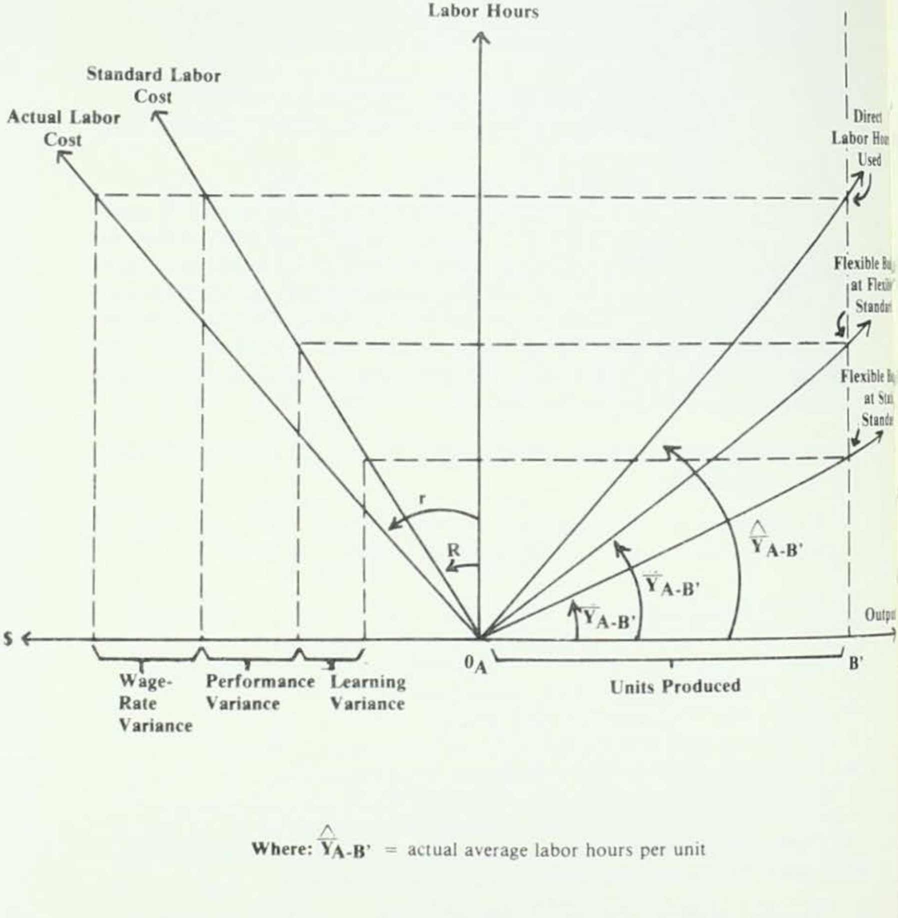
Then, following equations (5) and (6), the following figures can be derived:

$$Y_{A \to B} = 10{,}000\,[25^{1-0.32} - (6-1)^{1-0.32}]$$
$$= 59{,}374 \text{ hours} \quad \text{See Eq. (5)}$$

$$Y_{A \to B} = 10{,}000\,[15^{1-0.32} - (6-1)^{1-0.32}]$$
$$= 33{,}184 \text{ hours} \quad \text{See Eq. (5)}$$

Figure 2

Three-Way Approach to Variance Analysis



Where: $\hat{Y}_{A-B'}$ = actual average labor hours per unit

$\overline{Y}_{A \to B}$ = 59,374/(25 - 6 + 1)
= 2,968.70 hours........................See Eq. (6)

$\overline{Y}_{A \to B'}$ = 33,184/(15 - 6 + 1)
= 3,318.40 hours........................See Eq. (6)

Finally, the three variances can be determined by the use of Equations (8), (9) and (10):

V_1 = \$2.0 (3,318.40 - 2,968.70) (15 - 6 + 1)
= \$6,994 unfavorable........................See Eq. (8)

V_w = 32,000 (\$2.1 - \$2.0)
= \$3,200 unfavorable........................See Eq. (9)

V_P = \$2.0 (32,000 - 33,184)
= (\$2,368) favorable........................See Eq. (10)

CONCLUDING REMARKS

In the foregoing, it was demonstrated that, when production costs follow the learning curve phenomenon, the use of flexible standard will result in a better matching of actual costs against expectations than does a static standard. It follows that the flexible standard could provide a more reasonable basis for variance analysis than its counterpart. Evidence shows that, not only labor costs, but also direct materials and variable overhead expenses follow the phenomenon of learning curve. [1], [4] Therefore, it is believed that the proposed three-way variance analysis is feasible and desirable to be applied to all cost elements, except probably fixed overhead.

REFERENCES

1. Harold Asher, *Cost-Quantity Relationships in the Airframe Industry* (Santa Monica, Cal.: The Rand Corporation, 1956).
2. A. B. Berghell, *Production Engineering in the Aircraft Industry* (New York: McGraw-Hill Book Company, Inc., 1944).
3. Joel S. Demski, "An Accounting System Structured on a Linear Programming Model," *The Accounting Review* (October, 1967), pp. 701-12.
4. T. P. Wright, "Factors Affecting and Cost of Airplanes," *Journal of The Aeronautical Sciences* (February, 1936), pp. 122-28.

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