MIX VARIANCES IN PROFIT RATE ANALYSIS

The Essence Of The Problem Is One Of

"Volume and Mix"

By Frank Warthen

The cost of a product is not always the same percentage of its gross sales price as the cost of some other item (in the same product line) is to its selling price. The profitability (profit rate) of any product line, therefore, is affected by changes in the proportion of sales achieved by each product. The essence of the problem is one of "volume and mix." Traditional analyses of gross profit variances have usually lumped volume and mix into one aggregate and indistinguishable sum. The emphasis of this article is on distinguishing between "volume" and "mix." The ultimate reason for making this distinction between the two variances is that mix affects profit rates whereas volume does not.

The mix variance is somewhat like the price and cost variances in that it can be objectively measured – product by product. Mix variance relates the performance of each product to the product line of which it is a part, i.e., it is a function of both actual total sales performance and the mix performance of the individual product.

It could well be asserted that the mix variance is more important than the price and cost variances because it occurs more frequently and, unlike price and cost variances, it even exists when an unbudgeted product is sold. In other words, the ability to explicitly recognize the

mix variance of each product will enable us to perform an in-depth post-audit of the profit plan at any time.

Exhibit 1 shows the “actual versus budget” relationships which must be considered for any product within a product line. The individual product can have an intrinsically higher or lower budgeted profit rate than that budgeted for the product line aggregation. In terms of actual results, the product can have a higher or lower proportion of total sales than was originally budgeted. There are two possible outcomes for any product (favorable or unfavorable) and the purpose of the algorithm is to identify the situation and accurately quantify it.

The Algorithm

Each product has certain unique properties which can cause variances:

1. Its own profit rate - which bears some influence upon and relationship to the profit rate of the product line of which the product is a part.
2. Its own budget and actual sales volume
3. Its own budget and actual sales mix

Product Variances

In Exhibit 2, we analyze the variances associated with products within a particular product line. The input data consists of the budgeted and actual gross sales and profit rates. The sales mix (budget and actual) is not really a separate input; it is a direct consequence of the sales volume and is shown for convenience only. Because the price and cost variances have been eliminated (for illustrative purposes only), the budget and actual profit rates of each of the three products comprising the product line show no variance. However, the actual profit rate of the product line has dropped by 20 percentage points and it is this variance which we will explain.

The first step consists of calculating the "isolated" volume variance of each of the three products. This is merely the difference between the actual sales and the budgeted sales at the budgeted gross profit rate. It is the volume variance which would exist for each product if it stood alone and were not considered as part of any product line.

In the second step, which is critical and provides the ultimate analytical key, the difference in mix (actual versus budget) is extended at the profit rate differential (for each product) and the compound result is then extended by the actual total gross sales of the product line.[1] The final

result of this second step gives us the product mix variance of each product and, in total, of the product line. Not only do we know that the 20 percent decline in profit rate caused a $40,000 decline in gross profit at the actual gross sales volume of $200,000 - we know the origins of that mix variance on a product by product basis.

[1] The profit rate differential, as indicated by the product mix matrix of Exhibit 1, is simply the arithmetic comparison of the gross profit rate of each product with the budgeted aggregate gross profit rate of the product line (63 percent in the case of the product line shown in exhibit 2).

The third step completes the calculation. We simply adjust each “isolated” volume variance to product volume variance by subtracting the product mix variance from the “isolated” volume variance. The characteristic of the number which we call the product volume variance is that it is the portion of the “isolated” volume variance of each product which did not have any impact on the gross profit rate of the product line - that portion of each product’s actual volume which did nothing to alter the gross profit rate of the product line away from its budgeted 63 percent.

The methodology shown in Exhibit 2 gives us the algorithm for explicitly recognizing both volume and mix variances and doing it on a product by product basis. The keystone of the analysis is the “Mix difference x Profit rate

differential” and we could well call the result the “Compound profit/Mix derivative.” The “Compound profit/Mix derivative” is the dynamic operative of the algorithm and after it has been determined, each of the product mix variances is a linear function of the same number - actual total gross sales.

The data in Exhibit 2 can now be interpreted in terms of Exhibit 1. For example, Product A has a profit rate lower than that budgeted for the product line (60 percent versus 63 percent) and an achieved sales mix (actual equals budgeted equals 10 percent). The product mix variance would thus be zero.

The product mix variance for Product B is unfavorable. Product B has a profit rate lower than that budgeted for the product line (30 percent versus 63 percent), and it achieves a higher sales mix than budgeted (30 percent budgeted, 70 percent actual).

Product C also occupies an unfavorable segment of the product mix matrix but for a different reason. It has a higher profit rate than that budgeted for the product line (80 percent versus 63 percent), but it has a lower sales mix than budgeted (60 percent budgeted, 20 percent actual).

Product Line Variances

In Exhibit 3 we carry the analysis to the next level of organizational hierarchy. We look at a division which contains three product lines - two in addition to the product line which we analyzed in Exhibit 2. The methodology used in the analysis is exactly the same as that used in Exhibit 2. Exhibit 3 shows how we can use the algorithm to show the change in profit rate of a division which occurs because of the variance of the mix of product lines which make up the division.

Divisional Summary

Exhibit 4 is a complete summary of divisional activity affecting profit rate. The 2.7 percent profit rate reduction at actual total divisional sales of $1,000,000 is an unfavorable $27,000. The unfavorable $27,000 is composed of the unfavorable $40,000 of product mix variance from Product Line #1 which has been partially offset by $13,000 of favorable product line mix variance. Product Lines #2 and #3 did not experience any change in profit rate from budget to actual.

Practical Implementation

Considering the complexity outlined here - covering, perhaps, thousands of products and hundreds of product lines-it is obvious why the computer must be harnessed to the task. This time, however, the computer will be providing far more than another intriguing mass of numbers. Equipped with a computer which can process this easily programmable algorithm, the knowledgeable controller can now pinpoint all facets of the achievement (or lack thereof) of the most important single piece of the profit plan - the product sales budget and its gross profit rate.

Conclusion

The analysis is completely flexible because it can be applied at any level of the organizational hierarchy. The important point is that every single factor affecting the profit rate of an organization can be traced precisely to its origin. The significance of this type of reporting cannot possibly be overstated.

Exhibit 1

PRODUCT MIX MATRIX
GROSS PROFIT EFFECTS

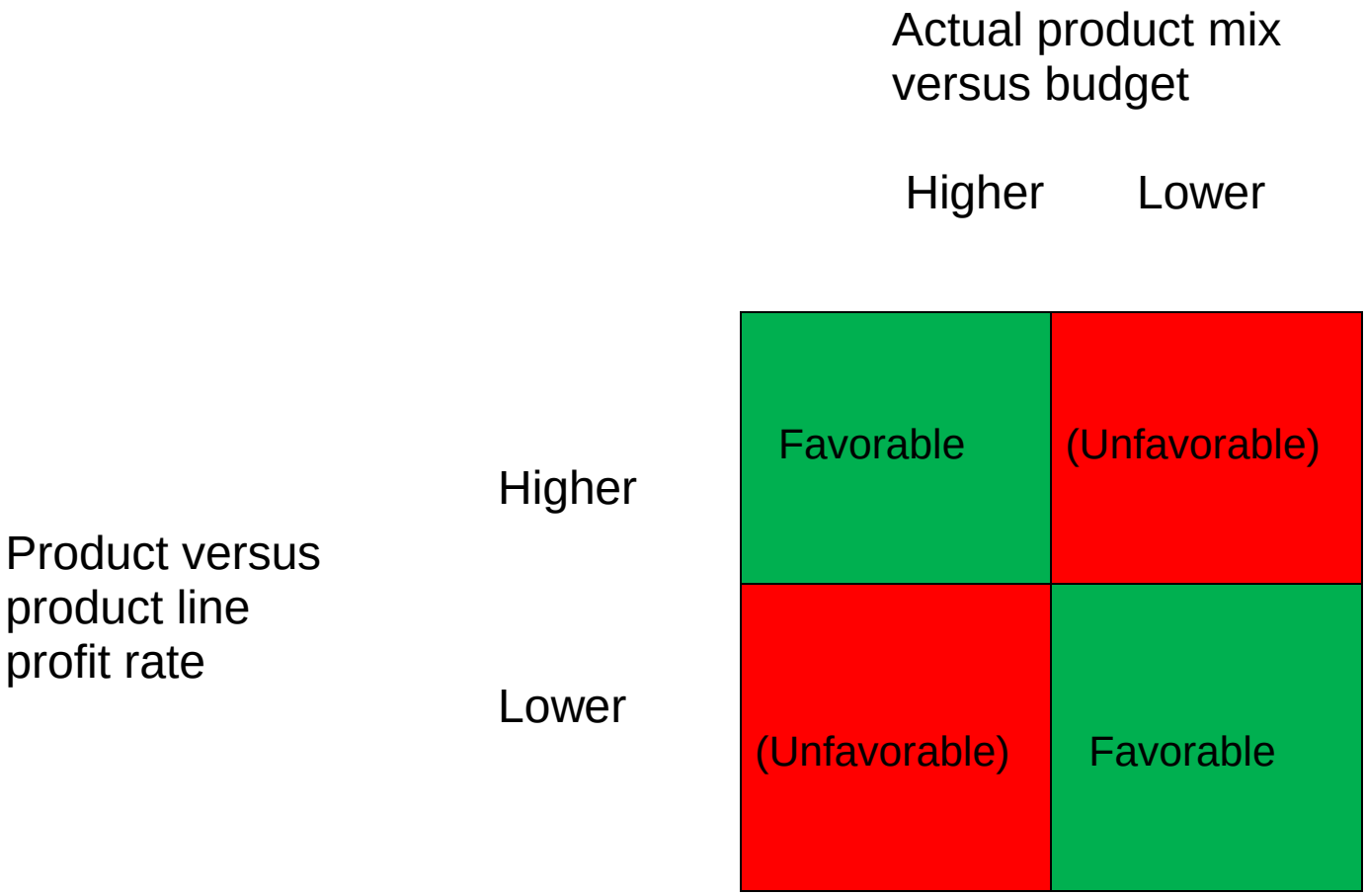

Exhibit 2

VARIANCE ANALYSIS
PRODUCT LINE # 1

	Product			
	A	B	C	Total
Gross sales:				
Budget	$ 10,000	$ 30,000	$ 60,000	$ 100,000
Actual	$ 20,000	$ 140,000	$ 40,000	$ 200,000
Profit rate:				
Budget	60%	30%	80%	63%(1)
Actual	60%	30%	80%	43%(2)
Sales mix:				
Budget	10%	30%	60%	100%
Actual	10%	70%	20%	100%
Sales difference	$ 10,000	$ 110,000	$ (20,000)	$ 100,000
x				
Budget profit rate	60%	30%	80%	23%(3)
=				
"Isolated" volume variance	$ 6,000	$ 33,000	$ (16,000)	$ 23,000
Mix difference	0%	40%	(40)%	
x				(20)%(4)
Profit rate differential	(3)%	(33)%	17%	
x				
Actual total Gross sales	$200,000	$ 200,000	$ 200,000	$ 200,000
=				

Product mix variance	$ 0	$ (26,400)	$(13,600)	$(40,000)
"Isolated" volume variance	$ 6,000	$ 33,000	$(16,000)	$ 23,000
-				
Product mix variance	$ 0	$ (26,400)	$(13,600)	$(40,000)
=				
Product volume variance	$ 6,000	$ 59,400	$ (2,400)	$ 63,000

(1) $63\% = \frac{(60\%)(10,000)+(30\%)(30,000)+(80\%)(60,000)}{100,000}$

(2) $43\% = \frac{(60\%)(20,000)+(30\%)(140,000)+(80\%)(40,000)}{200,000}$

(3) $23\% = \frac{60,000+33,000+(16,000)}{10,000+110,000+(20,000)}$

(4) $(20)\% = (0\%)(-3\%)+(40\%)(-33\%)+(-40\%)(17\%) = -20\%$

Exhibit 3

VARIANCE ANALYSIS
DIVISION

	Product line			
	#1	#2	#3	Total
Gross sales:				
Budget	$ 100,000	$ 200,000	$ 200,000	$ 500,000
Actual	$ 200,000	$ 300,000	$ 500,000	$1,000,000
Profit rate:				
Budget	63%	37%	50%	47.4%(1)
Actual	43%	37%	50%	44.7%(2)
Sales mix:				
Budget	20%	40%	40%	100%
Actual	20%	30%	50%	100%
Sales difference	$ 100,000	$ 100,000	$ 300,000	$ 500,000
x				
Budget profit rate	63%	37%	50%	50%(3)
=				
"Isolated" volume variance	$ 63,000	$ 37,000	$ 150,000	$ 250,000
Mix difference	0%	(10)%	10%	
x				(1.3)%(4)
Profit rate differential	15.6%	(10.4)%	2.6%	
x				

Actual total Gross sales	$1,000,000	$1,000,000	$1,000,000	$1,000,000
=				
Product line mix variance	$ 0	$ 10,400	$ 2,600	$ 13,000
"Isolated" volume variance	$ 63,000	$ 37,000	$ 150,000	$ 250,000
-				
Product line mix variance	$ 0	$ 10,400	$ 2,600	$ 13,000
=				
Product line volume variance	$ 63,000	$ 26,600	$ 147,400	$ 237,000

(1) $47.4\% = \frac{(63\%)(100{,}000)+(37\%)(200{,}000)+(50\%)(200{,}000)}{500{,}000}$

(2) $44.7\% = \frac{(43\%)(200{,}000)+(37\%)(300{,}000)+(50\%)(500{,}000)}{1{,}000{,}000}$

(3) $50\% = \frac{63{,}000+37{,}000+150{,}000}{100{,}000+100{,}000+300{,}000}$

(4) $1.3\% = (0\%)(15.6\%)+(-10\%)(-10.4\%)+(10\%)(2.6\%)$

Exhibit 4

VARIANCE ANALYSIS
DIVISIONAL SUMMARY

	Product line			
	#1	#2	#3	Total
Profit rate:				
Budget	63%	37%	50%	47.4%
Actual	43%	37%	50%	44.7%
Variance	(20)%	0%	0%	(2.7)%
Explanation:				
Product line mix variance	$ 0	$ 10,400	$ 2,600	$ 13,000*
Product mix variance	$(40,000)	$ 0	$ 0	$(40,000)
Total	$(40,000)	$ 10,400	$ 2,600	$(27,000)
Actual Gross Sales	$200,000	$300,000	$ 500,000	$1,000,000
Total Mix Variance Divided by Actual Gross Sales	(20)%	3.5%	0.5%	(2.7)%

*** The product line mix variances have no influence upon the profit rates of the individual product lines.**