COPING WITH UNCERTAINTY IN SMALL BUSINESS BUDGETS BY SENSITIVITY ANALYSIS

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'n Inherente probleem van standaardbegrotings is dat hulle nie die uitwerking of implikasies van afwykings van die begroting weergee nie. 'n Sensitiwiteitsontleding van die begroting sal aan die organisasie addisionele inligting verskaf wat sal aantoon waar die organisasie die gevoeligste is vir fluktuasies in die beramings soos weergegee in die begroting. Aan die einde van die artikel behoort die leser, volgens die skrywer, in staat te wees om so'n sensitiwiteitsanalise uit te voer. Aan die hand van so'n analise kan bestuur doeltreffender vasstel hoe en waar die aandag van die verskillende bestuursvlakke toegespits moet word.

OBJECTIVE OF ARTICLE

The problem with standard organizational budgets is that they do not reflect the effects or implications of deviations from the budget. A sensitivity analysis of the budget will give the organization the additional information needed to show where the organization is *most susceptible* to fluctuations in the estimates reflected in the budget.

At the conclusion of the article, the reader should be able to carry out a sensitivity analysis of the organization budget and determine the parts of the organization which are most sensitive to fluctuations.

Management can then determine more effectively how and where the attention of the various managerial levels should be directed.

Basically *two types of analysis* need to be carried out; since most revenue or cost figures can be assessed in terms of two components; namely a price component and a volume component.

For example, Sales Revenue = Selling Price x Units Sold, or
Raw Material Costs = Purchase price per unit x Units used.

Therefore we need to know what the effect will be of deviations of the various price and volume components from budget.

Sensitivity analysis can be used for *two purposes:*

If it is to be used for *control* purposes, a well designed sensitivity analysis can immediately give the impact of a actual price or volume change of a certain cost or revenue item for the *whole* organization.

If it is to be used for *planning* purposes, the sensitivity analysis can give either the impact of an expected or possible change in the variable, or it can give the amount by which a price or volume must change to affect profits by a certain amount. Consider the very simple budget in table 1:

Table 1: Simple Budget

Product	Sales in Units	Selling price	Raw Material at $4/gallon		Labour at $5/hr.		Margin	Contribution
			Gallons used	Total cost	Hours	Total cost		
1	1 000	20	—		3	15 000	5	5 000
2	500	40	8	16 000	—	—	8	4 000
3	2 000	10	1	8 000	1	10 000	1	2 000
4	1 500	30	1	6 000	2	15 000	6	9 000
						Total Contribution		20 000

The first sensitivity analysis we shall consider, will be one for *control* purposes. We want to know immediately, the impact of changes in the *price* components.

SENSITIVITY ANALYSES OF PRICE COMPONENTS

The best way to do this is to calculate the effect of a dollar change in price for each price component — as will be explained below.

This has been done in Table 2 (with a number of explanatory examples below table 2 where it can be seen that the table is calculated using the most elementary arithmetic).

Table 2: First sensitivity table: effects of changes in price components

	a	b	c	d		e	
	Product	Sales	Effect of $ 1 change in price	Raw Material: Effect of $ 1 change in Price per gallon		Labour effect of $ 1 change in Rate per hour	
				Gallons used	Effect	Hours used	Total Effect
f	1	1 000	1 000[1]	—	—	3	3 000[2]
g	2	500	500	8	4 000[3]	—	3 000
h	3	2 000	2 000	1	2 000	1	2 000
i	4	1 500	1 500	1	1 500	2	3 000
			Total				
j			Effect		7 500		8 000

EXAMPLES:

(1) 1 000 Units of Product 1 will be sold, so a price change of $1 will affect budget by $1 000.
(2) 1 000 Units of Product 1 will be sold, each unit requiring 3 hours labor. The efffect of a $1 change in labor rate will therefore be $3 per unit sold or 3 x 1 000 = $3 000 for 1 000 units.
(3) 500 Units of Product 2 sold, each unit requiring 8 gallons of raw material. The effect of $1 change in cost per gallon will therefore be $8 per unit sold or 8 x 500 = 4 000 for 500 units.

The usefulness of such a sensitivity table for a more complex budget becomes immediately apparent.

We know from the table what the total effect for the whole budget is for any price change.

For instance, the total effect per dollar change in price of Raw Material is $7 500 (Table 2, column d). So, a change of 11 cents per gallon would mean that the budget would be affected by

$$7500 \times \frac{11}{100} = \$825$$

Similarly a change in labor rate of 25 cents per hour would affect the budget by

$$8000 \times \frac{25}{100} = \$2\,000,$$

While a change in selling price of $2 for product 3 would mean the budget would change by $2 x 2 000 =$4 000.

For control purposes, then, it is possible to rapidly assess the total impact of change for even the most complex budgets, and remedial action can be taken quickly.

It is very important to recognize that the sensitivity table depicted in Table 2 be "carved up" and sent to those people in the organization responsible for the various sectors. For instance, Column c of Table 2 should go to the Marketing Manager, Column d to the Procurement Manager, Column e to the Personnel Manager, and Rows f, g, h and i to the line managers repsonsible for products 1, 2, 3 and 4 respectively.

Once the effect of changes in price components have been calculated, it is possible to turn to the problem of developing a sensitivity table for *planning* purposes. This can be done in two ways — by calculating the effect of certain *possible* changes in the price components, or by calculating the *changes required* for a certain effect.

Let us consider the first method. Essentially a budget is an estimate of the *expected* prices, that is, the most probable prices. If we return the budget to the various responsible managers and ask them to give us an indication of possible deviations from the budget price we can then calculate a second sensitivity table.

Suppose the following estimates of possible deviations from the budget were obtained from the people setting up the budget from Table 1.

		Estimates of possible deviations
Product 1:	Expected Price $20	— $2.50
Product 2:	Expected Price $40	— $3.00
Product 3:	Expected Price $10	— $0.50
Product 4:	Expected Price $30	— $3.00
Raw Material	Expected Price $4 per gallon	+ $1.20
Labour	Expected Rate $5 per hour	+ $0.75

These figures have been used to determine Table 3, the second sensitivity matrix, by using Table 2 directly

Table 3: Second sensitivity table: effects of possible changes in price components

PRODUCT	Expeced sales	Possible change in selling Price $	Effect of change in Price $	Raw Material possible change Price = $1.20 Total effect of change.	Labour possible change in rate = $0.75 Total effect of change.
1	1 000	— 2,50	— 2 500[1]		
2	800	— 3.00	— 2 400		
3	2 000	— 0,50	— 1 000		
4	1 500	— 3,00	— 4 500		
			TOTALS	— 9 000[2]	—6 000[3]

(1) From Row f and Column c of Table 2: A change in selling price of $1 will change budget by $1 000, so a $2,50 price decrease will reduce budget by 2,50 x 1 000 = $2 500.
(2) From Row j, Column d of Table 2: A $1 price change per gallon for raw material will affect the budget by $7 500 so a $1,20 increase will decrease the budget by 1,20 x 7 500 = $9 000.
(3) From Row j, Column 3 of Table 2, a $1 change in rate for labour will affect the budget by $8 000, so a 75c increase will decrease budget by 0,75 x $6 000.

Note that it is *not* necessary to calculate all the figures inside the raw material and labour cost colums — we are concerned with the total effects only.

The information obtained from this analysis is invaluable because it indicates where the organisation is most sensitive to the possible changes *forecast by the specialists* responsible for each price component.

If we extract the sensitivities from this table and list them in decreasing order of impact we get a list as follows:

	POSSIBLE IMPACT	
Raw material Price	— $9 000	For top management attention
Labour rates	— $6 000	
Product 4 Selling Price	— $4 500	For
Product 1 Selling Price	— $2 500	Middle, management attention
Product 2 Selling Price	— $2 400	
Product 3 Selling Price	— $1 000	
For lower management attention		

The company can now systematically decide which price components should receive explicit attention from various levels of management.[1]

Let us say that the company decides that any possible impact of $5 000 or more requires top management attention, while specific middle managers should be looking at possible impacts of $2 400 or more and lower management at possible impacts of less than $2 400.

[1] Note that the degree to which management can control or influence the price component will also be considered before final "allocations" of managerial attention are made.
Note also that the highly simplified assumption is made here that price components change without corresponding volume changes. Once attention has been drawn to the price component, possible volume changes should also be considered.

According to these criteria (which each company will decide for itself) *top management* of this company must *now* start catering for possible increases in raw material prices and labour rates, the *marketing manager* must start planning how to cope with possible price decreases in Products 4, 1 and 2 and the *salesman* for product 3 must pay attention to possible price erosion of product 3.

Note that with this approach *every* price component receives management attention, *but according to the impact. No* price component is ignored, but receives attention at the most suitable level.

This disposes of the first sensitivity table required for planning purposes.

The second way of looking at it is to ask by how much the price component must change in order to affect the budget by a certain amount.

This type of information serves a useful planning and control purpose, for the following reason. Remember that we arbitrarily decided that the top management should pay attention to those price components which have a possible sensitivity of $5 000 or more. In the course of the budget year, we therefore need a monitoring signal which indicates *when* this could occur for each price component. If we therefore set up a table which indicates what price change must take place for an effect of $5 000 to occur; we will have the danger signals.

This has been done in Table 4, which as can be seen from the examples below table 4, is extracted directly from table 2.

Table 4: Price component changes required to affect budget by $5 000

product	Effect of $1 change in in selling price	required change in selling price for $5 000 effect	raw material effect of $1 price change per gallon $7 500	labour effect of $1 per hour change in rate $8 000
1	1 000	$5		
2	500	$10		
3	2 000	$2,50		
4	1 500	$3,33[1]		
		change required for $5 000 effect	$0,67[2]	$0,625—

Examples:

(1) From Table 2, Row i, Column c we see that an change of $1 affects budget by $1 500, so for a $5 000 effect a change in selling price of $\frac{5000}{1500} = \$3{,}33$ must occur.

(2) From Table 2, Row j, Column d we see that a change of $1 affects budget by $7 500, so for an effect of $5 000, a price increase of $\frac{5000}{7500} = \$0{,}67$ per gallon must occur.

(3) From Table 2, Row j, Column e a change of $1 in labour rates affects budget by $8 000, so for a $5 000 effect a price increase of $\frac{5000}{8000} = \$0{,}625$ per hour must occur.

Table 4 now serves two purposes. Firstly we know the ciritcal point, for each price component, at which top management must actively give attention. Remember that we decided above that Product 3, because of its low possible change in selling price should only receive the attention of the relevant salesman. However, from table 5, we see that, should the sales price of product 3 show signs of declining, then by the time it has declined by $2.50 it should already be receiving top management attention. In fact, by the time the sales price has shown signs of declining by

$$\$\frac{2400}{2000} = \$1{,}20$$

It should already be receiving the attention of the marketing manager since the cut-off for middel management attention was previously set at $2 400.

A new table 4 can therefore be calculated for each cut-off point decided upon by the organization, and thus then provides the control signals which indicate when the next highest level of management must be notified if changes do occur in the course of the budget year.

The second purpose served by Table 4 is that it gives the managers responsible for the various price components a yardstick by which to allocate attention to the right areas in terms of their intuitive assessments of uncertain changes. For instance, the production manager, though he may be enusre of the possible price change in raw material, is now alerted that a cost price increase from $4,00 to $4,67 will have a $5 000 impact on the organization and can start considering how likely it is that this price will increase. In a detailed sensitivity analysis, with a large number of raw materials involved, this will provide useful indications of where he must pay particular attention in his planning.

SENSITIVITY ANALYSIS OF VOLUME COMPONENTS

Thus far only price components have been considered. Much the same type of analysis can be applied to volume components.

This has been done in Table 5 where the effect of a unit change in *volume* of sales, raw material *usage* and labour *usage* has been calcualted for each product. In addition, because it has been found useful, the effect of a *1%* change has also been calculated.

As with the first sensitivity analysis for price components, the first sensitivity analysis for volume components can serve a useful *control* function. For instance the marketing department will know immediately they are informed that a drop in sales of 100 units of Product 1 is occurring, that the total impact in profits is 100 x 5 = $500. Alternatively, the knowledge that raw material consumption for product 2 has increased by 5% would mean a profit impact of 5 x 80 = $400. The reason why both 1 unit and 1%

Table 5: Sensitivity table for effect of unit and percent change in volume

	PRODUCT	SALES IN UNITS	MARGIN	EFFECT OF CHANGING VOLUME		RAW MATERIAL AT $4 PER GALLON			LABOUR AT $5 PER HOUR		
				By 1 Unit	By 1%	Gallons used	Effect of one Gallon less	Effect of 1% less	Hours Needed	Effect of one hour less	Effect of 1% less
(a)	1	1 000	5	5	50	—	—	—	3	5 000	150
(b)	2	500	8	8	40	8	2 000	160	—	—	–
(c)	3	2 000	1	1	20	1	8 000	80	1	10 000	100
(d)	4	1 500	6	6	90	1	6 000	60	2	7 500	150
				(e)	(f)		(g)	(h)		(i)	(j)

Examples:

(1) From Table 1 the margin is $5 for product 1 so a change of 1 unit in sales will affect the budget by $5.
(2) Forecast sales are 1 000. 1% change in salesforecast means a change of 10 in sales units. At a margin of $5, this means 1% change in sales affects the budget by 5 x 10 = $50.
(3) Labour costs $5 per hour. 1 000 units of product 1 are produced. Therefore a change of 1 hour in labour per unit means a change of $5 x 1 000 = $5 000 in the budget.
(4) 3 hours of labour are needed per unit sold. Total labour hours needed for 1 000 units are 3 x 1 000 hours. A 1% change in labour for product 1 means $\frac{1}{100} \times 3 \times 1\,000$ change in hours needed. At $5 per labour hour thus means a change of $\frac{1}{100} \times 3 \times 1\,000 \times 5 = \$150$.

effects are given is because volumes are often given in either unit changes or percentage changes.

As with the price components, it is also useful for *planning* purposes to go back to the budget compilers and ask them to give indications of the possible deviations from the budget.

Suppose the following results come back:

Possible deviation in:

PRODUCT	SALES VOLUME	RAW MATERIAL	LABOUR
1	— 100	—	+6%
2	— 50	+ 10%	—
3	— 300	+ 5%	+6%
4	— 300	+ 60%	+6%

Using Table 5 it is now possible to calculate the effect of possible deviations on the budget, as has been done in Table 6.

Table 6: Sensitivity table for possible deviations from budget — volume components

PRODUCT	Effect of Sales Forecast Deviations	Effect of Raw material Deviatsions	Effect of Labour Deviations
1	— 500(1)	—	— 900(2)
2	— 400	— 1 600(3)	—
3	— 300	— 400	— 600
4	— 1 800	— 3 600	— 900

Examples:

(1) Possible decrease in sales = 100
From Table 5, Row a, Column e effect = $5 per unit.
Total effect = 5 x 100 = $500
(2) Possible increase in labour = 6% more hours.
From Table 5, Row a, Column j effect = $150 per percent.
Total effect = 6 x 150 = $900
(3) Possible increase in raw material = 10% more gallons.
From Table 5, Row b, Column h effect = $160 per percent.
Total effect = 160 x 10 = $1 600.

Table 6 can be used for planning purposes in much the same way as for the price component sensitivity analysis

RANKING AS BEFORE, WE GET

Raw material consumption for Product 4	= $3 600	Middle Management
Sales Volume Product 4	= $1 800	Lower Management
Raw material consumption for Product 2	= $1 600	
Labour required for Products 1 and 4	= $900	
Labour required for Product 3	= $600	
Sales of Product 1	= $500	
Sales of Product 2 and Raw Material for Product 3	= $400	
Sales of Product 3	=$300	

According to the cut off criteria discussed above, none of the above sensitivities require top management attention, and only the possible raw material deviation for Product 4 requires middle management attention.

Finally, as with the price component, we may ask by how much the volume component must change in order to affect the budget by a certain amount, (say $5 000, to find the points at which top management attention is needed).

This gives Table 7, obtained directly from Table 5.

Table 7: Change in volume components required to affect budget by $5 000.

PRODUCT	Sales Volume Charges Required		Raw Material Consumption changes required.		Labour Requirements Changes needed.	
	UNITS	%	GALLONS	%	HOURS	%
1	1000(1)	100(2)	—	—	1(3)	33(4)
2	625	125	2,5	31	—	—
3	5 000	250	2,5	62	0,5	50
4	835	56	0,8	83	0,67	33
		(k)		(l)		(m)

Examples:

(1) From Table 6, Row a, Column e, an effect of $5 occurs for a unit change in sales, so for a $5 000 effect, a change in

5000/5 = 1000 units is needed.

(2) From Table 6, Roq a, Column f an effect of $50 is obtained for a 1% change, so for a $5 000 effect a

$\frac{5000}{50}$ = 100% change is needed.

(3) From Table 6, Row a, Column i an effect of $5 000 is obtained for a change of 1 hour labour in product 1. So for a $5 000 effect a

$\frac{5000}{5000}$ = 1 hour labour change per unit is required.

(4) From Table 6, Row a, Column j an effect of $150 is obtained for a reduction in labour usage for product 1 of 1%, so far a $5 000 effect, a change in labour usage of

$\frac{5000}{150}$ 33% is required.

As before, a number of sensitivity tables like Table 6 can be drawn up for each cut-off point, thus providing control signals indicating, for each level of management, the time to notify the next highest level of the need for attention.

The other interesting feature of sensitivity Table 7 is that is provides some very useful additional information for specialist attention.

Reading down column h of Table 7 we see that the major thrust for sales volume should be on Product 4, where the lowest percentage (56%) sales volume change results in a $5 000 effect.

Reading down Column (1) of Table 7 we see that the major benefits for reduction in material consumption will occur with product 2, where a 31% reduction would mean savings of $5 000. So if a value analysis project *should* be done it is on material consumption of Product Z. Reading down Column (m) of Table 7 we see that if work study is to be undertaken, then the best areas to start are Products 1 and 4, where the lowest percentage (33%) labor reduction will effect $5 000 savings.

CONCLUSION

The use of sensitivity analyses in budgeting and implementation of budgets can (and has) proved very useful-particularly if the company has access to even a moderate sized computer. Lack of a computer is not a serious problem, all of the calculations are simple arithmetic calculations which can be handled by clerks. The technique is thus available to even the small company without a computer.

The analysis becomes a little more complex when products using joint facilities are encountered. This, however, is not difficult to overcome and interested readers' questions in this regard are welcomed.