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A Simple Methed

For

Short - term Fore Costing

by

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A simple method for short-term-forecasting

It is well known that statistics can provide management with statistical estimations of the development in the next furture. There are many methods of statistical forecasting in all countries which often require a big amount of calculations and the use of computers. Many examples collected in the GDR show that it is possible to get good results of short-term-forecasting with a simple method, called M_1. This method M_1 includes only simple parameters which are useful for analysis and forecast.

The general model of M_1 consists of two conditions or assumptions about the general development of the economic process:

Assumption 1: The annual (or periodical) rates of growth must be nearly equal in a certain part of the develoment. This condition fits the situation in many cases.

Assumption 2: The seasonal changes must be nearly equal in a certain part of the development. This condition is also useful in many cases.

The model of the general development is therefore:

$$\hat{y}_t = a\, q^t\, P_i \qquad (1)$$

and

$$y_t = a\, q^t\, P_i + e_t \qquad (2)$$

t = time variable
i = seasonal part of a period ($i=1, \dots, m$)
j = period ($j=1, \dots, n$)
$t = i + m(j-1)$
y_t = real value of y, $y_t = y_{i,j}$
$\hat{y}_t$ = estimated value of y

$$y_j = \sum_i y_{i,j}$$

$$T_i = \sum_j y_{i,j}$$

$e_t = y_t - \hat{y}_t$ = equation error.

Formula (1) shows that the model includes an exponential function connected with a proportional seasonal component. It is easy to show that in this case, according to equation (1), the proportions.

$$Q'_{i,j} = y_{i,j} : y_j \qquad (3.1)$$

and $$Q^{+}_{i,j} = y_{i,j} : y_{i-1,j} \qquad (4.1)$$

are nearly equal for all j.

The relations (3) and (4) can be easily used as development indicators for planning purposes and also for estimations of values for the period j.

In order to get an average for the values $Q'_{i,j}$ or $Q^{+}_{i,j}$ we use the following calculation of averages:

Let $x_1, \ldots, x_k$ be the individual values of x. If each value of x consists of two different components c and d in form of

$$x = c : d \qquad (5)$$

we get the average $\bar{x}$, as a general representative of all x, by using the sums of c and d:

$$\bar{x} = \sum c : \sum d \qquad (6)$$

From equation (6) we get the average of Q' and Q^{+}

$$Q_i' = \sum_j y_{i,j} : \sum_j y_j = T_i : \sum_i T_i \quad (3.2)$$

and

$$Q_u^+ = \sum_j y_{i,j} : \sum_j y_{i-1,j} = T_i : T_{i-1} \quad (4.2)$$

For demonstration we use the following example of the retail trade turnover of the GDR from 1967 to 1971.

Table 1 Retail Trade Turnover of the GDR, 1967 - 1971
- Mrd. Mark -

Quarter	1967	1968	1969	1970	1971	1967-1971
I	12,5	12,9	13,6	14,2	14,9	68,1
II	13,3	14,0	14,8	15,7	16,2	74,0
III	15,9	14,4	15,4	16,1	16,6	76,4
IV	15,6	16,6	17,6	18,0	18,9	86,7
	55,3	57,9	61,4	64,0	66,6	305,2

We get the average of $Q_{1,j}'$ according to formula (3.2)

$$Q_1' = 68,1 : 305,2 = 0,22313$$

Q_1' means that the share of the first quarter in a year is about 22,313% . The results for all Q_i' are given in table 2, column 2.

Table 2

Quarter	T_i	Q'_i	$y_{i,72}$	$y_{i,72}$	$y_{i,72}(M_1)$
0	1	2	3	4	5
I	68,1	0,22313	15,7	16,1	15,6
II	74,0	0,24246	17,1	17,0	17,0
III	76,4	0,25033	17,7	17,5	17,5
IV	86,7	0,28408	20,0	19,9	19,9
	305,2	1,00000	70,5	70,5	70,0

In the same way it is necessary to divide the given values for a certain period into values for the seasonal parts of the period, in general to take the values of Q'_i for the estimation:

$$\hat{y}_{i,j} = Q'_i \ \hat{y}_j \qquad (7)$$

If we have the planned value for the year 1972 with 70,5 Mrd. M. we get from equation (7) the estimated values for each quarter of 1972, for instance

$$y_{1,72} = 0{,}22313 \cdot 70{,}5 = 15{,}7$$

The results are given in table 2, column 3. The real values are given in column 4. These are relatively good estimations.

If it is necessary to have an estimated value for the next quarter according to the value of the last quarter we use the estimation

$$\hat{y}_{i,j} = Q_i^+ \; y_{i-1,j} \qquad (8)$$

This method of calculation of seasonal changes differs from the usual way of calculating the simple average of all $Q'_{i,j}$ with

$$Q'_{i,simple} = \sum_j Q'_{i,j} : n \qquad (9)$$

The calculation of the simple average according equation (9) requires much more computations than that according to equation (3.2). The relation between Q'_i and $Q'_{i,simple}$ is:

$$Q'_i = Q'_{i,simple} \left(1+V_{y_j} \; V_{Q'_{i,j}} \; r_{y_j Q'_{i,j}} \right) \qquad (10)$$

The linear correlation r is generally very small, the coefficient of variation $V_{Q'}$ is also often very small, so that the difference between the two averages is very small. In our example the difference between Q'_i and $Q'_{i,simple}$ is 0,00006.

On the other hand Q'_i is a weighted average

$$Q'_i = \sum_j Q'_{i,j} \; y_j \; : \; \sum_j y_j \qquad (11)$$

and it posseses all advantages and disadvantages of weighted averages. If y_j increases steadily, the last value of y_j has the greatest influence on the value of Q'_i and vice versa. The condition of using the coefficients Q' is to know something about the total value of y for the next period. In the GDR we can often use the planned value of y. If there is no information about the value of the next year or if somebody wishes to check other calculations he can use the complete method M 1. From equation (1) it is to be seen that

$$\hat{y}_{i,j} = q^m \hat{y}_{i,j-1} = q^{m(j-1)} \hat{y}_{i,1} \qquad (12)$$

That means, the calculation needs an estimation of the value q^m or of the annual rate of growth $p = q^m$ and an estimation of the value in the first period. All other estimations can be reached only by multiplication with the same constant p for all quarters.

As an estimation of the value p we use the formula

$$p = \sqrt[n-1]{y_n : y_1}\ , \quad q = \sqrt[m]{p} \qquad (13)$$

In order to calculate the constant (a) we take the condition

$$\sum_t e_t = 0 \qquad (14)$$

that means for the trend function

$$\sum_t y_t = \sum_t a\, q^t$$

and therefore

$$a = \sum_t y_t : \sum_t q^t \qquad (15)$$

In the same way we use for each seasonal part the condition in (14) in order to calculate the values P_i. We get the result:

$$P_i = T_i : (a\, q^i S_p) \qquad (16)$$

and

$$S_p = 1 + p + p^2 + \dots + p^{n-1} \qquad (17)$$

For the starting value $y_{i,1}$ we get from formulae (1),(15) and (16)

$$\hat{y}_{i,1} = T_i : S_p \qquad (18)$$

This estimated value for the seasonal parts of the first period is easily to calculate.

The complete method M 1 needs therefore the sum T_i, which is usually given in a statistic table, the annual rate of growth p and its sum S_p. Thus we have only one division step for the calculation of each estimated value. For the next period we have

$$\hat{y}_{i,n+1} = p^n\, T_i : S_p \qquad (19)$$

In our example we have

$$p = \sqrt[4]{\frac{66.6}{55.3}} = 1,048$$

$$S_p = 5,499$$

$$p^n = 1,262$$

and $y_{1,72} = 1,262 \,.\, 68,1 : 4,499$

The results are given in table 2 column 5. It is to be seen, that the estimated values fit the real values in a very good way. The coefficient of determination for the actual data is B = 0,994 and the genral coefficient of correlation is R = 0,997. The relative linear mean of deviations is δ' = 0,007.

Some results of using M 1 in the GDR are given in table 3. The time converage in the example is different in each case.

Table 3

Item	R	δ'
Industrial Production	0,958	0,014
Production in the construction sector	0,977	0,027
Passengers Carried	0,998	0,010
Goods Transport Performance	0,937	0,019
Retail Trade Turnover	0,997	0,007
Holiday Trips to the East Sea	0,998	0,039

Summary

Method M 1 is a very simple method for short-term-forcasting. The manual calculation lasts only few minutes. The model of M 1 is the connection of an exponential trend function with a proportional seasonal component. The parameters of the model are determined by simple conditions: the existance of an average rate of growth, and the vanishing of error sums for each seasonal part. Using M 1 many good results of fitting and short-term-forecasting are reached in the GDR.(*)

*) See R. Struck, "Kurzfristige statistische Vorausberechnung", Berlin, 1973, Verlag Die Wirtschaft.