Pistunov IM
Doctor of Technical Sciences, Professor
NTU "Dnipro Polytechnic", Dnipro

DETERMINATION OF THE RATE OF SALE OF BANK ASSETS BY INCOMPLETE INFORMATION

In case you need to know the distribution of sales over a certain horizon of calculation (T), for each of its stages t ($1 \leq t \leq T$), а точних даних щодо динаміки продажів немає, окрім загальної суми продажів (S_P) and the qualitative characteristics of these dynamics, the following algorithm is proposed.

Since, in most cases, the schedule of changes in sales time has one extreme and is shifted relative to the middle of the calculation horizon in one direction or the other, it is advisable to use the lognormal distribution density formula to establish the relationship between time and sales volume. In Fig. 1 shows the possible variants of the curve $X \sim \mathrm{LogN}(\mu, \sigma^2)$ [1].

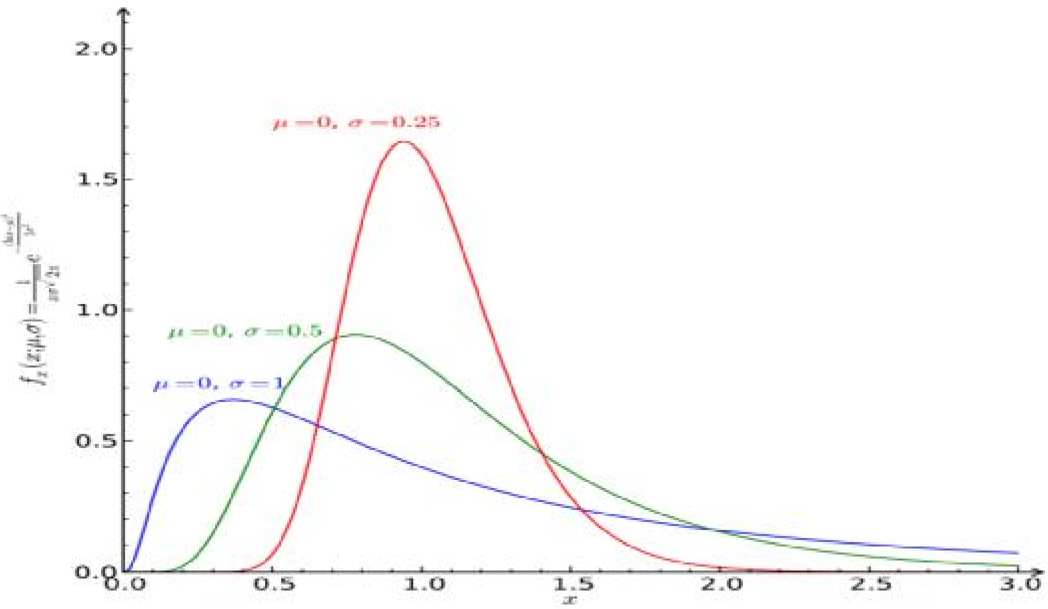

Fig. 1 - Graphs of the density curve of lognormal distribution depending on factors σ and μ

It should be noted that the graphs of this function have different appearance depending only on the factor σ, but factor μ is always zero.

Schedule for $\sigma = 1$, reminds of sales dynamics, more active at the beginning of the horizon of calculation, and for $\sigma = 0{,}25$ – at the end. The first case is characterized by the almost complete decrease of the curve to zero when $x > 3$, and for the other – at $x > 2$.

Therefore, the change in the timing of the sale of bank assets can be described by dependency [1]

$$S_t = \frac{ABExp\left(\left(\frac{Lnt}{B\sigma}\right)^2 / 2\right)}{t\sigma\sqrt{2\pi}}, \tag{1}$$

where A – sales scale ratio, B – time scale factor.

Formula (1) is transcendental, so the coefficients are determined A, B and σ can only be conducted by solving the optimization problem in the following order:

1. Determine the calculation horizon, total sales, and the type of sales dynamics at the beginning or end of the horizon.

2. We calculate the initial values of the coefficients:

$$A = \frac{S_П}{T}; \tag{2}$$

$$B = \frac{T}{k}, \tag{3}$$

where $k = 3$, if sales are more intense in the first part of the calculation horizon, $k = 2$ – if in the second;

$$\sigma = 1. \tag{4}$$

3. By the initial values of the coefficients, we calculate the amount of sales for each point in time according to (1)

$$S_\Sigma = \sum_{t=1}^{T} S(t). \tag{5}$$

4. Set the point in time when sales were highest t_M ($1 \le t_M \le T$) and form a system of logical relationships that indicate that sales are at a point t_M are greater than the sales of two points before and two after the moment t_M

$$S(t_1) < S(t_2) < S(t_3) > S(t_4) > S(t_5), \qquad (6)$$

5. If for some points in time the exact values of sales are known, we form an array of these values in the form of a table with values of pairs.

$$t_i \text{ та } S(t_i) \qquad (7)$$

6. Then, to find the unknown coefficients A, B, and σ, formulate an optimization problem with the objective function

$$S_\Sigma \rightarrow S_\Pi, \qquad (8)$$

under restrictions (1) - (7) as well $A, B \geq 0,\ 0{,}2 \geq \sigma \geq 1{,}5.$ (9)

7. We assign variable factors A, B and σ.

Then, after solving the problem, sales amounts will be found for each point in time. In case the calculation horizon does not start from the beginning of the financial year, the first stage of the calculation should be assigned the number 1 and so on. And not to be confused, put real dates in the table of values next to the stage numbers.

Here is an example of calculation by the proposed method.

Let it be known that the total sales of the bank's assets is $S_\Pi = 100$ conventional units, the horizon of calculation $T = 12$, and the highest level of sales is in the third stage. At the same time, there were hardly any sales in the first stage.

Then:

– initial values of the coefficients $A = 100/12 = 8{,}33$; $B = 12/3 = 4$;

– restrictions $S(t_1) < S(t_2) < S(t_3) > S(t_4) > S(t_5)$;

– where $t = 1$, $S(t) = 0$.

In the table. 1 shows an example of how to calculate this data using the Excel Solution Spreadsheet Solution using the method of branches and borders for solving nonlinear problems.

As you can see, the amount is almost exactly in line with the set one, but for the first quarter the condition of zero sales is not exactly fulfilled. But the estimated value of the sale is less than 1%, therefore, in the context of considerable uncertainty we can assume that the solution is quite acceptable.

Table 1

Example of calculation according to the proposed method

Quarter number	The value of the function of lognormal law	Quarter number	The value of the function of lognormal law
1	0,946055353	8	5,108101768
2	11,34131074	9	3,349295841
3	19,89654076	10	2,190582934
4	19,89654099	11	1,435960888
5	15,84051689	12	0,946055445
6	11,34131122	$S_\Sigma =$	100,0000003
7	7,707727516		

The values of the coefficients that provided a given sales schedule (Fig. 2) $\sigma = 0{,}5$; $A = 22{,}93623$; $B = 4{,}44799456$.

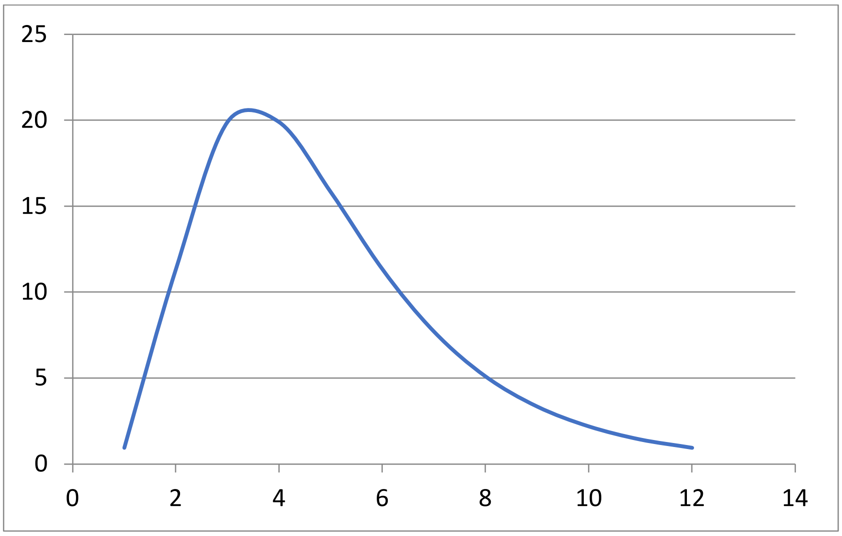

Fig. 2 - The chart of rate of sale of assets of the bank, constructed according to table. 1

References

1. https://uk.wikipedia.org/wiki/%D0%9B%D0%BE%D0%B3%D0%BD%D0%BE%D1%80%D0%BC%D0%B0%D0%BB%D1%8C%D0%BD%D0%B8%D0%B9_%D1%80%D0%BE%D0%B7%D0%BF%D0%BE%D0%B4%D1%96%D0%BB