

TO APPLY RANDOM MARGINE TO PRODUCTION

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We will apply definite and random margin in order to solve two equations:

$$mC = AC \quad (1)$$

$$P = mC \quad (2)$$

at the HCMC-based Nhân Dân Printing House with the aim to:

a) Find the daily output which enables the average cost for each printed page to be the lowest.

b) Find the output q which causes the highest profit (in July 1992) to the factory with the current market price of VND35 per printed page, size 19x27.

The figures we collected are in the period from Jan 1, 1991 to June 30, 1992.

After using the method of examining the statistical assumption, we have the following table and results:

Table 1: MTC table, sTC (q)

Output q (million sheets)	MTC (q) (VND mil.)	sTC (q) (VND mil.)	χ^2
0.7	18.96	1.36	2.33
1	26.02	1.32	1.52
2	48.07	1.95	2.96
3	71.73	2.40	4.72
4	100.27	3.30	2.06
5	140.17	4.19	1.45
6	180.50	4.62	2.11

From this table, we see quantity $TC(q)$ has the standardized normal distribution.

To regulate the functions $MTC(q)$ and $sTC(q)$ by the minimum squaring method, we have:

$$MTC(q) = 0.46 q^3 - 2.07 q^2 + 25.3 q + 2.31 \quad (1)$$

$$sTC(q) = \frac{1}{20} q^{\frac{5}{3}}, AMTC(q) \quad (2)$$

$$\text{with } AMTC(q) = \frac{MTC(q)}{q}$$

Now we solve equations $mC = AC$ and $P = mC$ in the two definite and random stages.

$$\text{Equation } mC = AC$$

From (1) we have:

$$mMTC(q) = 1.38 q^2 - 4.14 q + 25.3 \quad (3)$$

$$AMTC(q) = 0.46 q^2 - 2.07 q + 25.3 + \frac{2.31}{q} \quad (4)$$

From (3) and (4) we deduce:

$$0.92 q^3 - 2.07 q^2 - 2.31 = 0$$

After solving, we have the following approximate outcome:

$$q_0 = 2.595 \text{ million printed pages.}$$

From (2) we have:

$$sTC(q) = \frac{1}{20} (0.46 q^{\frac{5}{3}} - 2.07 q^{\frac{2}{3}} + 25.3 q^{\frac{1}{3}} + 2.31 q^{-\frac{1}{3}})$$

Deducing: $msTC(q) =$

$$\frac{1}{20} [0.46 \cdot \frac{8}{3} q^{\frac{8}{3}} - 2.07 \cdot \frac{5}{3} q^{\frac{5}{3}} + 25.3 \cdot \frac{2}{3} q^{\frac{2}{3}} - 2.31 \cdot \frac{1}{3} q^{-\frac{1}{3}}]$$

and $AsTC(q)$

$$= \frac{1}{20} [0.46 \cdot q^{\frac{5}{3}} - 2.07 \cdot q^{\frac{2}{3}} + 25.3 \cdot q^{-\frac{1}{3}} + 2.31 \cdot q^{-\frac{5}{3}}]$$

Thereby: $AsTC(q) - msTC(q) =$

$$= \frac{1}{20} [-0.46 \cdot \frac{5}{3} q^{\frac{5}{3}} + 2.07 \cdot \frac{2}{3} q^{\frac{2}{3}} + 25.3 \cdot \frac{1}{3} q^{-\frac{1}{3}} + 2.31 \cdot \frac{4}{3} q^{-\frac{5}{3}}]$$

$$(MTC)(q) = 2.76 q - 4.14$$

with $q_0 = 2.595$ million printed pages. (5)

We have:

$$B = \frac{AsTC(q_0) - msTC(q_0)}{(mTC)'(q_0)} = 0.092653 \text{ mil. pages} \quad (6)$$

From (5) and (6) we can draw the following conclusion: Output q with lowest average cost is on the interval $(q_0 - B, q_0 + B)$ that is, the interval $(2,502,347; 2,687,653)$ (printed pages).

$$\text{Equation } P = mC$$

We will find the output q so that the factory earns highest profit with the market price of VND32.5 per printed page, size 19x27 (July 1992).

We have equation:

$$mMTC(q) = 1.38 q^2 - 4.14 q + 25.3 = 32.5$$

The approximate outcome is:

$$q_0 \approx 4.232 \text{ (million pages)} \quad (7)$$

We have:

$$C = \frac{msTC(q_0)}{(mTC)'(q_0)} = 0.098934 \quad (8)$$

From (7) and (8) we have the conclusion:

The output q which causes maximum profit is on the interval $(q_0 - C, q_0 + C)$, that is, $(4,133,066; 4,330,934)$ (printed pages)

Comparing the problem with the production practice:

After solving the above problem at the Nhân Dân Printing House, we have the outcome:

Outcome 1: If the output q is on the interval $I = (2,502,437; 2,687,653)$, then the average cost for each page is minimum.

Outcome 2: If the output q is on the interval $j = (4,133,066; 4,330,934)$ then the factory's profit is maximum.

- In case of the output mentioned at the outcome 1, the average cost for each page is VND23.91. This is a minimum average cost, in fact we have the following comparison:

$$q = 1 \text{ million} \implies \text{average cost: VND28/page}$$

$$q = 1.5 \text{ million} \implies \text{average cost: VND24.77/page}$$

$$q = 2 \text{ million} \implies \text{average cost: VND24.15/page}$$

$$q = 3 \text{ million} \implies \text{average cost: VND24/page}$$

$$q = 4 \text{ million} \implies \text{average cost: VND24.95/page}$$

Thus in case of materials having large number of printed pages, to attain minimum average cost, the factory should assign to each workshop the number of printed pages which is on the interval I . Certainly, we also pay attention to the deadline of the printing contract.

With the output mentioned at the outcome 2, the profit is highest, in fact:

$$q = 4.232 \text{ million} \implies MTC(4.232) = 107.16 \text{ million}$$

While the earning is:

$$R(4.232) = 4.232 \text{ mil.} \times \text{VND 32.5} = \text{VND}137.54 \text{ million}$$

So the profit is: $137.54 - 107.16 = 30.38$ (million)

We assume the production reaches the highest output $q = 6$, then:

$$\begin{aligned} MTC(6) &= 178.98 \text{ million} \\ R(6) &= 4.232 \times 32.5 \text{ million} \\ &= 195 \text{ million} \end{aligned}$$

The profit is: $195 - 178.95 = 16.05$ (million)

Although the production reaches the highest output $q = 6$ million, the factory still earns less profit than that of $q = 4.232$.

As a result, when the factory signs a contract with a great number of printed pages, it should assign to each workshop the output of 4.232 million pages (the output on the interval J)■