Section 12
The Relationship Between Least Square and Linear Programming

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Abstract

The predication is important tool for planning where the aim of any statistician is to predicate the values of dependent variable which minimize the error (the different between actual and predicated value).
The least square method is classical method which used to achieve this purpose.
The predication by using least square method depends on minimizing the sum square of errors.
This paper introduces the restrictions of least square method,while
The predication by using linear programming method depend on the assumation of minimizing the sum of absolute errors

1-The predication by using least square method

The estimation of parameter model B_j , $j = 1, 2, \ldots, k$
Of least square method defined as follow:-

$$Min \;\; z = e_1^2 + e_2^2 + \cdots + e_n^2$$

s.t:

$$B_0 + B_1 x_{i1} + \cdots + B_k x_{ik} + e_i = y_i \;\;, \;\; i=1,2,\ldots,n$$

$$B_j, e_i \;\; unrestricted \; in \; sign$$

2-The predication by linear programming method

Thepredication formula by using this method depend on the assumation:

$$Min \;\; z = |e_1| + |e_2| + \ldots + |e_n|$$

So ,to estimate the parameter model $B_j$suppose

$$e_i = e_i^+ - e_i^-$$

Because ei unrestricted in sign also , the restriction of linear programming method is nonnegative variables (B_j)
So, the model becomes as follow:-

$$Min \;\; z = e_1^+ + e_1^- + \cdots + e_n^+ + e_n^-$$

s.t:

$$B_0 + B_1 x_{1i} + \cdots + B_k x_{ik} + e_i^+ - e_i^- = y_i$$

$$B_j \;\; unrestricted \; in \; sign$$

$$e_i^+, e_i^- \geq 0$$

3-Example

Consider , the linear model:-

$$y_i = B_0 + B_1 x_i + e_i$$

Where

$y_i$represent the monthly average in comeper capita.

$x_i$represent the monthly average expenditure per capita.

So , to estimate the parameter model $B_j$by using least square method defined as follow:-

$$Min \ z = e_1^2 + \cdots + e_{16}^2$$

s.t:

$$B_0 + 10.2B_1 + e_1 = 6.10$$

$$B_0 + 10.32B_1 + e_2 = 5.48$$

....

$$B_0, B_1, e_1, \dots, e_{16} \ unrestricted \ in \ sign$$

And the estimation parameter model Bj by using linear programming method (simplex) defined as follow:

$$Min \ z = e_1^+ + e_1^- + \cdots + e_{16}^+ + e_{16}^-$$

s.t:

$$B_0^+ - B_0^- + 10.20(B_1^+ - B_1^-) + e_1^+ - e_1^- + R_1 = 6.10$$

$$B_0^+ - B_0^- + 10.32(B_1^+ - B_1^-) + e_2^+ - e_2^- + R_2 = 5.48$$

....

$$B_0^+ - B_0^- + 48.40(B_1^+ - B_1^-) + e_{16}^+ - e_{16}^- + R_{16} = 15.63$$

$$B_0^+, B_0^-, B_1^+, B_1^-, e_1^+, e_1^-, \dots, e_{16}^+, e_{16}^-, R_1, \dots, R_{16} \geq 0$$

Table(1)

Show the values of parameter , error and objective function for two methods

Variables	Least square	Linear programming (simplex)*
b_0^+	3.568073	3.0018506
b_0^-	0	0
b_1^+	0.280519	0.31850788
b_1^-	0	0
e_1^+	-0.3293668	0
e_1^-	0	0.15063103
e_2^+	-0.98302908	0
e_2^-	0	0.80885172
e_3^+	-0.4235225	0
e_3^-	0	0.25618345
e_4^+	-0.2165086	0
e_4^-	0	0.12134842
e_5^+	-0.04045596	0
e_5^-	0	0
e_6^+	-0.13255939	0
e_6^-	0	0.12895234

e_7^+	0.13289566	0.09661418
e_7^-	0	0
e_8^+	0.29562419	0.16627026
e_8^-	0	0
e_9^+	0.40074107	0.26530853
e_9^-	0	0
e_{10}^+	0.3992064	0.18096179
e_{10}^-	0	0
e_{11}^+	0.3912076	0.08520817
e_{11}^-	0	0
e_{12}^+	0.50671882	0.07687327
e_{12}^-	0	0
e_{13}^+	0.35105728	0
e_{13}^-	0	0.14184997
e_{14}^+	0.73965561	0.17342989
e_{14}^-	0	0
e_{15}^+	0.75389175	0
e_{15}^-	0	0
e_{16}^+	-1.5151926	0
e_{16}^-	0	2.7876320
R_1	.	0
R_2	.	0
R_3	.	0
R_4	.	0
R_5	.	0
R_6	.	0
R_7	.	0
R_8	.	0
R_9	.	0
R_{10}	.	0
R_{11}	.	0
R_{12}	.	0
R_{13}	.	0
R_{14}	.	0
R_{15}	.	0
R_{16}	.	0
Z	5.689599	5.440116

***: treationNo = 26**

4-Results

The table (1) shows the values of parameters , errors and the objective function values for two methods as follow:-

5- Conclusion

1-The estimation of parameter of both methods is approximately equal.
2-The value of objective function of both methods also is approximately equal.
3-There is strong relationship between both methods.

4-The aim of both methods is minimize the errors.

***table(2)**

Shows the monthly average income per capita (y) and the monthly average expenditure per capita(x)

Y	X
6.10	10.20
5.48	10.32
6.09	10.50
6.83	12.40
7.41	13.84
7.59	14.81
8.15	15.86
9	18.31
9.15	18.47
9.76	20.65
10.40	22.96
11.43	26.22
11.74	27.88
12.67	29.81
14.07	34.75
15.63	48.40

The minister of planning, family budget 1979

References

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