An Improved Regression Model of Group Rationality by Member Rationality and Characteristics: Group Decision-making under Limited Rationality by Problem-solving and Persuasion

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Introduction :

The purpose of this experiment is to present the regression model which describes the relation between group rationality and group member traits, especially group member characteristics. There are many problems to be solved in the world but our rationality to challenge them is limited. If problem-solving or decision-making within groups is an important part of our lives and if group rationality which determines the problem-solving or decision-making level depends on group member traits, it is essential to estimate the relation between group rationality and group member traits.

Although a large number of studies have been made in this field, there has been only limited success (Williams and Sternberg, 1988 ; Heslin, 1964 ; Mann, 1959). But, with poor R^2, the preceding model developed by GOTO(2002) showed that member traits had a statistically strong relation to group decision-making or group rationality.

In order to improved poor R^2, this experiment developed some dummy variables. These dummy variables brought successful R^2.

This experiment does not, however, treat all types of group decision-making and group member traits. First, group decision-making may be classified into four major types according to March and Simon (1958) : (1) problem-solving, (2) persuasion, (3) bargaining and (4) politics. But, group decision-making in this study covers only problem-solving and persuasion processes. Furthermore, member traits in this paper only mean member rationality scored from a questionnaire and E and N score from Maudsley Personality Inventory (MPI). Although member traits in this paper are limited, they will act as useful factors in regression analysis.

The aim and the method of this experiment :

The aim of this experiment is to develop the regression model which shows group rationality structured by group members' traits.

(1) The subject of this experiment :

Five hundred eighty-seven university students were divided into two, three, four or five-person groups which made one hundred seventy-five groups in total. In the grouping process, the following three criteria were employed for simplification.

a. Group members already know one another.

b. In a group, members are on an equal status. Therefore, members of a group are composed of the same grade university students.

c. Groups have only male or female members. Thus, there are no mixed groups in this experiment.

(2) Measurement of personal characteristics :

Maudsley Personality Inventory (MPI, Japanese edition) was employed.

(3) Measurement of rationality :

Personal rationality of a group member and group rationality were measured by the game developed by Hikaru YANAGIHARA (1982). In this game, the lower the point total, the higher the rationality.

In the beginning, participants are asked to answer the following questionnaire for themselves.

In 1972, Japanese young people were asked to select the most important item in their life among the following eight items.

Now, guess the first item they selected and give the item one point. Next, give two points to the second item, three points to the third item and so on. Thus the last item gets eight points. Don't use the same point more than once.

a. Release from restraint
b. No special reasons for life
c. Money and status
d. Sincerity and love
e. Devotion to the state and society
f. A rewarding job
g. Devotion to international cooperation
h. Religious salvation

There is, of course, the correct answer which came from an actual investigation done by the Prime Minister's Office of Japan in 1972. But, participants can only guess the correct answer. Thus their rationality is limited and their decision-making standards are not optimal but satisfactory.

After completion of the questionnaire, participants were asked to do the same questionnaire by a consensus of group members. At the same time, they were asked to make a consensus not by majority rule but by persuasion.

Data for personal rationality (PR) of a participant were measured by the following formula.

$$\mathrm{PR} = \sum_{i=1}^{8} | X_i - x_i |$$

X_i : Points for the correct answer for the i-th item

x_i : Points for a personal answer for the i-th item

And data for group rationality (GR) were obtained from the next formula.

$$\mathrm{GR} = \sum_{i=1}^{8} | X_i - z_i |$$

X_i : Points for the correct answer for the i-th item

z_i : Points for a group answer for the i-th item

Model :

The preceding model developed by GOTO (2002) :

$$\mathrm{GR} = \beta_0 + \beta_1 \mathrm{MRAV} + \beta_2 \mathrm{EAV} + \beta_3 \mathrm{EAV}^2 + \beta_4 \mathrm{NAV} + \beta_5 \mathrm{NAV}^2 + \beta_6 \mathrm{D} + \varepsilon$$

The variables in the equation mean as follows.

GR : Group Rationality

MRAV : Average of Member Rationality

EAV : Average of Member E score from MPI

NAV : Average of Member N score from MPI

D : Dummy variable; male=1, female=0

This model passed the test of heteroscedasticity by Goldfeld-Quandt test.
The results estimated :

β_0 : 12.604 (t = 3.931)
β_1 : 0.764 (t = 9.214)
β_2 : −0.501 (t = −2.911)
β_3 : 0.008 (t = 2.944)
β_4 : −0.343 (t = −2.520)
β_5 : 0.008 (t = 2.671)
β_6 : −1.006 (t =−2.061)

corrected R^2 = 0.380 P = 1.21E−16

This model succeeds in structuring the relation between group rationality and member traits, namely member rationality and member characteristics. The dummy variable D in the model tells that group rationality of female is lower than that of male group. But because of poor R^2, this model is not useful for prediction.

In order to improve poor R^2, this experiment developed a new model.

$$GRC = \beta_0 + \beta_1 MRAV + \beta_2 EAV + \beta_3 EAV^2 + \beta_4 DMRAV2 + \beta_5 DMRSTD1 + \beta_6 DMRSTD2 + \beta_7 DEAV1 + \beta_8 DESTD2 + \beta_9 DNAV1 + \beta_{10} DNAV2 + \beta_{11} DNSTD1 + \beta_{12} DNSTD2 + \varepsilon$$

The variables in the equation mean as follows.

GRC : Group Rationality expressed by 0～100
MRAV : Average of Member Rationality expressed by 0～100
EAV : Average of Member E score from MPI
DMRAV2 : Dummy variable on Average of Member Rationality
DMRSTD1・2 : Dummy variables on Standard Deviation of Member Rationality
DEAV1 : Dummy variable on Average of Member E score from MPI
DESTD2 : Dummy variable on Standard Deviation of Member E score from MPI
DNAV1・2 : Dummy variables on Average of Member N score from MPI
DNSTD1・2 : Dummy variables on Standard Deviation of Member N score from MPI

Dummy variables in this model were found out by principal component analysis.

(1) Principal component analysis applied to GRC and MRAV made two dummy variables of DMRAV1 and DMRAV2. But, because of poor t-value, DMRAV1 was eliminated in regression analysis.

(2) Principal component analysis applied to GRC and Standard Deviation of Member Rationality made two dummy variables of DMRSTD1 and DMRSTD2.

(3) Principal component analysis applied to GRC and EAV made two dummy variables of DEAV1 and DEAV2. But, because of poor t-value, DEAV2 was eliminated in regression analysis.

(4) Principal component analysis applied to GRC and Standard Deviation of Member E score from MPI made two dummy variables of DESTD1 and DESTD2. But, because of poor t-value, DESTD1 was eliminated in regression analysis.

(5) Principal component analysis applied to GRC and NAV made two dummy variables of DNAV1 and DNAV2 .

(6) Principal component analysis applied to GRC and Standard Deviation of Member N score from MPI made two dummy variables of DNSTD1 and DNSTD2.

This model passed the test for heteroscedasticity by the Goldfeld-Quandt test.
The results estimated :

β_0 : 21.046 (t = 4.499)
β_1 : 0.379 (t = 5.942)
β_2 : 0.644 (t = 2.588)
β_3 : −0.013 (t = −3.224)
β_4 : 4.729 (t = 5.305)
β_5 : 4.358 (t = 4.906)
β_6 : 3.104 (t = 3.745)
β_7 : 2.607 (t = 2.673)
β_8 : 1.779 (t = 2.336)
β_9 : 2.226 (t = 2.621)
β_{10} : 2.759 (t = 3.453)
β_{11} : 3.090 (t = 3.808)
β_{12} : 3.020 (t = 3.664)

corrected R^2 = 0.872 P = 3.44E−68

This model succeeded in structuring the relation between group rationality and member traits, namely member rationality and member characteristics. Furthermore, this model has sufficient R^2 for prediction.

Conclusion :

In this experiment, as a result of making an effort to find dummy variables we succeeded in raising accuracy of the model. The new regression model developed here can offer useful information for improvement in group rationality and in effective personnel management. And this model proved that MPI was useful. Furthermore, by using MPI and dummy variables, we can expect to raise group rationality.

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