Let's Start

Multicollinearity and its impact on estimates of model parameters

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Multicollinearity

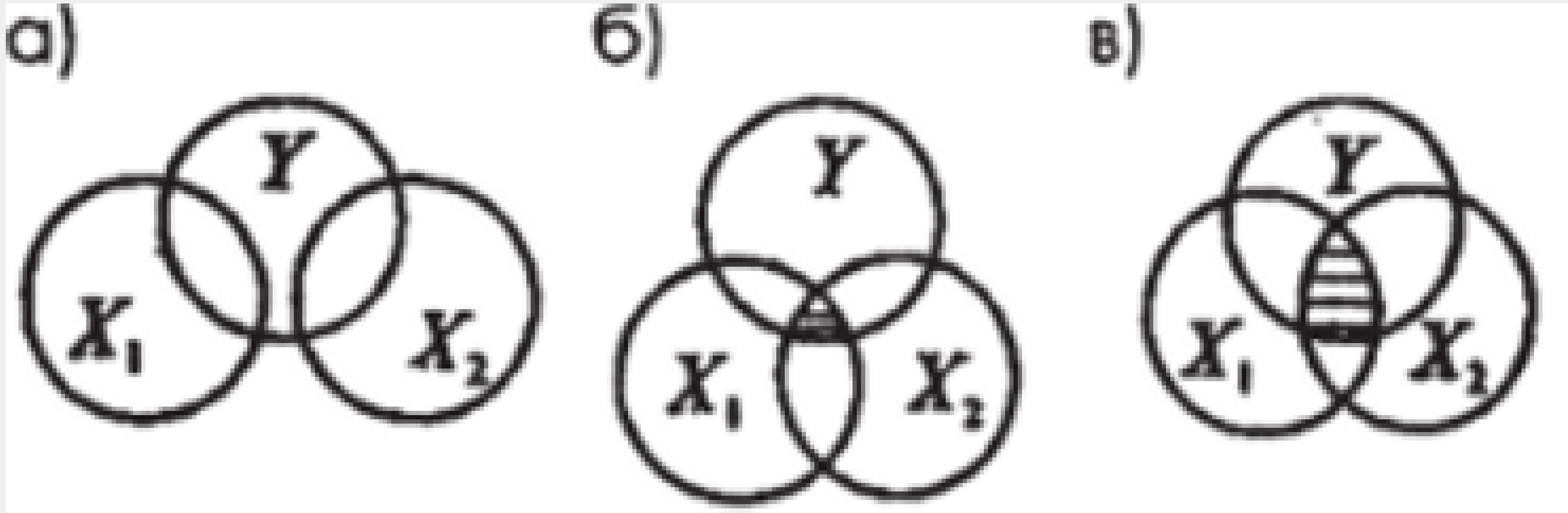
Multicollinearity is a phenomenon in which there is a dense linear relationship between two or more factor variables of the model or, in other words, factor variables have a high degree of correlation

The term "multicollinearity" means that in a multivariate regression model, two or more independent variables, factors are interconnected by a linear relationship or, in other words, have a high degree of correlation.

$$R = \begin{pmatrix} 1 & r_{12} & r_{13} & \cdots & r_{1m} \\ r_{21} & 1 & r_{23} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & r_{m3} & \cdots & 1 \end{pmatrix}$$

г)

Graphically, this situation is presented in the form of a pie chart:



- Subset 1 - describes the individual effect of factor x1.
- Subset 2 - describes the individual effect of factor x2.
- Subset 3 - the combined effect of both factors on the variable y, which can not be separated. Graphically describes the situation of collinearity.

The inevitability of multicollinearity

- Multicollinearity is a normal phenomenon.
- Almost any model contains multicollinearity.
- We do not pay attention to multicollinearity until the appearance of obvious symptoms.
- Only excessively strong connections get in the way.

Methods for determining multicollinearity

The most complete study of multicollinearity is carried out according to the Farrar-Glober algorithm, which uses three types of statistical criteria and allows to detect multicollinearity:

- the whole array of independent variables (criterion 2)
- each independent variable with all others (F-criterion)
- each pair of independent variables (t-test)

The Farrar-Glober algorithm
Seven steps

Step 1:

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Normalize variables x1, x2, ..., xm of ecometric model, calculating new (normalized) values of variables xy

$$x_{ij} = \frac{x_{ij} - \overline{x}_j}{\sqrt{n}\sigma_j}$$

Step 2:

Based on the matrix X *, the elements of which are normalized independent variables Xij *, calculate the correlation matrix (matrix of moments of the normalized system of normal equations):

$$R = X^{*T} X^{*} = \begin{pmatrix} 1 & r_{12} & \cdots & r_{1m} \\ r_{21} & 1 & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & 1 \end{pmatrix}$$

Step 3:

Determine | R | - the determinant of the correlation matrix R; calculate the experimental value of criterion 2:

$$\chi^2_{exp} = -[n - 1 - \frac{1}{6}(2m + 5)] ln|R|$$

Compare the value of x^2 with the table at degrees 1 / 2m (m-1) of freedom and the significance of α

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Step 4:

Determine the matrix of errors:

$$C = R^{-1} = \begin{pmatrix} c_{11} & c_{22} & \cdots & c_{1m} \\ c_{21} & c_{22} & \cdots & c_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & c_{mm} \end{pmatrix}$$

Step 5:

Calculate F-criteria:

$$F = \frac{(c_{kk} - 1)(n - m)}{m - 1}$$

Calculate the coefficients of determination for each variable:

$$R_k^2 = 1 - \frac{1}{c_{kk}}$$

Step 6:

Find the partial correlation coefficients that characterize the density of the relationship between two variables, provided that other variables do not affect this relationship (the existence of paired multicollinearity):

$$r_{kj} = \frac{-c_{kj}}{\sqrt{c_{kk}c_{jj}}}$$

Step 7:

Calculate t-criteria:

$$t_{kj} = |r_{kj}| \frac{\sqrt{n-m}}{\sqrt{1-r_{kj}^2}}$$

The values of the t_kj criteria are compared with the tabular ones at n-m degrees of freedom and significance levels α; if t_kj> ttable, then there is multicollinearity between the independent variables xk and xi.

Conclusions of the method:

There may be a linear relationship between independent variables, but it may not be a phenomenon of multicollinearity

If F_exp> F_table, then x_k depends on all other independent variables and it is necessary to decide whether to exclude it from the list of variables

If t_kj> t_table, then xk and xi are closely related

Analyzing the F- and t-criteria, we conclude which of the variables should be excluded from the model (of course, if possible for economic, logical and theoretical reasons)

If following paragraphs. 2-4, we did not achieve the goal, ie did not eliminate multicollinearity, the estimation of the model parameters should be calculated using another method

Conclusion

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End

Thank you

Do you have any questions?