Appendix exhibit 1.

Decomposition-standardization methods

1.1 The case of two factors

To measure the relative effect of each of the two factors, we used the decomposition method described by Das Gupta[1,2]. This decomposition was based on the calculation of the standardized rates of each factor, and then, we calculated the addictive contributions of each factor to the changes in hospital outpatient or inpatient total expenditure in different years from 2008 to 2018 using the following equations:

Price and intensity standardized medical expenditure: y_0: $\frac{P_{y1}+P_{y0}}{2}V_{y0}$

Price and intensity standardized medical expenditure: y_1: $\frac{P_{y1}+P_{y0}}{2}V_{y1}$.

The difference between the y_0 price and intensity standardized medical expenditure and the y_1 price and intensity standardized medical expenditure is the effect of the difference in the service volume, or the contribution of the difference in the service volume to the difference in the medical expenditure between y_0 and y_1 based on the following equation:

$$V_a = \frac{P_{y1}+P_{y0}}{2}(V_{y1} - V_{y0}).$$

Similarly, the difference between the y_0 service volume standardized medical expenditure and the y_1 service volume standardized medical expenditure is the effect of the difference in the price and intensity, or the contribution of the difference in the price and intensity to the difference in the medical expenditure between y_0 and y_1 based on the following equation:

$$P_a = \frac{V_{y1}+V_{y0}}{2}(P_{y1} - P_{y0}).$$

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Then, we obtain the following identity:

$$\Delta TME = TME_{y1} - TME_{y0} = V_a + P_a \, .$$

The relative contributions of the two factors can be expressed as follows:

$$V_r = {V_a}/{\Delta TME} * 100\%,$$

$$P_r = {p_a}/{\Delta TME} * 100\%,$$

where ΔTME is the change in the total medical expenditures between y_1 and y_0 (e.g., 2008 and 2018). V_a is the difference in the total medical expenditures associated with the difference in the service volume in counterfactual scenarios if the price and intensities were identical in the two years; P_a is the difference in the total medical expenditures associated with the difference in the service price and intensity in counterfactual scenarios if the service volumes were identical in the two years; V_r is the relative contribution rate of the difference in the total medical expenditure attributed to the in the service volume by expressed as a percentage; and P_r is the relative contribution rate of the difference in the total medical expenditure attributed to the difference in the service price and intensity by expressed as a percentage.

1.2 The case of four factors

The following four factors were constructed: (1)the total Chinese population, (2) the utilization rate (hospital visits per capita), (3) the share of public hospital service utilization, (4) the service price and intensity; then, the total medical expenditure of public hospitals can be written as follows:

$$\mathrm{TME_y} = Pop_{\,y} \times \frac{V_{th,y}}{Pop_{\,y}} \times \frac{V_{ph,y}}{V_{th,y}} \times \mathrm{P}_y,$$

where y indicates the year; $\mathrm{TME_y}$ is the total medical expenditure of public hospitals; Pop_y is the population size; $\mathrm{V_{th,y}}$ is the service volume of all hospitals (including public and private hospitals); $V_{ph,y}$ is the service volume of public hospitals; and $\mathrm{P_y}$ is the service price and intensity of public hospital care.

To make it easier to write the above equation, the total medical expenditure can be written as follows:

$$\mathrm{TME_y} = \alpha\ \beta\ \gamma\ \delta\ .$$

Then, we can express the total medical expenditure in y_0 and y_1 as follows:

$$\mathrm{TME_{y0}} = \mathrm{ABCD},\ \ \mathrm{TME_{y1}} = \mathrm{abcd}$$

From the decomposition method described by Das Gupta[1,2], we obtain $\beta\ \gamma\ \delta$-standardized expenditure as follows:

in y_0=Q(A),

in y_1=Q(a),

such that

$$\alpha\text{\_effect} = Q(a-A),$$

where Q is a function of b,c,d,B,C,D given by the following:

$$Q = Q(b,c,d,B,C,D) = \frac{bcd+BCD}{4} + \frac{bcD+bCd+Bcd+BCd+BcD+bCD}{12}.$$

Other standardized total medical expenditure and factor effects can be easily derived by interchanging the letters in the above equations. For example, the $\alpha\ \gamma\ \delta$ standardized total medical expenditure and effect are obtained by substituting b,a,B,A for a,b,A,B, respectively.

Then, we obtain the following identity:

$$\Delta\mathrm{TME} = \mathrm{TME_{y1}} - \mathrm{TME_{y0}} = \alpha\text{\_effect} + \beta\text{\_effect} + \gamma\text{\_effect} + \delta\text{\_effect}$$

Note

1. Das Gupta P. Decomposition of the difference between two rates and its consistency when more than two populations are involved. *Mathematical Population Studies:: An International Journal of Mathematical Demography* 1991;3(2):105-25.
2. Das Gupta P. Standardization and decomposition of rates: a users's manual: US Department of Commerce, Economics and Statistics Administration, Bureau of the Census 1993.

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