of physicians in relation to population between any two areas depends on the difference in income, the proportion of income, a, spent on each visit, the number of visits per person per unit of time, b, and the total number of physicians, N. However, (3) the relative distribution of physicians, as shown by a Lorenz curve, is independent on the magnitude of either $a$, $b$, or $N$.

The effect on distribution of an increase in $N$ can easily be demonstrated graphically. In Figure 1 an increase in the number of physicians from $N_1$ to $N_2$ raises the physician-population ratio in area $Y_{r_1}$ from $R_1$ to $R_3$ and in area $Y_{r_2}$ from $R_2$ to $R_4$. The absolute increase in the ratio is greater in area $Y_{r_2}$ than in area $Y_{r_1}$, since $R_4 - R_2 > R_3 - R_1$, but the relative increase is the same in both areas, since $R_2/R_1 = R_4/R_3$. The percentage increase in the physician-population ratio in any area will be the same as the percentage increase in the total number of physicians.[8]

The distribution of physicians in this situation could therefore not be made more equal by simply increasing the number of physicians; it would in fact become less equal in an absolute sense. Nor would a willingness on the part of physicians to reduce their fees in relation to income result in a more equal relative distribution, unless fees were reduced to zero. A change in fees or in the number of visits per person would have the same effect on physician distribution as a change in the number of physicians, since they all affect the slope of the distribution line.

[8] This can be demonstrated mathematically by showing that the elasticity of the regional physician-population ratio with respect to changes in the number of physicians equals one:

$$E_{R_r \cdot N} = \frac{dR_r}{R_r} \bigg/ \frac{dN}{N} = 1$$

By substituting $\frac{(abY)P}{N}$ for $y$, we get

$$R_r = \left(\frac{Y_r}{YP}\right) N \quad \text{and} \quad \frac{dR_r}{dN} = \frac{Y_r}{YP}$$

We can now show that:

$$\frac{dR_r}{R_r} \bigg/ \frac{dN}{N} = \frac{Y_r}{YP} \cdot \frac{N}{R_r} = \frac{Y_r N}{YP} \cdot \frac{1}{Y_r N/YP} = 1$$

*B. Nonlinear Models*

It is not consistent with known facts to assume that the number of visits per person remains constant as per capita income increases. As a rule higher incomes are correlated with larger numbers of visits, although the absolute increase is not likely to be very large. We can easily take this relationship into account by expressing the number of visits as a function of income. Let

$b'Y$ = number of visits per person per unit of time in the country as a whole, and

$b'Y_r$ = regional number of visits per person per unit of time.

The regional physician income then becomes

$$y = \frac{ab'Y_r^2}{R_r} \tag{4}$$

and the regional physician-population ratio

$$R_r = \frac{ab'Y_r^2}{y} \tag{5}$$

The relationship between regional income and the physician-population ratio is now nonlinear, and the distribution lines are curves convex to the origin.

Other things remaining equal, the introduction of a positive relationship between visits and income makes the physician distribution more unequal, in the sense of pushing the Lorenz curve to the right. However, as before, an increase in the number of physicians would still leave the relative distribution unaffected and increase the physician-population ratio everywhere by the same percentage.[9]

[9] As in the previous case, the elasticity of the physician-population ratio with respect to changes in number of physicians equals one. From equation (5) we get

$$R_r = \frac{Y_r^2}{Y^2} \cdot \frac{N}{P}$$