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PROGRESSIVITY OF HEALTH CARE FINANCING: ESTIMATION AND STATISTICAL INFERENCE*

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This paper examines the vertical distribution of health care financing in Finland. The empirical analysis is based on a new approach that allows the estimation of inequality indices from micro-level data, and testing for the statistical significance of differences in the distributions. Estimates of standard errors were computed for the Gini coefficient of gross income and for concentration and progressivity indices of various health care financing sources. The results suggest that overall health care financing in Finland in the early 1990s was distributed progressively: poorer households financed health care by a smaller proportion of their gross income than richer households. However, the level of progressivity of various financing sources differed, and in most cases the differences were sufficiently large to rank the various financing components according to their contribution to overall progressivity. (JEL: H22, I19)

1. Introduction

Nowadays many types of policy evaluation studies incorporate the measurement of inequality. Two common inequality measures are the Gini coefficient of income inequality and the related concentration coefficient. The concentration coefficient can be used to measure the extent of inequality arising from different income components (taxes, social insurance contributions, public transfers) or, more generally, the distribution of other economic or non-economic resources across socio-economic groups (e.g. public expenditure, morbidity, medical procedures). These two measures are also employed for examining the progressivity of distributions, such as taxes, public transfers or user charges.

Despite the improved accuracy of inequality measures in recent years – attributable to technical and methodological development – methods for testing their statistical significance have been lacking. The sampling properties of the Gini coefficient are widely documented (e.g. Nygård and Sandström 1981, Kakwani 1990), but although the concentration and progressivity indices are related to the Gini coefficient, they cannot be exposed to statistical testing in a similar manner. The reason is that these indices can be negative or positive and cannot, therefore, be written in the form of order statistics (Kakwani *et al.* 1997).

This paper applies a new method that permits the computation of standard errors for concen-

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tration and progressivity indices. The approach is introduced here by estimating the progressivity of health care financing in Finland, but its use is more general and it can be applied to various forms of distributional analysis. The new method has several advantages: the computation of inequality indices is based on micro-data and produces relatively reliable estimates; the standard errors can be used to test if differences in the distributions of various income or financing sources are statistically significant; confidence intervals can be constructed to assess the significance of distributional changes over periods of time, or to evaluate the equity implications of various policy alternatives.

The paper is organised as follows. Section 2 provides a summary of the Finnish health care system along with a brief description of the distributional characteristics of various financing mechanisms. Section 3 outlines the data and assumptions underlying the choice of variables. Section 4 illustrates the approach employed to estimate the concentration and progressivity indices and the construction of confidence intervals. Section 5 presents the progressivity results for various health care financing sources, and the corresponding confidence intervals using two different estimators of standard errors. Lorenz-dominance and the robustness of the results to the choice of equivalence scale are also investigated. The final section summarises and discusses the findings.

2. *Health care financing, progressivity and distributional aspects*

Health care in Finland is mainly based on public financing and provision of services. In 1990 about 85% of total health care expenditure was financed through the public sector. The public financing share was derived from taxes (direct income taxes and indirect taxes) and tax expenditures (75%), and sickness insurance payments (10%). The remaining 15% was financed by direct payments from households, including user charges for public services, and non-subsidised medicines, and copayments for private treatment. Private health insurance occupied a relatively unimportant role in Finland, accounting for less than 2% of overall health care financing.

The structure of the financing system and the coverage of public health services are important for reasons associated with the incentives to use health services, but also because of the distribution of noncash income received from public health care utilisation and of disposable income and consumption potential in general. The financing mechanism may constrain people from using health services they need, and, on account of their lower income, it may affect the poor more than the rich. Examples of such constraints are eligibility under particular insurance schemes, premium rates and out-of-pocket payments. Even if there is no link between health care payments and utilisation, the distribution of disposable income after health care payments may influence health (positively or negatively) through the consumption of commodities other than health care. It may also be considered socially undesirable if the financing of health services is concentrated among those sections of the population whose ability to pay is the lowest.

The emphasis given to each of the four financing sources – taxation, social insurance, private insurance and out-of-pocket payments – varies between different health care systems, as does the distributional characteristics of these systems. In international comparisons on progressivity of health care financing (van Doorslaer *et al.* 1992, Wagstaff *et al.* 1998) the most progressive health care systems are found in countries where the main source of financing is general taxation. The degree of progressivity varies from proportional to mildly progressive with respect to the weight given to progressive direct and regressive indirect taxes in the financing mix. Regressive financing sources are social insurance and private payments. Countries where the bulk of health care is financed through social insurance contributions tend to have regressive systems, while the most regressive systems are found in countries where private financing, either in the form of private insurance or out-of-pocket payments, is a significant source of revenue.

However, for many purposes it is not sufficient to compare the progressivity of various forms of finance without reference to the statistical properties of the underlying data. Since differences in progressivity are often very small, the absence of statistical testing is an obvious shortcoming in analyses concerning comparisons of individual financing sources, international comparisons of different financing systems, or analyses examining changes in progressivity over periods of time.

3. Data and variables

The main data source was the 1990 Finnish Household Survey (FHS). The FHS is a multipurpose sample survey used to analyse the structure of household income, consumption and utilisation of social services. The target population consists of resident households, with those in institutions excluded. In 1990 the sample size was about 11 700 households and complete data were received from 8 258 households.

The FHS includes data from administrative files, such as registers of income taxation, national pensions, sickness insurance, child benefits and housing supports. Indirect taxes were estimated from the FHS data by weighting each household's consumption by the value-added and excise tax levies on aggregated commodity groups. Data on households' health care expenditure were derived from the FHS data and administrative files, except for hospital inpatient charges, which were estimated from the Finnish Hospital Discharge Registers (FHDR) of 1989, 1990 and 1991. The FHDR gathers data annually on discharges from all public and private hospitals in Finland. The register contains information on e.g. discharge diagnoses, surgical procedures, length of stay, type of hospital and specialty. Due to the infrequency of hospital care, the one year period used in the survey is relatively short for analysing hospital utilisation. For this reason inpatient charges were calculated from a merged data set combining the FHDR and FHS files. Households' total inpatient charges were obtained by weighting the three-year average of hospital inpatient days by the *per diem* inpatient charge in 1990 (FIM 80).

In the absence of earmarked taxes and social insurance contributions the proportion of each revenue source used to finance health care is not directly observable. They were estimated by weighting all taxes and sickness insurance contributions by the revenue collecting sector's share of total health care expenditures. For example, the share of state taxes used to finance health care is equivalent to the state's share of total health care expenditures. Likewise, the proportions of sickness insurance contributions and out-of-pocket payments are equivalent to the expenditure shares of the Social Insurance Institution and direct payments by households, respectively.

In estimating sickness insurance payments it was assumed that the employers' share was borne entirely by employees (labour supply was assumed to be totally inelastic). Thus, households' sickness insurance contributions consisted of the payment shares of employers, employees, the state and the municipalities. The contributions of the state and the municipalities were assumed to be borne proportionally to state and municipality taxes.

Progressivity was analysed with respect to household gross income. All income, taxes and payments were adjusted by an equivalence scale. The OECD-scale was used, in which the first adult receives a weight of 1, every other adult a weight of 0.7, and each child a weight of 0.5. In order to test the sensitivity of the results to the choice of equivalence scale, progressivity indices were also computed using a parametric scale (cf. Buhman *et al.* 1988, Aronson *et al.* 1994) given by:

$$(1) \quad E_i = (A_i + \omega C_i)^{\alpha} \quad 0 \leq \alpha \leq 1{,}0 \leq \omega \leq 1$$

where A_i is the number of adults and C_i is the number of children in household i. The larger the elasticities ω and α the smaller the economies of scale assumed by the equivalence scale. The value of $\alpha = 0$ corresponds to not equivalising, using household gross income as the criterion for interhousehold welfare comparisons, while the value of $\alpha = 1$ (and $\omega = 1$) represents the other extreme, where welfare is defined

with respect to per capita income. The OECD-scale corresponds to the value of $\alpha = 0.73$ ($\omega = 1$). Household equivalent gross income (under an individualistic, utilitarian, social welfare function) was defined as:

$$(2) \quad y_i = n_i \left(\frac{Y_i}{E_i} \right)$$

where Y_i is household gross income and n_i is the number of persons in household i.

Households were ranked in ascending order according to their equivalent gross income, but since the individual rather than the household was regarded as the relevant income unit, the weighting procedure, outlined in equation (2), is equivalent to ranking individuals according to their household equivalent income (Danziger and Taussig 1979). The income distribution consists, therefore, of individuals whose income has been adjusted according to their household characteristics.[1]

In order to control for estimation bias arising from systematic nonresponse in the sample, population weighted variables were used. Because the proportion of the population represented by each household in the sample is not the same, the ranks R_i must be defined as the cumulative proportion of the population up to the midpoint of each group interval (Lerman and Yitzhaki 1989):

$$(3) \quad R_i = \sum_{j=0}^{i-1} w_j + w_i/2$$

where w_i are the population weights (number of persons represented by each household) and $w_0 = 0$. A relative rank variable was obtained by dividing each rank by the sum of the population weights.

4. *Measurement of progressivity and statistical inference*

Progressivity was measured by Kakwani's progressivity index (Kakwani 1977), which indicates the extent to which the financing system departs from proportionality. It is given by the difference between the concentration curve for health care payments $C(y)$ and the Lorenz curve for pre-payment income $L(y)$ (Fig. 1).

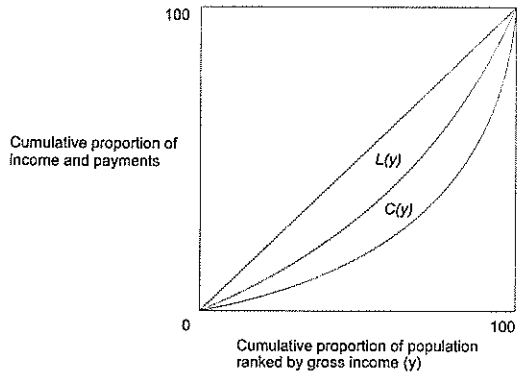

Figure 1. Lorenz (L) and concentration (C) curves

The $L(y)$ curve plots the cumulative proportion of households, ranked by gross income y, against the cumulative proportion of gross income, while the concentration curve $C(y)$ ranks the cumulative proportion of households against the cumulative proportion of health care payments. A positive value of the index implies that financing is progressive, and a negative value that financing is regressive. Kakwani's index can have values ranging from –2 (when all pre-payment income is concentrated to the richest person and the entire financing burden falls on someone else) to 1 (when pre-payment income is distributed proportionally and the entire financing burden falls on one person).

Income inequality was measured by the Gini coefficient G, which can be written in covariance form as:

$$(4) \quad G = \frac{2}{\bar{y}} \sum_{i=1}^{n} w_i (y_i - \bar{y})(R_i - \bar{R})$$

where $\bar{y}$ and $\bar{R}$ are the weighted means of equivalent income and relative ranks respectively ($\bar{R} = 0.5$).

Concentration indices, denoted hereafter by CI, can be obtained analogously by plotting the cumulative proportion of the population against the cumulative proportion of the relevant payment variable.

[1] *O'Higgins* et al. *(1989) provide a thorough summary on the methodological aspects of interhousehold welfare comparisons and the treatment of income units in distributional analysis.*

The value of G or CI can be estimated simply by running OLS on the following equation (cf. Kakwani *et al.* 1997):

$$(5)\quad 2\sigma_R^2\,(y_i/\bar{y}) = \alpha + \beta R_i + e_i$$

where if a weighted sample is used, σ_R^2 is the weighted variance of the relative rank, and the appropriate parameter estimates can be attained by running WLS (Weighted Least Squares) instead of OLS. The WLS estimator of β can be written as:

$$(6)\quad \hat{\beta} = \frac{2}{\bar{y}} \sum_{i=1}^{n} w_i (y_i - \bar{y})\left(R_i - \frac{1}{2}\right)$$

which from equation (4) is shown to equal G. This regression also gives the standard error of G. When y is replaced by the relevant payment variable, the parameter estimate and standard error of CI can be attained.

Ranking households by gross income is likely to make successive observations correlate with each other. If observations are not independent of one another, the standard errors are not entirely accurate. The following estimator of the variance of G (or alternatively of CI) takes into account serial correlation in the data:

$$(7)\quad \mathrm{var}(G) = \frac{1}{n}\left(\frac{1}{n}\sum_{i=1}^{n} a_i^2 - (1+G)^2\right)$$

where

$$(8)\quad a_i = \frac{y_i}{\bar{y}}(2R_i - 1 - G) + 2 - q_{i-1} - q_i$$

and

$$(9)\quad q_i = \frac{1}{\mu}\sum_{\kappa=1}^{i} y_\kappa$$

$\mu = \sum_{i=1}^{n} y_i$, being the weighted sum of gross income (the derivation of these estimators is presented in more detail in Kakwani *et al.* 1997).

The progressivity index KI is defined as twice the area between $C(y)$ and $L(y)$. It can be estimated by means of the following regression:

$$(10)\quad KI = 2\sigma_R^2\left(\frac{c_i}{\bar{c}} - \frac{y_i}{\bar{y}}\right) = \alpha + \beta R_i + e_i$$

where c_i denotes payments of household i and $\bar{c}$ is the weighted mean of payments. The WLS estimate of β will be equal to KI. This regression gives the standard error of KI. As before, the standard errors from this regression equation may not be wholly accurate. The following estimator takes into account serial correlation:

$$(11)\quad \mathrm{var}(KI) = \frac{1}{n}\left(\frac{1}{n}\sum_{i=1}^{n} \alpha_i^{*} - (a_i)^2 - KI^2\right)$$

where a_i^* is defined with respect to CI analogously to a_i. In addition, seemingly unrelated regressions (SUR) estimation was used to allow for cross equation correlation of the disturbance terms.

Since Kakwani's index is a summary measure of progressivity, two types of violations against the Lorenz-dominance criterion may occur: first, the concentration curves may cross (equal) the Lorenz curve at some income level(s), in which case the inequality estimate given by the average progressivity index does not conform to all parts of the distribution, and second, the concentration curves may cross (equal) each other, in which case the comparison of the distributions according to their degree of progressivity is ambigious. In order to identify any such cases, the dominance between each distribution was tested at the decile and the household level.

5. Results

Table 1 shows the distribution and progressivity of the various health care financing sources and overall financing. Direct taxes and sickness insurance payments were progressive forms of finance. Households' direct payments were clearly regressive, indicating that the lower income groups accounted for a bigger share of out-of-pocket payments than they received of gross income. State taxes were also regressive in terms of indirect taxation (–0.097), but progressive for income taxation (0.269). Since the emphasis was on the latter revenue source, the total financing burden of state taxation was distributed slightly progressively (0.039).

Overall, the public financing sources were distributed in favour of the poorer households, but the regressivity of out-of-pocket payments

Table 1. Distribution and progressivity of health care financing

	Gross income	Income tax	Indirect taxes	Local tax	Sickness insurance	Total public	Direct payments	Total financing
Revenue share (%)		14.0	24.0	37.0	11.0	86.0	14.0	100.0
CI	0.256	0.526	0.160	0.333	0.342	0.317	0.058	0.280
D-W	1.447	0.994	1.962	1.508	1.729	1.500	2.000	1.578
KI		0.269	–0.097	0.077	0.086	0.061	–0.198	0.024
se	(0.0044)	(0.0067)	(0.0042)	(0.0018)	(0.0020)	(0.0017)	(0.0100)	(0.0020)
L95	0.247	0.256	–0.105	0.073	0.082	0.058	–0.218	0.020
U95	0.265	0.282	–0.088	0.081	0.090	0.064	–0.178	0.028
se*	(0.0051)	(0.0097)	(0.0056)	(0.0023)	(0.0027)	(0.0021)	(0.0109)	(0.0023)
L95	0.246	0.250	–0.108	0.072	0.081	0.057	–0.219	0.019
U95	0.266	0.288	–0.086	0.082	0.091	0.065	–0.177	0.029

CI: concentration index
D-W: Durbin-Watson test for correlation of residuals
KI: Kakwani's progressivity index
se: standard error
se*: standard error accounting for serial correlation
L95 and U95: lower and upper limits of 95% confidence interval

made the distribution of total health care financing almost proportional to income. All health care financing sources were significantly different from zero (proportionality), indicating a redistributive effect in either direction.

The Durbin-Watson test statistics seemed to yield consistent results – serial correlation was present among those financing sources for which a high value of the dependent variable could be expected to appear together with a high value of the ranked income variable (Table 1). This was especially evident for the clearly progressive income taxes, and to a lesser degree for those financing components (local taxes, sickness insurance payments, total public financing and total financing) that were closer to proportionality. On the other hand, the distributions of indirect taxes and direct payments showed no evidence of autocorrelation. The apparent reason is that revenue collected through these financing sources is not as closely connected to the level of gross income as revenue collected through the progressive or proportional sources. For progressivity indices, accounting for serial correlation seemed to produce larger standard errors and wider confidence intervals compared to the situation where serial correlation was not taken into account (see Table 1). The adjustment did not affect the standard errors of concentration indices in any predictable way.

In all but one case the differences in the level of progressivity were large enough to rank the financing sources according to their contribution to overall progressivity (see Table 1). The exception was local taxes and sickness insurance payments which, when serial correlation was accounted for, had intersecting confidence intervals. The significance of the differences can be examined in more detail in a pairwise comparison of the various financing sources. Significance tests were based on the (SUR) estimated standard errors of the progressivity and concentration indices using Student's t-tests. The upper-right triangle of Table 2 (Table 3) indicates the significance of differences in progressivity (concentration) indices, when serial correlation was accounted for.

The lower-left triangle of Table 3 shows the dominance between concentration curves with respect to their decile ordinates. The results were in line with those of the significance tests – the concentration curve of local taxes intersected that of sickness insurance payments. The number of crossings increased substantially when the dominance test was carried out between all observations on micro-level data (Table 4). The criss-cross pattern apparent in the

Table 2. Statistical tests (t-test) of differences in progressivity indices

	Income tax	Indirect taxes	Local tax	Sickness insurance	Direct payments
Income tax	–	*** (>)	*** (>)	*** (>)	*** (>)
Indirect taxes		–	*** (<)	*** (<)	*** (>)
Local tax			–	ns	*** (>)
Sickness insurance				–	*** (>)
Direct payments					–

* = significant at 5% level, ** = significant at 1% level, *** = significant at 0.1% level
ns = not significant
(>)/(<): more/less progressive than

Table 3. Statistical tests (t-test) and dominance of concentration curves

	Gross income	Income tax	Indirect taxes	Local tax	Sickness insurance	Direct payments
Gross income	–	***	***	***	***	***
Income tax	sd	–	***	***	***	***
Indirect taxes	sd	sd	–	***	***	***
Local tax	sd	sd	sd	–	ns	***
Sickness insurance	sd	sd	sd	cr (1)	–	***
Direct payments	sd	sd	sd	sd	sd	–

* = significant at 5% level, ** = significant at 1% level, *** = significant at 0.1% level
ns = not significant
sd = strict dominance, cr = curves cross (number of crossings)

distributions of local taxes and sickness insurance payments is in a sense counter-intuitive, considering that these payments were determined proportionally with respect to the same income concept (taxable income under municipality taxation). The great number of crossings is likely to be caused by the two distributions being very close to each other, and the fact that unlike sickness insurance payments, local tax rates varied by municipality.

The progressivity indices were rather robust to the choice of equivalence scale (Fig. 2). As the value of the scale parameter α was increased from 0 to 1, the progressivity of total health care financing increased from 0.006 to 0.027.

In particular, progressivity of the public financing sources seemed to be insensitive to the choice of equivalence scale, while the index of households' direct payments responded more readily. The slight increase in the progressivity of total health care financing was, therefore, mainly attributable to the decrease in the regressivity of direct payments as different equiva-

Table 4. Dominance of concentration curves at micro-level

	Gross income	Income tax	Indirect taxes	Local tax	Sickness insurance	Direct payments
Gross income	–	cr (1)	sd	cr (15)	cr (70)	sd
Income tax		–	cr (1)	d	d	sd
Indirect taxes			–	cr (1)	cr (1)	cr (158)
Local tax				–	cr (1252)	sd
Sickness insurance					–	sd
Direct payments						–

d = dominance, sd = strict dominance, cr = curves cross (number of crossings)

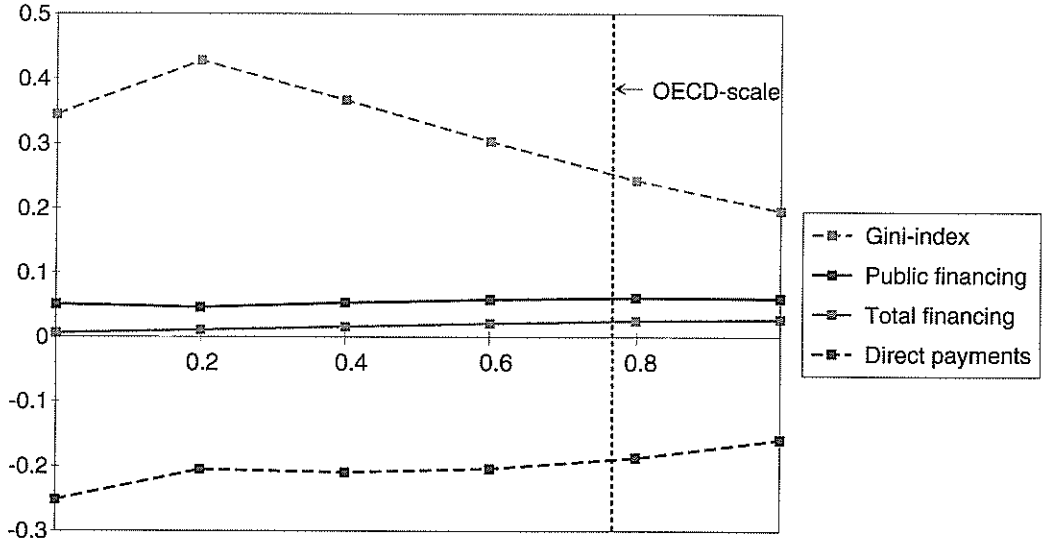

Figure 2. Change in indices using different equivalence scales

lence scales were used. By itself, the Gini coefficient seemed to be highly sensitive to the treatment of additional household members, but since the distributions underlying the concentration indices changed accordingly, progressivity was not affected much. The appendix shows the effect of varying the weight given to children in the equivalence scale (when $w = 1$ the scale coincidences with the respective scale in Fig. 2).

6. *Conclusions and discussion*

Health care financing in Finland was distributed slightly in favour of the poorer households in 1990. The progressive revenue sources were direct taxation and sickness insurance contributions, whereas indirect taxation and households' out-of-pocket payments were clearly regressive. The reason for the surprisingly low level of progressivity of direct income taxes was that a larger share of revenue was collected from proportional local taxes than from the more progressive state income taxes. By similar reasoning, the overall system turned out to be progressive because the emphasis in financing was on the progressive revenue sources. Had indirect taxes and out-of-pocket payments contributed more, the outcome would have been different in that poorer households would have participated in health care financing by a larger share.

On the basis of standard errors estimated for the progressivity indices, the differences proved to be sufficiently large to rank individual financing sources according to their level of progressivity. To improve the accuracy of the standard error estimates, an estimator that takes into account serial correlation in the data was used. The adjusted standard errors of progressivity indices seemed to become systematically larger, although the differences between these two classes of standard errors were rather small. It was also shown that while the underlying distributions appeared very different depending on which equivalence scale was used, the conclusions regarding progressivity remained the same.

The fact that progressivity of one financing source differs significantly from another does not mean that this is true for all income ranges across the entire distribution. Furthermore, since Kakwani's index is a summary measure of inequality, it is possible for the distribution of payments to be progressive over one range of income and regressive over another. Dominance tests showed that, at the decile level, con-

centration curves were generally well behaved and non-intersecting (the statistical significance of this relationship was not tested). However, as concentration curves were plotted at the household level, most crossed at least once and several curves recorded multiple crossings. This indicates that for a great number of households the relative ranking and inequality effect of certain payment sources was exactly the opposite of the effect suggested by the general progressivity indices.

In cases where the dominance criterion is satisfied, computation of confidence intervals allows to make inference about the relative degree of inequality of various distributions in a statistically sound manner. This is useful in situations where the purpose is to assess the equity implications of various policy alternatives or to examine changes in inequality over time. Although the objective of this study was to measure the progressivity of the health care financing system, the methods, results and conclusions presented here are more general – the results concerning the distribution of various taxes conform equally to the overall tax system, describing the contribution to overall inequality arising from each revenue source. In future work the methods and results outlined in this paper can be used to examine the distributional consequences of changes in the economic situation and the effects of the various health care reforms instituted at the begging of this decade.

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Appendix. Effect of variation in household size and composition

Parameter value		Gini coefficient	Public financing	Direct payments	Total financing
$\alpha = 0.0$		0.345	0.051	–0.252	0.006
$\alpha = 0.2$	$\omega = 0.0$	0.455	0.041	–0.209	0.007
	$\omega = 0.2$	0.447	0.042	–0.209	0.008
	$\omega = 0.4$	0.441	0.043	–0.208	0.009
	$\omega = 0.6$	0.436	0.044	–0.207	0.010
	$\omega = 0.8$	0.432	0.045	–0.206	0.011
	$\omega = 1.0$	0.428	0.046	–0.205	0.011
$\alpha = 0.4$	$\omega = 0.0$	0.427	0.043	–0.223	0.008
	$\omega = 0.2$	0.409	0.047	–0.221	0.010
	$\omega = 0.4$	0.395	0.049	–0.219	0.013
	$\omega = 0.6$	0.384	0.051	–0.216	0.014
	$\omega = 0.8$	0.375	0.052	–0.213	0.015
	$\omega = 1.0$	0.367	0.053	–0.210	0.016
$\alpha = 0.6$	$\omega = 0.0$	0.396	0.046	–0.232	0.008
	$\omega = 0.2$	0.366	0.051	–0.229	0.013
	$\omega = 0.4$	0.344	0.055	–0.223	0.016
	$\omega = 0.6$	0.327	0.057	–0.217	0.018
	$\omega = 0.8$	0.313	0.058	–0.210	0.020
	$\omega = 1.0$	0.303	0.058	–0.204	0.021
$\alpha = 0.8$	$\omega = 0.0$	0.363	0.047	–0.236	0.008
	$\omega = 0.2$	0.319	0.055	–0.229	0.015
	$\omega = 0.4$	0.290	0.059	–0.219	0.019
	$\omega = 0.6$	0.268	0.060	–0.208	0.022
	$\omega = 0.8$	0.253	0.061	–0.197	0.024
	$\omega = 1.0$	0.243	0.061	–0.187	0.025
$\alpha = 1.0$	$\omega = 0.0$	0.330	0.047	–0.232	0.008
	$\omega = 0.2$	0.274	0.057	–0.220	0.017
	$\omega = 0.4$	0.239	0.060	–0.204	0.022
	$\omega = 0.6$	0.217	0.062	–0.188	0.025
	$\omega = 0.8$	0.203	0.061	–0.172	0.027
	$\omega = 1.0$	0.196	0.060	–0.159	0.027