Intra-age, inter-age and lifetime income redistribution*

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Abstract

This paper analyzes intra-age, inter-age, and lifetime income redistribution effects of present taxation and social security programs, based on the 1996 Survey on the Redistribution of Income. Among others, the main findings are: (1) the income redistribution effect of taxes and social security systems manifests itself more between age groups than within age groups; (2) while taxes have more impact on intra-age redistribution, social security programs have more impact on inter-age redistribution; and (3) redistribution effects of the Employees' Pension Insurance in terms of lifetime income are very limited compared to those on a cross-section basis.

Key words: income redistribution, taxation, social security.

1. Introduction

Taxation and social security are social mechanisms that directly or indirectly bring income redistribution. From the standpoint of economics, however, there are some delicate issues related to evaluating their redistribution functions. This paper aims to evaluate the income redistribution effect of current taxes and social security services from three perspectives, that is, on intra-age, inter-age, and lifetime income bases, using micro data (household micro data) of the 1996 Survey on the Redistribution of Income.

The Survey on the Redistribution of Income, which provides the basis of the analysis in this paper, is a representative investigation on income redistribution. According to this Survey, while the Gini coefficient has been on an upward trend in the recent several years, the rate of reduction in the values of the coefficient by social security and taxation is increasing (see Table 1). However, it would be a problem to conclude, based only on these data, that social security and taxation have made great contributions to reducing income differentials among households.[1]

This argument is made because the widening income gaps shown by a rising Gini coefficient and the increasing rate of the coefficient's reduction as a result of redistribution policies might reflect the facts (1) that the ratio of elderly people, who had originally great income differentials, grew higher because of population-aging and

Table 1 Time-series change in the income redistribution effect of taxation and social security programs

		Redistributed income		Income redistributed by taxation		Income redistributed by social security programs	
Survey year	Gini coefficient of initial income	Gini coefficient	Degree of improvement (%)	Gini coefficient	Degree of improvement (%)	Gini coefficient	Degree of improvement (%)
1981	0.3491	0.3143	10.0	0.3301	5.4	0.3317	5.0
1984	0.3975	0.3426	13.8	0.3824	3.8	0.3584	9.8
1987	0.4049	0.3382	16.5	0.3879	4.2	0.3564	12.0
1990	0.4334	0.3643	15.9	0.4207	2.9	0.3791	12.5
1993	0.4394	0.3645	17.0	0.4255	3.2	0.3812	13.2
1996	0.4412	0.3606	18.3	0.4338	1.7	0.3721	15.7

Note: The degree of improvement is the ratio of decrease in the Gini coefficient obtained by redistribution policies to the Gini coefficient of the initial income.

that (2) the income redistribution function between generations, which is inherent in the current social security system, was activated. Thus, it might not mean any lessening of income gaps.

According to Ohtake and Saito [1999], who analyzed changes in income inequalities and the effects of redistribution policies using the 1981 and 1993 Surveys on the Redistribution of Income, while policy effects were almost all brought by a reduction of differentials within age groups in 1981, the narrowing of income gaps between age groups made a greater contribution in 1993. Based on the results of the analysis, they pointed out the risk of simply linking a reduction of income differentials in the entire economy with an evaluation of redistribution policies. They also argued that redistribution policies should place special emphasis on lessening gaps within higher age groups.

However, to assess the effects of redistribution policies precisely, it is insufficient to pay attention only to reductions in differentials within age groups at a particular time, and it is important to make lifetime income-based analyses. For example, Coronando, Fullerton, and Glass [2000a] [2000b] demonstrated, using panel data in the U.S., that the redistribution effect of social security programs is much less on a lifetime income basis than on an annual income basis, and emphasized that the effects of institutional reform should be discussed on a lifetime income basis. In Japan, too, there have been many attempts to analyze income redistribution between generations from a "generational accounting"-like standpoint based on lifetime income, by selecting representative households or individuals for each generation.[2]

In Japan, however, it is very difficult to make a lifetime income-based analysis of the intra-age redistribution effect in the same age group, because unlike in the U.S., adequate panel data is unavailable. Under these circumstances, the study by Takayama, et al. [1990], who used micro data of the 1994 National Survey on Consumption, can be called an exceptional case. They estimated the stream of lifetime income etc., that cannot be obtained from the survey directly, and made estimates of the redistribution effect not only between generations, but also within generations. As a result, they found an interesting fact: in higher age groups, those with higher incomes receive greater net pension amounts, which suggests the regressive feature of public pensions. On the other hand, Shimono and Tachibanaki [1985] analyzed to what extent income redistribution on a lifetime income basis is created by public pensions using a numerical analysis of two-period models instead of actual data. They showed that the fixed part of the Employees' Pension Insurance (EPI) - Kosei Nenkin Hoken - helps lessen differentials in lifetime income and that increases in premium rates in proportion to wage contribute to reductions in differentials.

This paper refers to the achievements of these preceding studies and presents a general account of income redistribution on intra-ages, inter-ages, and lifetime income bases. First, it summarizes the methods of decomposing income redistribution factors (Section 2), and examines the situation of intra- and inter-age income redistribution in great detail using data from the 1996 Survey on the Redistribution of Income (Section 3). Section 3 studies differences in the redistribution effect of taxation and public pensions and other social security programs. It also sheds light on the degree of "completeness" of income redistribution policies (the degree to which the policies secure their financial resources), a subject that has tended to be neglected thus far. Then, making considerably bold assumptions, some conjectures are made as to what kind of intra-generation income redistribution EPI brings on a lifetime income basis (Section 4). It is demonstrated here that the level of income inequality on a lifetime income basis is lower than that on an annual income basis and that the redistribution effect of EPI is also limited. Finally, the outcome of the analysis in this paper is summarized (Section 5).

2. Decomposition of income redistribution: basic idea

The indicators commonly used to show the level of income inequality include Gini coefficient, Atkinson coefficient, and Theil coefficient. But, these coefficients have a common defect: because they are strongly nonlinear, there is a need to make some adjustments to them when using them for the decomposition of inequality and redistribution effects. This paper is interested in inter- and intra-group inequality and in the decomposition of factors behind it, so it uses the "squared coefficient of variation" (relative variance; SCV), which can deal with these problems relatively easily. Ohtake and Saito [1998] [1999], Iwamoto [2000] and some others expressed the degree of income inequality by the logarithmic variance of income. It is possible to analyze income redistribution factors by logarithmic variance, but because we want to take account not only of changes in income variation but also of the

completeness of redistribution as well, as noted later, we use SCV here since it can handle the latter problem more easily.

Assuming average income to be μ and variance to be V, SCV is defined:

$$SCV = \frac{V}{\mu^2}.$$

It is assumed here that the total population to be analyzed is divided into n groups. Assuming the average income of each group to be μ_i, variance to be V_i and ratio of the number of members of each group to the total to be ω_i, total variance V can be divided into two components in such a way as:

$$V = \sum_{i=1}^{n} \omega_i (\mu_i - \mu)^2 + \sum_{i=1}^{n} \omega_i V_i,$$

where

$$\sum_{i}^{n} \omega_i = 1.$$

The first term shows the inter-group variation and the second one, the intra-group variation.

Assume that a given redistribution policy is implemented. If the financial resources for the policy are all procured within the population, the average income after redistribution must be the same μ, the pre-redistribution average. However, the average and the variance of each group, as well as the average of the total population change, resulting in changes in the value of SCV. These post-redistribution values are expressed as V_i^* and SCV*, respectively. The change in inequality caused by the redistribution policy is calculated by:

$$\frac{SCV^* - SCV}{SCV} = \frac{V^*/\mu^{*2} - V/\mu^2}{V/\mu^2} = \frac{V^* - V}{V},$$

where a negative value means a reduction in inequality.

Actual income redistribution, however, is not always completed only by the redistribution policy analyzed. This is because the policy may either rely on another policy for the procurement of financial resources or take charge of securing financial resources for another policy. There will also be a mechanism for obtaining financial resources from, or transferring these resources to, outside the population.[3] In these cases, the population's average income μ^* after income redistribution does not agree with the pre-redistribution average income μ.

Where income redistribution is not completed for such a reason, the decomposition of redistribution effect is shown by:

$$\begin{aligned}
\frac{SCV^* - SCV}{SCV} &= \frac{V^*/\mu^{*2} - V/\mu^2}{V/\mu^2} \\
&= \frac{V^* - V}{V} + \frac{\mu^2 - \mu^{*2}}{\mu^{*2}} \cdot \frac{V^*}{V} \\
&= \frac{1}{V} \sum_{i=1}^{n} \omega_i \left[(\mu_i^* - \mu^*)^2 - (\mu_i - \mu)^2 \right] \\
&\quad + \frac{1}{V} \sum_{i=1}^{n} \omega_i (V_i^* - V_i) \\
&\quad + \frac{\mu^2 - \mu^{*2}}{\mu^{*2}} \cdot \frac{V^*}{V}.
\end{aligned}$$

The first term expresses to what degree the gap is narrowed between the average of each group and that of the total population as a whole, and this can be called a "inter-group redistribution effect." The second term shows the degree of reduction in the variance of each group as a whole, and this can be regarded as an "intra-group redistribution effect." These two effects can be divided into those of each group, too. Finally, the third term represents the effect caused by the fact that income redistribution is not completed either within the population in question or by the policy in question, and this effect is called the "incompletion effect" below. For example, where the average level of redistributed income becomes higher than that of the initial income due to a redistribution policy depending on another policy for the procurement of financial resources, the income inequality assessed by SCV will decrease if all of the other conditions are the same.[4] In such a case, the policy's income redistribution would require careful interpretation.

It is important to explicitly consider the incompletion effect, to which past analyses do not seem to have paid sufficient attention. The incompletion effect can help precisely assess the redistribution effect of social security programs, which rely on not only premiums but also income and other taxes to finance their benefits.

In particular, due to historical and structural backgrounds, the Japanese social security programs have become far from a pure "social insurance" scheme in which total benefits are ideally equal to total premiums. Thus, without considering tax finances, we may overemphasize the redistribution effect of social security programs.

On the other hand, the redistribution effect of taxation depends on not only how to collect taxes but also how to use them. In particular, if we do not consider how taxes are used to finance social security benefits, we may underestimate the redistribution effect of taxation. That is the case especially for the public programs where benefits to lower income groups rely more heavily on taxes, as in the case of health and long-term nursing care. The estimation of the incompletion effect thus can help assess how complementary taxation and social security programs are in terms of income redistribution.

3. Intra- and inter-age income redistribution

3.1 Overview of redistribution effect using original survey data

This section decomposes the income redistribution effect into intra- and inter-age effects by the method described in the previous section, using micro data of the 1996 Survey on the Redistribution of Income. As a first step, a rough estimate is made as to how the initial income[5] is redistributed by social security programs and taxation, without making any adjustments to the micro data and based only on age groups classified by age of household heads. Here, the heads of households are divided into age groups at intervals of ten years,[6] and the effect of redistribution on each group is compared for taxation and social security programs.

Table 2 Redistribution effect of taxation and social security programs
(before adjustment as to members of different generations living together)

(1) Initial income (10,000 yen, ratios)

Age group	Average	Standard deviation	*SCV*
29 years or under	390.9	228.1	0.341
30-39 years	591.7	354.8	0.359
40-49 years	721.7	472.3	0.428
50-59 years	845.4	603.2	0.509
60-69 years	501.7	660.8	1.735
70 years or over	284.1	545.3	3.685
Total	601.1	563.4	0.878
Inter-age cohort income inequalities			0.099
Intra-age cohort income inequalities			0.780

(2) Income redistributed by taxation and social security programs (10,000 yen, ratios)

Age group	Average	Standard deviation	*SCV*
29 years or under	353.1	223.0	0.399
30-39 years	534.8	297.3	0.309
40-49 years	666.3	421.8	0.401
50-59 years	763.2	533.0	0.488
60-69 years	619.0	570.3	0.849
70 years or over	528.3	520.7	0.971
Total	618.0	484.4	0.614
Inter-age cohort income inequalities			0.032
Intra-age cohort income inequalities			0.583

(3) Decomposition of redistribution effect (%)

Total (SCV decrease rate)	30.04
Inter-age cohort redistribution effect	7.40
Intra-age cohort redistribution effect	18.70
Incompletion effect	3.94

First of all, let us look at the income redistribution effects of taxes and social security programs combined (Table 2). For the initial income (top part of Table 2), it is confirmed that income inequality increases with age. The SCV value of age groups rises from 0.341 for those aged 29 or under to 1.735 for the 60-69 year group and to 3.685 for those aged 70 or over. Although the data are cross-sectional, they suggest that differences in income-earning ability and in luck become more apparent and accumulates, as people get older, thereby widening income differentials among them. The table also shows that of the entire population's SCV of 0.878, 0.780 or about 90% can be explained by inequality within the age group.[7]

To what extent do taxation and social security programs correct these inequalities in the initial income? The value of SCV decreases by 30% from that of the initial income to 0.614. From Table 2 (middle part), which shows income redistribution by age group, the following facts can be pointed out: first, the comparison of the effect of narrowing income gaps in terms of the rate of fall in SCV values shows that the effect is greatest in higher age groups of 60 years or over. But, it is clear that the values of SCV decrease as a result of substantial increases in the average redistributed income, rather than as a result of reductions in variances in income within the age group. By contrast, in the case of active workers younger than 60 years, the average redistributed income decreases instead of increasing, and reduction in income variance results in the narrowing of income differentials within the age group. This suggests that income transfers are occurring from active workers to the elderly.

On the other hand, according to Table 2 (bottom part), which shows the decomposition of redistribution effect of the entire population, the redistribution effect is 30% as a whole and is 7.4% between age groups and 18.7% within age groups. The intra-age redistribution effect appears to be greater than the inter-age effect. The incompletion effect is 3.9%, which is a small value compared to that of the entire redistribution effect. Thus, for taxation and social security programs combined, the "incompleteness" of Japanese redistribution policies can be said to be limited.

3.2 Comparison of redistribution policies using original survey data

Next, let us divide redistribution policies into tax and social security policies and subdivide social security programs into public pensions, health care and welfare, and others[8] and compare the effect of these policies. Because the effect of each policy cannot be divided additively in SCV, we examine what redistribution effect will be if policies are introduced individually or in combination.

Table 3 summarizes the results of the calculation. From this table, the following can be pointed out:

First, the comparison between taxation and social security programs shows that the latter has a much greater redistribution effect than the former. In terms of the level of reducing SCV, social security has a redistribution effect that is three times as much as taxation.

Second, while taxes show a great effect on intra-age redistribution, social security makes a great contribution to inter-age redistribution. This is no surprising thing considering that taxes are imposed progressively on the basis of income and that the present mechanisms of social security, including public pensions and health care services, are managed by an official assessment-like method. What is more noteworthy is that social security increases intra-age inequalities as a whole.

Third, it can be confirmed that the incompletion effects of taxes and social security offset each other to some extent. Although social security contributes to closing gaps more than taxes, it is not completed as a redistribution system. By contrast, taxation has only a limited redistribution effect itself and also raises inequality in terms of SCV by reducing disposable income. However, taxes provide funds to social security programs and thereby contribute to the redistribution of funds through social security (what is called public cost bearing).[9] This suggests the need to consider taxation and social security together in the evaluation of redistribution policies.

Finally, the classification of social security programs into pensions, health care and welfare and others makes the characteristics of each program clearer. Pensions make the greatest contribution to reducing in inequality (but their incompletion effect is great together with health care) and their inter-age redistribution effect is a little greater. By contrast, it is noteworthy that health care policies work in the direction of increasing intra-age inequalities.[10] This result is understandable assuming that health care benefits are not affected very greatly by the income levels of consumers. In addition, the original purpose of health insurance consists more in covering disease risks socially than in income redistribution, so it is not appropriate to assess health insurance systems on the basis of their income redistribution results. The effect of welfare and others on reducing inequality is very small, and a considerable part of the effect can be explained by the incompletion effect, depending on government procurement of finan-

cial resources.

There may be counterarguments against separating taxation and social security programs, comparing their redistribution effect and pointing out their incompletion effect, as attempted here. These arguments are raised because social security programs do not assume in advance that they complete the procurement of their financial resources only by social insurance contributions, and can exist as systems by inputting taxes into them. We do not argue in this paper that the systems' procurement of financial resources should be completed. Instead, what we want to emphasize is that it is misleading to evaluate the redistribution effect of individual systems without regard to their mutual complementary relation.

3.3 Analysis using data adjusted for members of different generations living together

The analysis in the preceding section uses the data on age groups classified by the age of household heads to examine inter- and intra-age income differentials and the effects of redistribution policies. Where the heads of households are of middle or advanced age, however, their households often consist of both members receiving pensions or covered by health care services for the elderly and insured people who pay premiums, and in these households, inter-age income distribution overlaps and is complex. This makes analyses by age groups inaccurate. Thus let us try a similar analysis after making the following two adjustments to sampling and to numerical value processing.

First, we exclude households where both active and retired generations live together from our samples. In other words, in the analysis of households whose heads are in their twenties to fifties, only those having no members aged 60 or over are adopted as our samples. And, to analyze households whose heads are aged 60 or over, we use those composed only of members aged 60 or over. This adjustment aims at clearly showing differences in redistribution effects between active and retired people. But, limiting samples in this way results in a substantial loss of the weight of households consisting of elderly members, which might distort the whole picture of income redistribution.

Second, to avoid such a distortion as much as possible, we make the calculation of average, variance, and SCV of the total population on the assumption that the weight of each age group is the same as that in the original samples. This means that using the age composition of household heads for the original samples, we assume that all households are composed only of active or retired generations. This method aims to roughly assess the original income redistribution effects of taxation and social security programs between young and old people, since such effects tend to be largely offset by private income redistribution between parents and their children within households especially if they live together.

Naturally, these two adjustments produce new biases, because they lead to a total disregard of private income transfers within households between members of different age groups. Pension benefits and other factors must also have some effects when parents and their children choose to live together. However, there will be some meaning in checking the direction of changes in the impact of income redistribution by these adjustments, which would reduce the influence of members of different generations living together, ignoring this and other possible biases.

Tables 4 and 5 summarize the income redistribution obtained using the data after the adjustments. By comparing them to Tables 2 and 3, the following can be pointed out: first, the SCV of the initial income becomes 1.085, which is a little greater than that before adjustment, 0.878. Especially noteworthy is that the intra-age income differentials

Table 3 Comparison of the redistribution effects of taxation and social security programs

(before adjusting for members of different generations living together)

(Ratios of initial income to SCV, %)

	SCV of redistributed	Inequality reducing effect	Inter-age cohort redistribution	Intra-age cohort redistribution	Incompletion effect
Taxation + social security	0.615	30.04	7.40	18.70	3.94
Taxation	0.812	7.60	1.87	24.19	-18.46
Social security	0.673	23.39	6.00	-4.35	21.73
Pension	0.696	20.72	5.36	3.85	11.51
Health care	0.826	5.99	1.90	-7.35	11.45
Welfare and others	0.869	1.14	0.08	0.40	0.65

Notes : 1. SCV of the initial income = 0.878.

2. Positive figures mean that contribution is made to reduction in inequalities.

of those in their sixties and those aged 70 or over after adjustment are considerably greater than pre-adjustment ones. This indicates that before adjustment, living together of active and elderly people hides income gaps in advanced-age groups to a considerable degree. The part of the total population's SCV that can be explained by inter-age inequality also increases to about 30% from about 10% before adjustment.

Next, let us look at the redistribution effect. Not only is the post-adjustment decrease ratio of SCV as much as 43%, which is higher than the value before adjustment, but the weight of inter-age redistribution effect grows much bigger than the pre-adjustment one (approximately 55% of the total effect vs. approximately 25% before adjustment),

Table 4 Redistribution effect of taxation and social security programs
(after adjustment as to members of different generations living together)

(1) Initial income (10,000 yen, ratios)

Age group	Average	Standard deviation	*SCV*
29 years or under	389.2	228.2	0.344
30-39 years	584.9	334.5	0.327
40-49 years	719.9	475.6	0.436
50-59 years	831.0	592.0	0.507
60-69 years	140.3	303.3	4.673
70 years or over	111.8	377.8	11.411
Total	499.3	520.2	1.085
Inter-Age group income inequalities			0.338
Intra-Age group income inequalities			0.747

(2) Income redistributed by taxation and social security programs (10,000 yen, ratios)

Age group	Average	Standard deviation	*SCV*
29 years or under	349.8	222.1	0.403
30-39 years	518.6	275.7	0.283
40-49 years	622.4	386.2	0.385
50-59 years	720.2	493.0	0.469
60-69 years	368.2	364.1	0.978
70 years or over	381.5	392.2	1.057
Total	524.8	412.7	0.619
Inter-Age group income inequalities			0.075
Intra-Age group income inequalities			0.544

(3) Decomposition of redistribution effect (%)

Total (SCV decrease rate)	43.01
Inter-Age group redistribution effect	23.55
Intra-Age group redistribution effect	13.49
Incompletion effect	5.98

Table 5 Comparison of the redistribution effects of taxation and social security programs
(after adjusting for members of different generations living together)

	SCV of redistributed income	Inequality reducing effect	Inter-age cohort redistribution effect	Intra-age cohort redistribution effect	Incompletion effect
Taxation + social security	0.619	43.01	23.55	13.49	5.98
Taxation	1.017	6.34	4.83	20.49	-18.98
Social security	0.695	35.95	20.70	-6.61	21.87
Pension	0.733	32.44	17.59	0.49	14.36
Health care	0.995	8.35	5.36	-6.93	9.91
Welfare and others	1.070	1.43	0.11	0.46	0.85

Notes: 1. SCV of the initial income = 0.878.
2. Positive figures mean that contribution is made to reduction in inequalities.

taking the place of the intra-age redistribution effect in importance. In particular, in the groups of those aged 60 or over, the average of redistributed income increases but its variation, shown by standard deviation, becomes larger.

The characteristics of redistribution effect of individual policies after adjustment are not very different from those before it, but it is noteworthy that social security has a much greater effect and that the inter-age effect of pensions is far greater than the pre-adjustment effects.

As noted, when the redistribution effect is examined after adjustments are made for members living together, income inequalities between age groups become clearer, and the fact that taxation and social security mechanisms make great contributions to redressing these inequalities is thrown into relief. Naturally, because the adjustments made here are very bold, inequalities between age groups and redistribution effect must have been overestimated. However, it could well be considered that the actual degree of inter-age inequalities and redistribution effects are considerably greater than those estimated on the basis of the age groups classified only by age of household heads.

Further we would like to add that while the correction of intra-age inequalities can be justified as it is, that of inter-age inequalities is harder to evaluate. This is because people ultimately belong to all age groups as they grow older and because as a result of changing population movements, the incompleteness of redistribution might increase in the form of transfers of burdens to future generations.

4. Income redistribution on a lifetime income basis: rough calculation for the Employees' Pension Insurance (EPI)

4.1 Methodologies of the calculation

The decomposition of income redistribution described so far is based on cross-section data by age group at the same point in time. However, there is another important problem concerning the redistribution effects of taxation and social security programs: to what extent is redistribution made on a lifetime income basis. It is debatable whether a cross-sectional approach properly measures the redistribution effect, since people are a net receiver in one period and a net payer in another. This is clearly the case for public pension programs, in which people pay contributions when young and receive benefits when old. But this also at least partly holds for other programs. Hence, it is most likely that income redistribution is much limited on a lifetime income basis than on an annual income basis, making the policy assessment on a lifetime income basis quite misleading.

Because no panel data are available in Japan, however, it is very difficult to assess the effects of lifetime income-based income redistribution. Therefore, in this paper, we reorganize the micro data of the Survey of the Redistribution of Income by the methods noted below to estimate lifetime income in a rough way, and then we evaluate the potential redistribution effects of current social security systems, especially EPI plans.

We reorganize the date in the following ways. First, we choose only households whose heads are males aged 59 or under and are employees (including officers of companies, organizations, etc. and short-term employees less than one year) from the survey. Second, we classify these households into eight age groups at intervals of five years, from 20-24 years old to 55-59 years old. Third, we divide each age groups into 20 income groups, to get 160 (=8 x 20) "cells" in total as in Figure 1. Fourth, we calculate the average employees' income and EPI premiums[11] — including those of mutual-aid pension plans (Kyosai Kumiai) — for each "cell."

Then, we assume that each household stays at one of 20 income groups at each of the life stages and earns income and pays EPI premiums, both of which are estimated to be earned or paid on average at each cell calculated from the micro data. Naturally, each household may move from one income group to another at each of its life stages. Then let us define "the degree of immobility" of income groups as α $(0 \leqq \alpha \leqq 1)$: if the household belongs to income group j at any life stage, it will remain in the same group j at the next life stage with a probability of $(1+2\alpha)/3 \times 100\%$ and move to neighboring group j-1 or group j+1 with a probability of $(1-\alpha)/3 \times 100\%$, respectively (see Figure 1 as an example). If the household belongs to either the 1st (the poorest) group or the 20th (the richest) group at any life stage, we assume that the probability that it remains in the group is $(2+\alpha)/3 \times 100\%$ and that the probability that it moves to either the 2nd group or the 19th group is $(1-\alpha)/3 \times 100\%$.

If $\alpha = 1$, that is, if we assume no mobility between income groups, all of the households will continue to belong to the income group to which they belong when they are in the 20-24 age bracket until they reach the 55-59 age bracket. Therefore, the income distribution observed by the cross-section analysis of the age groups from the 20-

24 to 55-59 age brackets will be presented in exactly the same form as it is. However, it is easy to prove that whatever value α may have, the income distribution shown by the cross-section analysis will be reproduced as it is. Thus, we can use the values of employment income (and premiums) for each age and income bracket obtained from the Survey on the Distribution of Income without making any adjustments to them.

In short, we create the streams of employees' income that would totally be consistent with the income distribution of active workers shown the Survey on the Distribution of Income, and attempt to perform a very rough micro-simulation using the streams to evaluate the effects of redistribution policies.[12] Although this work ignores a variety of factors affecting income redistribution, such as cohort effects and technical development, it will have some meaning in checking to see how the level of redistribution effect on a cross-section basis differs from that on a lifetime income basis.

The analysis here is made on the assumption that the members of households pay EPI premiums for 40 years from 20 to 59 years of age, that they totally depend on their pension (earn no employees' income) after retirement, and that all of them die when they reach 80 years. Their monthly earnings at each age are calculated backward on the basis of actually paid EPI premiums, and the pension—composed of the earnings-related part (obtained by multiplying the average monthly earnings, which are calculated using the monthly earnings obtained by backward counting, by the given multiplier) and the basic pension (for couples)—is paid to them from 60 years of age. The premium ratio used here is that current at the time of the survey (1996), i.e., 16.5% of which 8.25% are paid by the insured, the accrual factor is 7.5/1000, and the amount of the basic pension is 780,000 yen a year. For simplicity, we assume that wage and price inflation and population growth are zero. The data for the amount of pension and retirement lump sum for the elderly can be obtained from the Survey on the Distribution of Income, but are disregarded, too, because it is impossible to know the relations with their income when they were active workers. Income other than employment income, such as interest and dividend income is also ignored for the same reason.

As to the initial income before considering EPI and the redistributed income reflecting EPI premiums and benefits, their present discounted values at the age of 20 are calculated and redistribution effects on a lifetime basis are estimated. Because the results must be different accord-

Figure 1 Simulated Life (an Example)

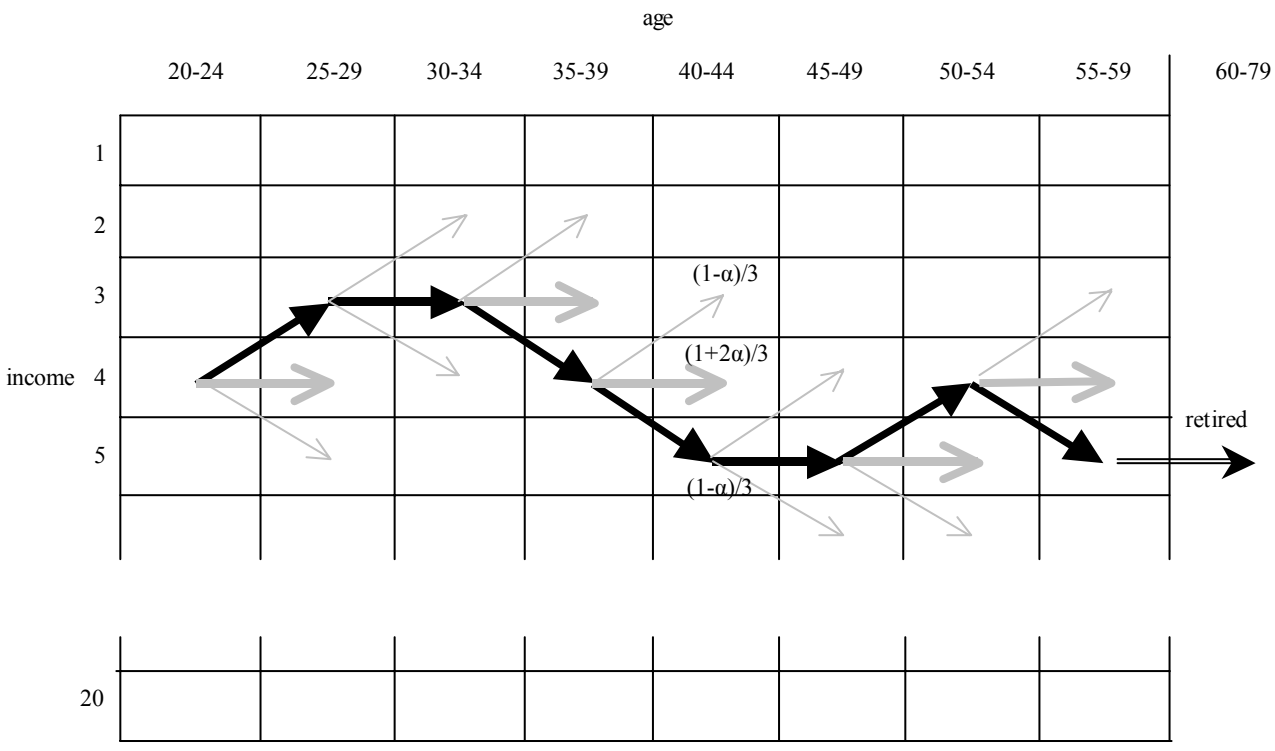

Table 6 EPI's redistribution effects on a cross-section basis

Initial income (10,000 yen)	
Average	392.6
Standard deviation	372.9
SCV	0.902
Redisributed income (10,000 yen)	
Average	459.6
Standard deviation	280.6
SCV	0.373
Inequality reducing effect (%)	58.69
of which incompletion effect	15.30

Note: See the text for the method of trial calculation.

Table 7 EPI's redistribution effects on a lifetime income basis

(1) Discount rate (r): 2%			
Income bracket's immovability (α)	0	0.5	1
Initial income (10,000 yen)			
Average	15,521	15,521	15,521
Standard deviation	5,963	6,147	6,459
SCV	0.148	0.157	0.173
Redisributed income (10,000 yen)			
Average	16,722	16,722	16,722
Standard deviation	5,973	6,157	6,470
SCV	0.128	0.136	0.150
Inequality reducing effect (%)	13.57	13.56	13.56
of which incompletion effect	13.90	13.90	13.90
(2) Discount rate (r): 3%			
Income bracket's immovability (α)	0	0.5	1
Initial income (10,000 yen)			
Average	12,855	12,855	12,855
Standard deviation	4,888	5,032	5,277
SCV	0.145	0.153	0.169
Redisributed income (10,000 yen)			
Average	13,448	13,448	13,448
Standard deviation	4,850	4,995	5,239
SCV	0.130	0.138	0.152
Inequality reducing effect (%)	10.02	9.99	9.94
of which incompletion effect	8.50	8.50	8.50
(3) Discount rate (r): 4%			
Income bracket's immovability (α)	0	0.5	1
Initial income (10,000 yen)			
Average	10,786	10,786	10,786
Standard deviation	4,062	4,178	4,371
SCV	0.142	0.150	0.164
Redisributed income (10,000 yen)			
Average	11,026	11,026	11,026
Standard deviation	4,002	4,117	4,310
SCV	0.132	0.139	0.153
Inequality reducing effect (%)	7.14	7.09	7.00
of which incompletion effect	4.18	4.18	4.19

ing to discount rate, more than one discount rate is used for the calculation.

4.2 EPI's redistribution effect on a lifetime income basis

Before examining the lifetime income-based redistribution effect, let us make a simple assessment of EPI's income redistribution on a cross-section basis (Table 6). Here, the groups composing society can be regarded as 240 households in total (12 age groups (20-24 to 75-79 years) x 20 income brackets). When they are observed by cross-section data, the SCV of the initial income of these groups is 0.902, which is similar to the values shown in Tables 2 and 4. If the EPI's redistribution effect is estimated on the assumption that the degree of immobility between income groups (α) is 0.5, SCV decreases by 58.7% to 0.373.[13] But, 15.3% of this redistribution effect is explained by the incompletion effect arising from the increase in redistributed income.

Now, let us take a look at income redistribution on a lifetime income basis. Table 7 summarizes nine cases, assuming the discount rate to be 2%, 3%, or 4% and the degree of immobility between income groups to be 0, 0.5, or 1. According to this table, the SCV of the initial income ranges from 0.142 to 0.173, which are much smaller than the values in cross-section terms. This is because the income distribution on a cross-section basis is affected much by inter-age inequalities, which mostly disappear on a lifetime income basis. On the other hand, EPI's redistribution effects reduce SCV values only by about 7-14% and are very limited compared with those on a cross-section basis. EPI is the mechanism for collecting premiums from active generations and paying pension benefits to retired generations. This effect of inter-age redistribution substantially diminishes on a lifetime income basis, since the present discount values of premiums and pension benefits are mostly, if not all, offset with each other throughout people's life.

It should also be noted that redistribution effects can be explained more by the incompletion effect than by reductions in the standard deviation of income. This is because (1) the portion of EPI premiums paid by employers and government subsidies to the basic pension are not taken into account, so the burden of households is underestimated to that extent, and (2) the premiums people pay while active and the pensions they receive after retirement offset each other to some extent.

In addition, the importance of the incompletion effect grows clearer if the discount rate is set lower. The reason is that the lower the discount rate is, the higher the present discounted value of pensions becomes. In particular, if the discount rate is set at as low as 2%, EPI works to raise the standard deviation values of lifetime income, and redistribution effect is totally dependent on incompletion effect.[14] The greater the lack of mobility of income groups is, the greater the redistribution effect tends to become, but not so much.

4.3 Negation of incompletion effect

As the discussion up to the preceding section suggests, the existence of the incompletion effect makes it difficult to evaluate EPI's redistribution effect. Even though it is a fact that EPI amends differentials in terms of lifetime income, EPI will lack completeness as a redistribution policy if its mechanism is maintained by means other than the procurement of financial resources directly from EPI's insured people. Thus, let us do a trial calculation of EPI's redistribution effect after adjusting the premium rate (which may be regarded as the income tax rate in proportion to wage) so that the necessary amount of EPI benefits can all be covered by the additional payment by active households. This assumes that active households bear part of the EPI contribution, which is currently borne by government subsidies, by paying additional premiums or taxes in proportion to their wage, and that the portion of the contribution borne by employers ultimately become a cost borne by households in the form of a reduction in employment income, thus EPI's fiscal revenue and expenditure are completed within the same generation. In this case, EPI's introduction will not result in changes in average income, and its redistribution effects will manifest themselves only by changes in income variance. The premium rate, which reflects government subsidies and employers' cost bearing, can be solved endogenously on condition that revenue and expenditure are balanced. Supposing the lack of mobility of income brackets to be 0.5, the rate ranges from 12.1% (discount rate: 4%) to 21.8% (discount rate: 2%), which are considerably higher than the benchmark of 8.25% (see Table 8). EPI's effect of reducing inequalities in this case is from 6.2% (discount rate: 4%) to 10.9% (discount rate: 2%), which are lower than the values where the incompleteness of income redistribution is accepted.

4.4 Impact of changes in EPI's system

Why does EPI's redistribution effect show up on a lifetime income basis? EPI makes some contribution to narrowing income gaps, because its benefits include the basic pen-

Table 8 EPI's redistribution effects on a lifetime income basis
(after the incompletion effect is negated)

Discount rate (%)	2	3	4
Initial income (10,000 yen)			
Average	15,521	12,855	10,786
Standard deviation	6,147	5,032	4,178
SCV	0.157	0.153	0.150
Revised premium rate (%)	21.8	16.3	12.1
Redisributed income (10,000 yen)			
Average	15,521	12,855	10,786
Standard deviation	5,803	4,821	4,047
SCV	0.140	0.141	0.141
Inequality reducing effect (%)	10.88	8.23	6.17
cf. where the incompletion effect is not negated	(13.56)	(9.99)	(7.00)

Note : The above is the case in which the premium rate is increased and the incompletion effect is totally negated within the EPI system. The pre-revision premium rate is 16.5%, of which a half, or 8.25%, is borne by

Table 9 Change in the weight of the remuneration-related and fixed parts and EPI's redistribution effect
(where the incompletion effect is negated)

Multiplier for remuneration-related part (%)	5/1000	7. 5/1000	10/1000
Basic pension (10,000 yen) (annual amount per person)	94.6	78.0	61.4
Inequality reducing effect (%)			
Discount rate: 2%	13.18	10.88	8.56
Discount rate: 3%	10.00	8.23	6.44
Discount rate: 4%	7.52	6.17	4.81

Note: The amount of the basic pension is determined independently of the discount rate.

sion (known as the "first-tier" fixed part). The "second-tier" earnings-related portion of EPI benefits reflects income differentials existing in the active period of workers and so makes no contribution to correcting income differentials, which are evaluated by SCV.

Thus, let us briefly examine how EPI's redistribution effects change as the weight of the earnings-related and basic pension components of EPI benefits changes, using the premium rate (and the amount of pensions) that maintains the completeness of income redistribution under the present system. In other words, we study the effect when reducing the multiplier for the earnings-related component (which was 7.5/1000 in 1996) to 5/1000, and when increasing it to 10/1000. In this case, the amount of basic pension benefits is also adjusted according to the change in the multiplier.

The results of the trial calculation are summarized in Table 9. As expected, although the situation differs depending on the discount rate (the lack of mobility of income brackets is set at 0.5), EPI's redistribution effects decrease as the accrual factor is increased to raise the weight of the earnings-related component and to reduce that of the fixed basic pension. For example, if the discount rate is set at 3% and the accrual factor is 7.5/1000, SCV decreases by 8.2% from the initial income. If the accrual factor is reduced to 5/1000, SCV decreases by 10.0%, while if it is raised to 10/1000, SCV's decrease ratio was only 6.4%. These results are compatible with the outcome of the analysis by Shimono and Tachibanaki [1985] mentioned above.

5. Conclusion

This paper has thus far made simple analyses of intra-age, inter-age, and lifetime income-based redistribution effects of present taxation and social security programs, using the micro data of the 1996 Survey on the Redistribution of Income. The main findings are summarized as follows:

First, it is inferred that, if the effect of more than one generation living together is controlled, the income redistribution effect of taxes and social security systems at present manifests itself more between age groups than within age groups.

Second, the comparison of the redistribution effect of taxation and social security programs shows that while the former has more impact on intra-age redistribution, the latter has more impact on inter-age redistribution. Of the various social security systems, pensions have an especially great redistribution effect. Health care services cause regressive intra-age redistribution. As a result, social security increases inequalities within age groups as a whole.

Third, the redistribution effect of taxation and those of social security are not "completed" by themselves, and instead have a mutually complementary relation. The redistribution effect of social security programs considerably depends on the procurement of financial resources by taxation.

Fourth, a rough calculation of EPI's redistribution effects in terms of lifetime income shows that the effects are very limited compared to those on a cross-section basis. Moreover, the greater part of EPI's redistribution effects can be explained by financial resources other than premiums paid directly by active generations, such as employers' premium payment and government subsidies to the basic pension. If this incompleteness of EPI's redistribution effect is negated by an increase in the direct cost borne by households, the effect decreases further.

Finally, a comparison of changes in redistribution effect resulting from adjusting the weight of EPI's earnings-related and fixed components, after negating the incompleteness of redistribution effects, indicates, as theoretically expected, that EPI's redistribution effect increases as the weight of the fixed component is raised.

The results of the analysis in this paper outlined above suggest that in evaluating the effects of income redistribution policies, (1) there is a need to pay attention to the "completeness" of the policies and (2) it is important to make a comparison not only within and between age groups, but on a lifetime income basis as well.

Notes

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1. One example where such conclusion was drawn is the "White Paper on Health and Welfare 1999," p. 50," published by the Ministry of Health and Welfare (present Ministry of Health, Labor and Welfare).
2. For recent studies from this viewpoint, see, for example, Hatta, Oguchi, and Sakamoto [1998] and Suzuki [1999].
3. There is also a statistical possibility that although income redistribution could be completed theoretically, it is hindered by a sample bias. This type of incompletion effect is not discussed in this paper.
4. This is also the case where the level of inequality is measured with the Gini coefficient.
5. The "initial income" used in this paper is faithfully based on the definition of the Survey on the Redistribution of Income.
6. But, those younger than 30 years old and those aged 70 or over are grouped into one group, respectively.
7. According to the term used by Teruyama and Ito [1994], the intra-age inequality obtained by this method is the "true level of inequality," while inter-age inequality is the "apparent level of inequality." Teruyama and Ito also used SCV to break down inequality factors.
8. The benefits of "welfare and others" mean allowances under the Livelihood Protection Law, other social security benefits, and benefits in kind and municipal welfare expenditure under the Livelihood Protection Law, the Law on the Welfare for the Elderly and other laws. The costs of these benefits are borne by social insurance contributions of unemployment insurance and others.
9. The redistribution effect of benefits in kind — such us public education and housing — which are finance by taxes, is ignored in our analysis. If this effect is included, the redistribution effect of taxation should be larger than indicated in Table 3.
10. A similar evaluation of the redistribution effects of health care programs was made by Kaneko [1998], who compared such effects by a different method from the one used in this paper.
11. Actually paid premiums are used rather than those calculated on the basis of employees' wages because it is impossible to know the monthly earnings the basis of premium calculation, including unavailability of data on bonus ratios.
12. Recent micro-simulations that analyze income redistribution on a lifetime income basis include Nelissen [1998], who used Dutch data. Nelissen reported similar ana-

lytical results to this paper, including the fact that the lifetime income-based redistribution effect of social security tends to be less than annual income-based effects and that if the discount rate rises, redistribution effects decrease.

[13.] Little effect was observed on the result even if the value of α was changed from 0 into 1.

[14.] This fact can easily be confirmed using a simple two-period model. Assume the rate of the premium contributed in proportion to the employment income of active workers ("monthly earnings") to be t, the accrual factor for the earnings-related component of the pension paid after they retire to be s, and the fixed portion of the basic pension to be C, then we get:

$$\mu^* = \left(1 - t + \frac{s}{1+r}\right)\mu + \frac{C}{1+r},\ V^* = \left(1 - t + \frac{s}{1+r}\right)^2 V.$$

Here, if s/(1+r) >t, the lower the discount rate r becomes, the more the average of redistributed income and the value of variance increase. Because a rise in the average lowers SCV and a rise in the variance increases it, if the discount rate falls, the incompletion effect, which is explained by a rise in the average, grows greater.

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