Measuring Economic Well-Being

Following the international literature we assume a scale elasticity of 0.5 for our household sharing. All income calculations are of household post-tax post-transfer income—income from all sources (labor earnings, income from investments and savings, public and private pensions, and transfers) minus total household taxes and social insurance contributions. Non-money transfers are not included. Using the TAXSIM Module provided by the NBER, we develop an estimation procedure that approximates the income tax payments available in the CPS for the years 1979 through 2000 and that can be used with consistently top-coded income variables in CPS to estimate income tax payments. Post-tax income is calculated in CNEF data for Germany and Great Britain. The Japanese data captures these values directly. (See the Data Appendix of Burkhauser, Oshio and Rovba, 2006 for greater detail.)

Trends in Income and Income Inequality

Table 1 shows mean and median income as well as the 90/10 ratio and Gini coefficients for Germany, Great Britain, Japan and the United States over the peak years of their respective business cycles for the entire population. Household size-adjusted after-tax income (both mean and median) increased over both the 1980s and 1990s business cycles in the United States. But the fruits of economic growth were much more equally shared in the 1990s than in the 1980s whether measured by the 90/10 ratio or the Gini coefficient.

Income increased even more in Great Britain over the 1990s than in the United States and inequality fell. In contrast, while income in Germany increased by about the same amount as in the United States, inequality grew dramatically whether measured by a change in the 90/10 ratio or in the Gini coefficient. As a result, inequality in Germany, which was substantially below inequality in Great Britain at the beginning of the 1990s business cycle, was by the end approximately equal to inequality in Great Britain. But inequality in both countries still was considerably below inequality in the United States. In Japan, income increased over the 1990s,

population samples whose levels and trends in income inequality are similar to those using the consistently top coded method..

while the magnitudes of the percentage changes in inequality were near those experienced in the Germany during the 1990s. As a result Japan moved closer to the levels of income inequality in the United States than to those in Great Britain and Germany by the end of the period.

Measuring Changes in the Income Distribution Using Kernel Density Estimation

The 90/10 ratio and the Gini coefficient are well-established methods for summarizing inequality in an income distribution. By design, however, they summarize an entire distribution with a single value. Because few distributions with known properties can be completely described by one or even two parameters, the use of these summary indices produces an incomplete view of the underlying distribution of interest.

Kernel density estimation is an elegant alternative to using traditional summary statistics to measure income inequality and changes in economic well-being. It provides a picture of the entire income distribution in terms of the income density function, from which we can observe the distribution's location, spread, and modality simultaneously. It can also capture absolute increases in income levels via shifts in the density function to the right. Hence, it can show that increases in inequality arise from a variety of changes in the shape of the density function. For a more technical discussion of the kernel density method employed here in the context of measuring economic well-being, see Burkhauser et al. (1999).

Table 1 used summary measures of the income distribution to show first, that the fruits of growth in the United States were more equitably distributed over the business cycle of the 1990s than the business cycle of the 1980s and second, that while the United States and Great Britain experienced substantial economic growth in the 1990s, with decreasing income inequality, Germany and Japan did so with substantial increases in income inequality. We now more fully explore how the distribution of income changed in each of these countries by estimating their probability density functions based on Epanechnikov kernels with adaptive bandwidths of the post-tax, post-transfer household size-adjusted income of their populations.

The first panel of Figure 1 shows that in 1979 the distribution of income in the United States had the traditional inverted U shape with the great mass of the population bunched around

the mode of the distribution. But by the end of the 1980s business cycle in 1989, the distribution had become much flatter. The middle mass of the distribution around the mode fell (fewer people were in the middle of the distribution) with the vast majority spilling toward the higher tail of the distribution and a much smaller but still important group spilling toward the lower tail of the distribution. In contrast, the entire United States income distribution moved to the right between 1989 and 2000, the two peak years of the 1990s business cycle. More formally, the income distribution in 2000 attained *first order stochastic dominance* over the 1989 distribution. At every percentile of the 2000 distribution, the level of income is higher in 2000 than in 1989, the previous business cycle peak year. While not everyone gained at the same rate, everyone in the distribution gained.

The second panel of Figure 1 captures the change in the income distribution for Great Britain over their 1990s business cycle. As in the United States, the 2000 income distribution attained first order stochastic dominance over the 1990 distribution. Furthermore, the noticeable second hill in the 1990 distribution is considerably smoother in the 2000 distribution. While the mode values declined, a far larger proportion of the distribution remained bunched near the middle of the distribution than was the case in the United States. Nonetheless, the income distribution movements in Great Britain and the United States were very similar over their 1990s business cycles. This stands in stark contrast to the movement in the income distribution in Germany and Japan over their 1990s business cycles.

In 1991, the beginning year of their business cycle, the distribution in Germany (Panel 3 of Figure 1) also had the traditional inverted U shape with the great mass of the population near the mode of the distribution. But unlike the United States or Great Britain, the income distribution in Germany at the end of their 1990s business cycle in 2001 did not attain first order stochastic dominance. Rather, like the United States in the 1980s, the mass of the population near the mode of the distribution fell with the vast majority of people spilling to the right and becoming unequally richer and a smaller but important share becoming poorer.

As can be seen in Panel 4 of Figure 1 a similar movement in the income distribution occurred in Japan. By the end of the 1990s business cycle in 2001, the income distribution in Japan had become much flatter. The middle mass of the distribution around the mode fell with the majority spilling toward the higher tail of the distribution and a small group spilling toward the lower tail of the distribution.

We use the Kolmogorov-Smirnov statistic to test whether the shifts in the distributions described above were statistically significant. For the United States population we compare the 1979 and 1989 distributions, the 1989 and 2000 distributions, and the 1979 and 2000 distributions. For Great Britain, we compare the 1990 and 2000 distributions. For Japan we compare 1989 and 2001 distributions and, for Germany, the 1991 and 2001 distributions. All tests indicate that the changes in the income distribution are statistically significant at the 1 percent level. Thus, we find statistically significant changes in the overall income distribution between peak-to-peak business cycle years in all four countries.

Where the Middle went during the 1980s in the United States and during the 1990s in Germany and Japan. We use a test based on the binomial distribution to more precisely examine how the spillage out of the middle of the income distribution in the United States over the 1980s business cycle and in Germany and Japan over the 1990s business cycle was distributed between the two tails of the distribution. We first define the left and the right tails of distribution. In the United States for the 1979 and 1989 income densities we define the left intersection, and the start of the left tail, as the point where the income density in 1989 drops below the income density in 1979. As can be seen in Panel 1 of Figure 1, this occurs at $7,812. The right intersection point, which defines the start of the right tail, is the point at which the income density in 1989 rises above the income density in 1979—$31,693. The intersections for Germany and Japan are defined in a similar way based their on values in Figure 1.

Table 2 shows the proportion of the population contained in the left tail, middle, and right tail as defined by the peak-to-peak year density function intersections for the United States (columns 1 and 2), Germany (columns 5 and 6), and Japan (columns 9 and 10) and their standard

errors. In the United States 7.18 percent (column 3) of the entire distribution slid out of the middle of the distribution over the 1980s business cycle. But the vast majority of that 7.18 percent (82.46 percent) became richer. Over the German business cycle of the 1990s an even greater percentage of the middle mass around the mode of the distribution (8.23 percent) slid into the two tails. But once again the vast majority (88.58 percent) became richer. In Japan, over the 1990s business cycle, 6.18 percent of the middle mass moved to the tails, mostly to the right tail (93.20 percent). Nonetheless, in the United States (17.54 percent), in Germany (11.42 percent), and in Japan (6.80 percent) a small minority became poorer as income inequality rose.

Conclusion

The economies of Germany, Great Britain, Japan and the United States all grew over their 1990s business cycles, propelling their average post-tax, post-transfer household size-adjusted income measured either at the mean or median upward. But the fruits of that economic growth were distributed differently across the four countries. The income distribution of the Great Britain and the United States at the end of their 1990s business cycle achieved first order stochastic dominance over their income distribution at the beginning. This was a remarkable change from what had happened in both countries over their 1980s business cycle. Hence, unlike the 1980s, all people in Great Britain and the United States shared the gains of economic growth in the 1990s. Moreover, in contrast to the 1980s, income inequality fell in both countries.

In contrast, income inequality in Germany and Japan grew substantially over their 1990s business cycle. Like the United States in the 1980s, the middle mass of the distribution around the mode fell. While the greatest share of the middle mass slid to the right, as people became unequally richer, a statistically significant but smaller share became poorer. More remarkably, the relative movement out of the middle and into the two tails in Germany and Japan is very similar in magnitude to that of the United States. About 83 percent of the decline in the middle in the United States over the 1980s was accounted for by people becoming richer compared to about 89 percent in Germany and about 93 percent in Japan.

This paper has focused on measuring what have been quite different changes in the income distribution of four major industrial countries over their 1990s business cycles. The causes for these differences are not clear. In the United States, the confluence of significant economic growth and work-based welfare reforms dramatically improved the employment and economic well-being of single women with children relative to the rest of the population and more generally did so for lower skilled workers. This may in part explain why economic growth in the 1990s was more equally shared in the United States than it was in the 1980s.

In Germany it may be that reunification, which occurred in 1989, not only dramatically expanded the German population but may also have changed its political and economic makeup relative to that of its pre-unification western states. This paper captures income distribution changes over reunified Germany's first full business cycle. It remains to be seen if this is simply a short term outcome that was inevitable given the significantly unequal market skills of the eastern and western states' populations that will quickly fade away. Or, whether this is the beginning of a longer term trend in a country where the greater inequality in market skills created with unification will continue to yield increases in income inequality for generations to come.

Post-World War II Japan has long been characterized as a homogeneous society and one with a relatively low degree of income inequality (Tachibanaki, 2005). But the rise in inequality over its 1990s business cycle suggests that by 2001, Japan could no longer be thought of as a "90 percent middle-class society." (Tachibanaki, 2005) By 2001, income inequality in Japan was closer to that of the United States than to Germany or Great Britain. The exact causes of this increase are not clear but may result from a complex interplay of demographic and economic factors, including population aging, greater heterogeneity in generational configurations within households, and most importantly the fuller emergence of a market-oriented economy, including a shift from a lifetime employment and seniority wage system to a more performance-based one. Finally, the steep rise in land and share prices during the "bubble economy" of the late 1980s and its subsequent fall over the 1990s may have increased inequalities in the distribution of assets.

This paper used kernel density estimation to look behind summary measures of income inequality and show how the entire income distribution shifted over the 1990s business cycle. Its major finding is that Germany and Japan experienced increases in inequality and a decline in the middle of their income distributions via mostly a growth in the right tail of the distribution, much like the United States did over its 1980s business cycle. In the 1990s Great Britain and the United States experienced both a decline in inequality and a movement to the right of their income distributions that achieved first order stochastic dominance. It remains to be seen whether this is the start of a longer term movement toward convergence in income distributions of these four major industrial countries.

REFERENCES

Artis, M.J., R.C. Bladen-Hovell and W. Zhang. 1995. "Turning points in the international business cycle: An analysis of the OECD leading indicators for the G7 countries," *OECD Economic Studies* 24: 125 -165.

Burkhauser, Richard V., Amy Crews Cutts, Mary C. Daly, and Stephen P. Jenkins. 1999. "Testing the Significance of Income Distribution Changes Over the 1980s Business Cycle: A Cross-National Comparison." *Journal of Applied Econometrics*, Vol. 14, 253-272.

Burkhauser, Richard V., Kenneth A. Couch, Andrew J. Houtenville, and Ludmila Rovba. 2004. "Income Inequality in the 1990s: Re-Forging a Lost Relationship?" *Journal of Income Distribution,* 12 (3-4), 8-35.

Burkhauser, Richard V., Takashi Oshio and Ludmila Rovba. 2006. "An International Comparison of Winners and Losers over the 1990s Business Cycles in Germany, Great Britain, Japan, and the United States" Cornell University Working Paper.

Tachibanaki, Toshiaki. 2005. *Confronting Income Inequality in Japan: a Comparative Analysis of Causes, Consequences, and Reform.* Cambridge: MIT Press

Table 1. Post-tax Post-transfer Household Size-Adjusted Income and Income Inequality, in the United States, Great Britain, Germany, and Japan.

	United States					Great Britain			Germany			Japan		
	1979 (1)	1989 (2)	2000 (3)	Percent Change 1979-1989 (4)	Percent Change 1989-2000 (5)	1990 (6)	2000 (7)	Percent Change (8)	1991 (9)	2001 (10)	Percent Change (11)	1989 (12)	2001 (13)	Percent Change (14)
Mean	22,494	24,954	26,767	10.93	7.27	11,539	13,917	20.61	17,377	18,605	7.07	3,205	3,399	6.04
Median	20,892	22,135	23,707	5.95	7.10	10,583	12,788	20.84	16,146	17,054	5.62	2,829	2,991	5.73
90/10	4.71	5.82	5.42	23.67	-6.82	3.89	3.63	-6.78	3.1	3.39	9.59	4.24	4.65	9.64
Gini	0.301	0.344	0.336	14.17	-2.24	0.274	0.264	-3.59	0.231	0.25	8.18	0.298	0.315	5.84

Notes: [a] Income values are in 2000 United States dollars, [b] Income values are in 2000 British pounds, [c] Income values are in 2000 euros, [d] Income values are in 2000 yens

Table 2. Change in the Distribution of the Population Mass over Paired Years in the United States, Germany, and Japan.

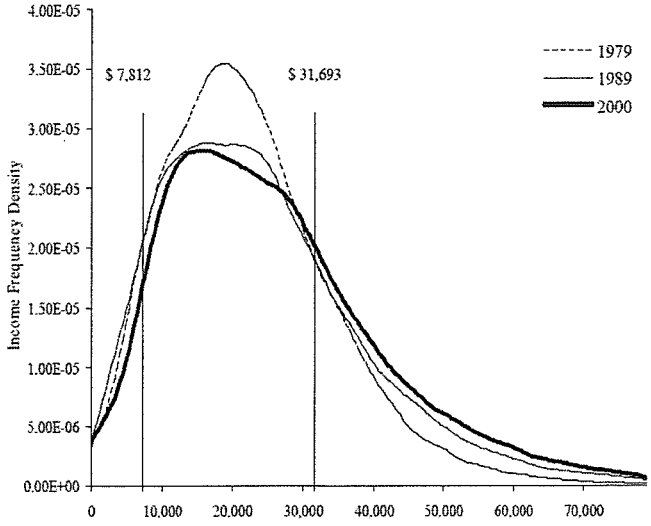
	United States				Germany				Japan			
Income Distribution Group[a]	**1979 [b]**	**1989 [b]**	**Difference [c]**	**Share of the Middle**	**1991 [b]**	**2001 [b]**	**Difference [c]**	**Share of the Middle**	**1989 [b]**	**2001 [b]**	**Difference [c]**	**Share of the Middle**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Less than left intersection	5.24	6.50	-1.26	-17.54	4.69	5.63	-0.94	-11.42	7.18	7.60	-0.42	-6.80
	(0.053)	(0.062)	(0.082)		(0.109)	(0.092)	(0.142)		(0.068)	(0.069)	(0.094)	
Middle of distribution	77.86	70.68	7.18	100.00	74.17	65.94	8.23	100.00	69.37	63.19	6.18	100.00
	(0.099)	(0.114)	(0.151)		(0.243)	(0.201)	(0.316)		(0.112)	(0.150)	(0.186)	
Greater than right intersection	16.90	22.82	-5.92	-82.46	21.14	28.43	-7.29	-88.58	23.45	29.21	-5.76	-93.20
	(0.089)	(0.106)	(0.138)		(0.231)	(0.193)	(0.301)		(0.096)	(0.125)	(0.142)	

Note: [a] See Figure 1 for the exact income values at the point of intersection of each density pair. [b] Standard errors are in parentheses. All distribution changes are significant at 1 percent level according to tests based on Z_p statistic. [c] Standard deviations are in parentheses

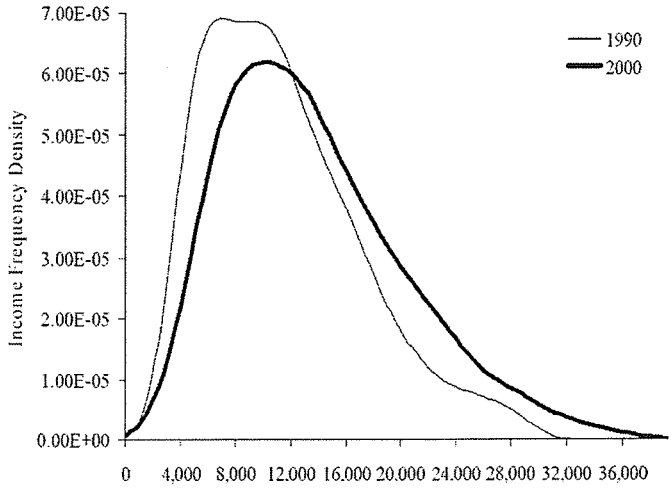
Source: Authors' estimations based on data from the March CPS Annual Demographic Files (1980-2001) in the United States and the Household Panel Survey (1991-2001) in Great Britain, the Socio-Economic Panel (1992-2002) in Germany, and the Japanese Survey of Income Redistribution (1990 and 2002)..

Figure 1. Distributions of Post-Tax, Post-Transfer Household Size-Adjusted Income in Peak Business Cycle Years for the United States, Great Britain, Germany and Japan.

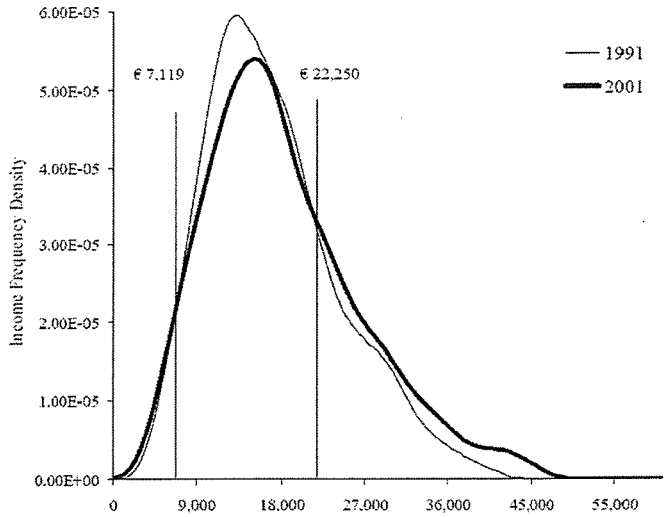
United States



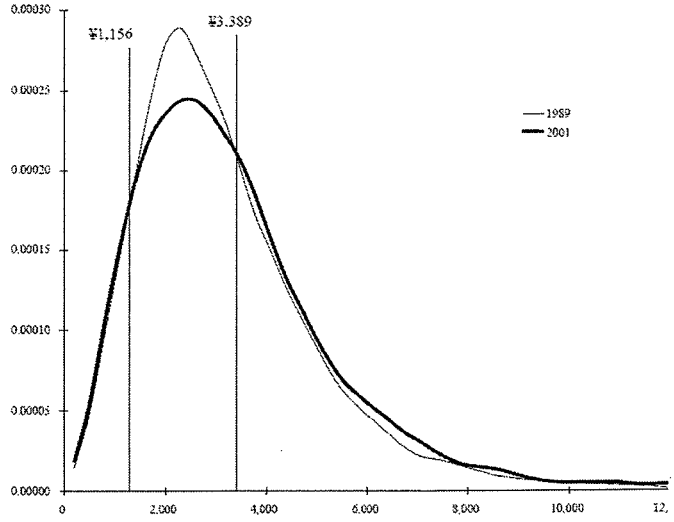
Great Britain



Germany



Japan



Source: Authors' estimations based on data from the March CPS Annual Demographic Files, 1980, 1990, and 2001; the British Household Panel Survey, 1991 and 2001; the German Socio-Economic Panel, 1992 and 2002, and Japanese Survey of Income Redistribution, 1990 and 2002 in 2000 real values of each country's currency.

Social security and intra-generational income redistribution in Japan

Graduate School of Economics, Kobe University
Takashi Oshio

Abstract

We examine how social security affects income distribution within the same generation in Japan. We assess the impact of current pension programs on annual income distribution, and estimate the potential impact of post-2004 Reform pension programs on lifetime income distribution. We show that social security substantially reduces inequality among the elderly on an annual income basis, but that it is mostly due to an income transfer from the young rather than redistribution within the elderly. We also confirm that the distributive impact of post-2004 Reform social security on lifetime income is quite limited, compared to what is implied by the analysis on an annual income basis. Finally, we conduct some policy simulations to assess the effects of some alternative pension reforms.

Key words: social security, income redistribution, lifetime income

JEL classification: D31, D63

1. Introduction

This paper investigates the extent to which social security programs affect income distribution within the same generation in Japan. It is often argued that a PAYG social security system reduces the net lifetime income of younger and future generations under population aging, because it entails substantial income transfers to older generations. In fact, there have been many attempts to address empirically the issues of intergenerational redistribution and inequality, based on the framework of generational accounting and overlapping-generations models. The consensus view in Japan seems to be that the current public pension scheme, even after the 2004 Reform, will keep a significant inequality between current and future generations virtually intact (see Suzuki, 2006 as a recent example).

It should be noted, however, that social security will also affect income distribution *within* the same generation. To be sure, social security benefits help to reduce income inequality among the elderly, because they raise the average level of their disposable income. Yet, there is a wide gap in social security benefits. In fact, National Pension Insurance (NPI) beneficiaries receive only a flat-rate benefit, which is called the Basic Pension benefit, whereas Employees' Pension Insurance (EPI) beneficiaries receive both flat-rate and wage-proportional benefits. In addition, among EPI beneficiaries, wage inequality at a young age will be largely carried over to post-retirement inequality via the wage-proportional benefit. Indeed, a cross-sectional analysis of OECD countries by Förster and Mira d'Ercole (2005) highlights uneven income distribution and high poverty rates among the elderly in Japan.

Under population aging, income inequality among the elderly will determine income inequality in the overall society more directly than in the past. To be sure, it is a well-established view in Japan that the widening income inequality in Japan is exaggerated by the impact of population aging

(see Ohtake, 2005), as income inequality tends to be wider among the elderly than among the young. It does not, however, mean that we do not need to worry about the recent upward trend in income inequality (see Tachibanaki, 2005). Indeed, the risk is that income inequality among the elderly will further dominate income distribution in society as a whole. In this regard, the distributive impact of social security benefits, which are a key determinant of income distribution among the elderly, needs to be scrutinized.

In addition, income inequality should be examined not only on an annual income basis but also on a lifetime income basis. The extent of income redistribution caused by social security programs tends to be overemphasized on an annual income basis. It is easy to intuitively understand this. Premiums paid during the working period and benefits received after retirement tend to significantly reduce inequality in annual income because they reduce the gap in disposable income between the young and elderly. However, these effects are likely to mostly cancel each other over a lifetime because every person experiences both the young and old ages in life. Indeed, Coronado, Fullerton, and Glass (2000) empirically show that the distributive impact of the US social security system is much smaller on a lifetime income basis than on an annual income basis. Also, Oshio (2006) shows that younger cohorts tend to face wider income inequality in Japan, based on estimations using synthetic panel data.

Keeping these redistribution issues related to social security in mind, we intend to discuss two empirical issues in this paper. The first issue is how the current social security scheme as a whole affects income distribution among the elderly on an annual income basis in Japan. We explicitly separate the impact of income transfer from the young from that of income redistribution among the elderly. This analysis is expected to give some hints about the distributive impacts of the current social security scheme within the same generation. We use micro-data from the "Survey on Income

Redistribution" (SIR), which is released by the Ministry of Health, Labour and Welfare in Japan.

The second issue is how the EPI program after the 2004 Pension Reform will potentially affect income distribution on a lifetime income basis. Longitudinal information about wages, tax payments, and social security contributions/benefits are rarely available from official statistics in Japan. Hence, we roughly estimate lifetime income distribution, based on pension benefit data from the Annual Report of the Social Insurance Agency, and assess the distributive impact of the 2004 Reform. We also present some alternative reform plans—including introduction of a Norwegian-type minimum pension benefit—and estimate their distributive impacts.

The remainder of this paper is construed as follows. Section 2 presents a simple framework to discuss distribution issues in relation to social security. Section 3 is allocated to the first empirical analysis, which examines the distributive impact of the current social security scheme as a whole on an annual basis. Section 4 is allocated to the second empirical analysis, which examines the potential redistribution of the EPI program on a lifetime income basis. Section 5 summarizes the estimation and simulation results, discusses their policy implications, and presents future research topics.

2. Analytical Framework

2.1 Income redistribution: the elderly *vs.* the young

This section presents a simple framework to discuss distribution issues in relation to the social security program[1]. We consider a very simple two-period, life-cycle model to illustrate the issues. We assume that in period 1 one gets wage income (W_1) and pays a social security premium, which consists of a wage-proportional component (tW_1) and a flat

[1] The model in this section is a simplified version of what is presented in Oshio (2005).

component (T). In period 2, the individual earns wage income (W_2), and receives a social security benefit, which consists of a wage proportional component (bW_1) with a benefit multiplier (b) and a flat-rate component (B). The premium and benefit are expressed as tW_1 and bW_1+B, respectively, in the EPI program, whereas they are expressed as T and B, respectively, in the NPI program. These types of program are interpreted as two special cases in our model. In addition, we assume no population growth and no interest rate for simplicity, and we interpret income in each period as *annual* income.

We focus on the squared coefficient of variation, SCV—which is defined by the ratio of variance to squared mean—to gauge income inequality and the distributive impact, although we use other inequality measures as well for the empirical analysis later. SCV can help us to intuitively understand the driving forces for a change in income inequality.

On an annual income basis, SCV of pre-social security (referred to as pre-SS hereafter) benefit for the elderly is expressed as

$$SCV_2 = \frac{\mathrm{var}(W_2)}{\overline{W}_2^2}$$

where the bar on the variable means its mean. SCV of post-social security (referred to post-SS hereafter) benefit for the elderly is given as

$$SCV_2^* = \frac{\mathrm{var}(W_2 + pW_1)}{\left(\overline{W}_2 + p\overline{W}_1 + B\right)^2}.$$

Comparing pre- and post-SS SCVs, we have:

$$\begin{aligned}\frac{SCV_2^*}{SCV_2} &= \frac{\overline{W}_2^2}{\left(\overline{W}_2 + p\overline{W}_1 + B\right)^2}\frac{\mathrm{var}(W_2 + pW_1)}{\mathrm{var}(W_2)} \\ &= \frac{\overline{W}_2^2}{\left(\overline{W}_2 + p\overline{W}_1 + B\right)^2}\frac{p^2\,\mathrm{var}(W_1) + \mathrm{var}(W_2) + 2p\,\mathrm{cov}(W_1, W_2)}{\mathrm{var}(W_2)},\end{aligned}$$

This equation indicates that the distributive impact of social security among the elderly can be decomposed into two parts. The first impact, which corresponds to the first term of the right-hand side, is a change in income inequality caused by an income transfer from the young via social

security benefits. This impact reduces income inequality among the elderly by raising the average level of their incomes.

The second impact, which is expressed by the second term of the right-hand side, implies a partial reflection of inequality in young-age income through a wage-proportional component of the social security benefit. As long as the correlation between young-age income and old-age income are not extremely negative, this impact is likely to increase income inequality among the elderly in contrast to the first impact.

It is unclear which of the first and second impacts is dominant; in other words, whether the impact of social security reduces or increases net income inequality among the elderly. In reality, and as discussed later, post-SS income is more evenly distributed than pre-SS income, meaning that the progressive impact of social security more than offsets the regressive impact among the elderly. However, this assessment of income redistribution tends to be misleading because the progressive impact of income transfer from the young to the elderly is largely offset over a lifetime.

In comparison, the impact of social security on income distribution among the young can be expressed in a simpler way. For the young, SCVs of pre- and post-SS income are given by

$$SCV_1 = \frac{\mathrm{var}(W_1)}{\overline{W}_1^2},\ SCV_1^* = \frac{(1-t)^2\,\mathrm{var}(W_1)}{\left[(1-t)\overline{W}_1 - T\right]^2},$$

respectively. Comparing SCVs of pre- and post-SS income, we have:

$$\frac{SCV_1^*}{SCV_1} = \frac{(1-t)^2\overline{W}_1^2}{\left[(1-t)\overline{W}_1 - T\right]^2} > 1,$$

as far as social security has a flat-rate premium, indicating the regressivity of the program.

2.2 Income redistribution: annual income *vs.* lifetime income

What about income inequality for society as a whole? We discuss income

redistribution on both annual and lifetime basis. To address this issue clearly, we take an extreme case in which the social security system has a simple structure consisting only of a wage-proportional premium and a flat benefit. If the social security program is a PAYG system, the equality of $B=t\overline{W}_1$ should hold. In addition, we assume that the elderly earn no wage income for simplicity. In all, lifetime income is simply expressed as W_1 and $(1-t)W_1+t\overline{W}_1=W_1+t(\overline{W}_1-W_1)$. Hence, the lower income group gets a positive (negative) net benefit over a lifetime, meaning that social security acts as a negative income tax on a lifetime income basis, and redistributes income progressively.

In this extreme case, pre-SS annual income for society as a whole is equal to $\overline{W}_1/2$, because there are the same number of the young who earn W_1 and the elderly who earn no wage income. The variance of annual pre-SS income is given by $\overline{W}_1^2/4+\mathrm{var}(W_1)/2$. Hence, SCV of pre-SS annual income, which is denoted as SCV_A, is calculated as:

$$SCV_A=\frac{\overline{W}_1^2/4+\mathrm{var}(W_1)/2}{\overline{W}_1^2/4}=1+2SCV_1.$$

In the same way, we can get the average and variance of post-SS annual income: $\overline{W}_1/2$ and $(1-2t)^2\overline{W}_1/4+(1-t)^2\,\mathrm{var}(W_1)/2$. So, its SCV is calculated as:

$$SCV_A^*=\frac{(1-2t)^2\overline{W}_1/4+(1-t)^2\,\mathrm{var}(W_1)/2}{\overline{W}_1/4}=(1-2t)^2+2(1-t)^2SCV_1.$$

Hence, comparing pre- and post-SS SCV, we have:

$$\frac{SCV_A^*}{SCV_A}=\frac{(1-2t)^2+2(1-t)^2SCV_1}{1+2SCV_1}<1,$$

which confirms that PAYG social security reduces inequality of annual income. Also, the larger the scale of social security is, the more progressively it redistributes annual income. However, this distributive impact might be misleading as mentioned above, as between-age income transfer from the young to the elderly is largely canceled over a lifetime.

Next, we consider redistribution in terms of lifetime income in this

simple model. Pre- and post-SS lifetime income are given by W_1 and $(1-t)W_1 + t\overline{W}_1$. Pre-SS lifetime income is the same as pre-SS young-age income, so its SCV, which is denoted as SCV_L is equal to the pre-SS SCV for the young, that is, $SCV_L = SCV_1$. For post-SS lifetime income, its average and variance are given as $\overline{W}_1$ and $(1-t)^2 \operatorname{var}(W_1)$, so we have: $SCV_L^* = (1-t)^2 SCV_1$. Hence, comparing pre- and post-SS SCV, we have:

$$\frac{SCV_L^*}{SCV_L} = \frac{(1-t)^2 SCV_1}{SCV_1} = (1-t)^2 < 1.$$

Then, we can confirm that the impact of redistribution policy on a lifetime income basis is lower than that on an annual income basis, because we have:

$$\frac{SCV_L^*}{SCV_L} - \frac{SCV_A^*}{SCV_A} = (1-t)^2 - \frac{(1-2t)^2 + 2(1-t)^2 SCV_1}{1+2SCV_1} = \frac{(2-3t)t_1}{1+2SCV_1} > 0 \ \ if \ \ t < \frac{2}{3}.$$

This suggests that the distributive impact of social security is smaller on a lifetime income basis than on an annual income basis, as long as the SS premium is not extremely high. This result appears to hold basically with more realistic assumptions for economic and demographic variables, as well as for social security schemes.

3. Empirical analysis on an annual income basis

3.1 Data

This section examines how current social security programs affect income distribution on an annual income basis. Our empirical analysis is based on micro-data from the SIR, which is conducted by the MHLW every three years. Unlike other household surveys, this survey primarily aims at measuring income distribution and effects of redistribution policies. The SIR is one of the most appropriate household surveys for analyzing income distribution given its wide coverage and reliability of reported income. We use micro-data from the SIRs in 1992 and 2001 to check whether or not there was any change in the pattern of income redistribution caused by

social security during the 1990s.

Our analysis is based on individual (rather than household) data. Most previous studies use household data, and they often adjust household size by dividing household income by the root of the number of household members. This method is reasonable and well-established, but any household size adjustment is arbitrary. Also, categorizing households by age of household heads fails to grasp the true structures of income distribution by age group and of income transfer across age groups. Of course, discussions based on individual data are not free from another bias; for example, they tend to ignore intra-family income transfer between husband and wife and/or between parents and children who reside together. Hence, it is reasonable to check whether estimated results based on individual data are consistent with those based on household data.

Our main focus is on three income variables: (1) pre-SS pre-tax income, which is called "initial" income in the SIR reports; (2) post-SS pre-tax income, which reflects social security (premium contributions and benefit receipts) but not tax payments; and (3) post-SS post-tax income, which reflects both social security and tax payments. Among these definitions, pre-SS pre-tax income is the sum of gross wages and salaries, self-employed income, farm income, dividends, interest, rents, and private transfer receipts.

In our analysis based on SIR data, social security means only public pension programs, and does not include medical and nursing care, employment insurance, and other social policy programs besides public pensions. Tax includes state/local income, property, and automobile tax, but not consumption tax. Unfortunately, we cannot precisely distinguish EPI and NPI members based on information available from the SIR. Our main comparisons are between pre-SS pre-tax income and post-SS pre-tax income, but we also look at post-SS post-tax income to examine the distributive impact of taxation for comparisons.

The original sample size in the SIR is 27,622 individuals for 1992 and 21,494 individuals for 2001. We exclude individuals who are younger than nineteen years old and those with zero or negative post-SS post-tax income. Then, the sample size is reduced to 20,576 for 1992 and 15,971 for 2001. We divide all individuals into two age groups: the young, who are aged between twenty and fifty-nine and the elderly, who are aged sixty or above. The threshold age, sixty, is the initial eligibility age for (partial) EPI benefits and the most common age of mandatory retirement in Japanese firms. In addition, a substantial number of NPI members start to receive pension benefits as early as at age sixty, even if the level of benefits is actuarially reduced.

In the empirical analysis, we additionally conduct the following two adjustments on data. First, we annuitize retirement lump-sum allowances, and include their annuatized values as countable income. We calculate the annuitized value of allowances based on the yield rate of the public pension fund, which can be implicitly calculated from the MHLW's statistics, as the annuity rate. Second, we bottom-code income at 1% of mean income in every survey year for all incomes. Even after excluding individuals of non-positive post-SS post-tax income, we have many individuals of zero pre-SS pre-tax income. We need this bottom-coding, because we cannot calculate some inequality measures which use logarithms if there is an individual with zero income.

3.2 Redistribution by social security

First, we overview the trend of income inequality over the period: 1992-2001. We look at four inequality measures in Table 1; (1) SCV, (2) LV (logarithmic variance), which is defined as the variance of logarithm of income, (3) Gini coefficient, and (4) MLD (mean logarithmic variation), which is defined as the mean of the logarithm of the ratio of average income to each individual's income.