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**How the Distribution of After-Tax Income
Changed Over the 1990s Business Cycle:
A Comparison of the United States, Great Britain,
Germany and Japan**

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How the Distribution of After-Tax Income Changed Over the 1990s Business Cycle: A Comparison of the United States, Great Britain, Germany and Japan

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Abstract

Using kernel density estimation we find that over their 1990s business cycles the entire distribution of after-tax (disposable) income moved to the right in the United States and Great Britain while inequality declined. In contrast, Germany and Japan experienced less growth, a rise in inequality and a decline in the middle mass of their distributions that spread mostly to the right, much like the United States over its 1980s business cycle. Inequality fell within the older population in all four countries and within the younger population in the United States and Great Britain, but rose substantially in Germany and Japan.

JEL Classification: D3

Key Words: income inequality, kernel density estimation, economic well-being, cross-country comparisons.

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1 Introduction

Over their 1980s business cycles the United States and Great Britain experienced large increases in income inequality (both before- and after-taxes) while the middle of their distributions decreased. (Duncan, Smeeding, and Rodgers, 1994; Gottschalk and Smeeding, 1997) However, Burkhauser, Cutts, Daly, and Jenkins (1999) using before-tax income data show that while the mass in both tails of their distributions increased significantly, by far the greatest gains were in the upper tail. So, income inequality increased primarily because the middle of their distributions got richer at different rates, rather than because a large part of the middle of their distributions became poorer. In this paper we update, expand and improve the methods used by Burkhauser, Cutts, Daly, and Jenkins (1999) to look at how the United States and Great Britain as well as Germany and Japan fared over the 1990s business cycle.

In contrast to the United States and Great Britain, before-tax income inequality grew only slightly and after-tax (disposable) income not at all in Japan and Germany over their 1980s business cycle. (Atkinson, Rainwater and Smeeding, 1995; Gottschalk and Smeeding, 1997). Hence by the beginning of the 1990s business cycle, the United States had the highest level of income inequality, followed by Great Britain, Japan and Germany.

However both the before- and after-tax income distributions in Japan have increased substantially since then. (Smeeding, 1997; Fukawa, 2002; Terasaki, 2002 and Tachibanaki, 2005). By the middle of the 1990s, Smeeding (1997) using Luxembourg Income Study (LIS) data reported that Japanese after-tax income inequality as measured by the Gini coefficient, while still substantially below the United States, was at or above the income inequality level of European countries.

Using data from the German Socio-Economic Panel (GSOEP), Biewen (2000) found that in the first few years following reunification, in 1989, after-tax income inequality in reunited Germany also increased. Forster and Pearson (2002) report similar results over a slightly longer period using LIS data. Most recently Bach, Corneo, and Steiner (2007) find even greater increases in income inequality over the period 1992-2001 using GSOEP data together with German tax record data to capture the upper tail of the German income distribution.

What is not known is how the shape of the income distribution in all four of these countries changed over their 1990s business cycles. Since we are interested in making cross-national comparisons, and because taxes play a much larger role in the other three countries than in the United States, in this paper we focus on after-tax (disposable) income and measure household income net of income and social security taxes in all countries.

2 Data

For the United States, we use data from the March Current Population Survey's Annual Social and Economic Supplement (CPS), for Germany and Great Britain we use data from the Cross-National Equivalent Files (CNEF) prepared at Cornell University (Burkhauser, Butrica, Daly and Lillard, 2001), and for Japan, we use data from the Survey on Income Redistribution (SIR) to compare longer term trends in average after-tax income and after-tax income inequality. We separate the cyclical factors that influence yearly fluctuations from longer secular changes by comparing peak years of the 1990s business cycle in each country. Since each country's business cycle peaks occurred over slightly different years, the calendar years we compare will differ slightly across countries.¹

The CPS, on which most studies of United States income inequality are based, does not directly question its respondents about their federal income or social security tax payments. Because most cross-national comparative studies of income inequality are based on disposable income, LIS simulates these tax values for the CPS data and makes them available to the research community. However LIS does not provide these values for all CPS years. Furthermore, because confidentiality rules prevent researchers from gaining access to most of the core country data sets in LIS, researchers can not independently verify these tax simulations and must accept all LIS harmonization procedures in order to use these data for cross-national comparisons.

For these reasons, we use the National Bureau of Economic Research TAXSIM model to approximate income and social security taxes with our consistently top-coded CPS income variables for the years 1979 through 2000. With this information we are able to calculate the household size-adjusted after-tax (disposable) income of individuals living in United States households. While we use data for all years from 1979 to 2000, we focus our comparisons on peak business cycle years 1979, 1989, and 2000.

We use CNEF for our calculations of Great Britain and Germany. While we use data for all years of their business cycles, we focus our comparisons on peak years 1990 and 2000 for Great Britain and peak years 1991 and 2001 for Germany. A major advantage of the CNEF data is that it provides harmonized measures of household income before and after the impact of the government tax-and-transfer systems in Germany and Great Britain, based on the German Socio-Economic Panel (GSOEP) and the British Household Panel Survey (BHPS). These are both representative household panels of their countries. CNEF, unlike LIS, is able to provide researchers access to its original country data sets and to all its harmonization programs so that individual researchers can either accept these harmonization decisions or customized them for their own purposes.

The CNEF data include standard demographic information as well as information on household income and its components and individual data on employment and labor earnings. Also included are cross-sectional and longitudinal sample weights, and macroeconomic indicators for each country. Households from the eastern states of Germany were included in the German data beginning with income year 1989. We use the CPS data here rather than the CNEF equivalized values from the Panel Study of Income Dynamics since we want to compare our results to Burkhauser, Couch, Houtenville and Rovba (2004) and more importantly because the CPS provides much greater sample sizes.

We use SIR data for our calculation of Japan which is fielded by the Ministry of Health and Welfare of Japan. Every third year SIR collects information on household income and its sources such as social security income, medical care, and family allowances, and the Ministry estimates tax payments for its households. We compare peak years 1989 and 2001.

Since most measures of income inequality are sensitive to outliers, we exclude observations in the top and bottom two percent of the household size-adjusted after-tax income distribution in Germany, Great Britain, and Japan. For the United States we use the consistent top coding convention discussed in Burkhauser, Couch, Houtenville and Rovba (2004) to control for outliers.

As Burkhauser, Couch, Houtenville and Rovba (2004) show, top coding in the uncorrected public use CPS data will dramatically distort trends in income inequality in the United States especially before and after 1995. Consistently top coding the data allows the researcher to consistently capture income inequality in approximately the bottom 97 percent of

the income distribution. However this method will also systematically miss the top part of the income distribution.²

3 Measuring Economic Well-Being

All income calculations are based on household after-tax (disposable) income. That is, income from all sources (labor earnings, income from investments and savings, public and private pensions, and transfers) minus total household income and social security taxes. Our measure of after-tax income does not include non-money transfers such as food stamps or the rental value of one's home.

To control for differences in the number of people living in a household and hence the share of household income each person controls, it is important to take into consideration economies of scale associated with joint residence. How much income sharing occurs among household members is a matter of some debate, as is the economies of scale associated with shared living within a household. We assume household income is equally shared and a scale elasticity of 0.5. Burkhauser, Smeeding and Merz (1996) note that these are common assumptions used in the cross-national literature.³

Sharing Unit. The CPS family definition, based on marriage or blood relationship, is often used as the income-sharing unit in the United States income distribution literature, but the CPS household definition, based on common residence, is closer to what is used in most cross-national studies. It is the one we use here for the United States. The BHPS and GSOEP sharing-unit definitions fall somewhere between the CPS family and common residence definitions in that they include unmarried non-blood-related cohabitants in the "family" but exclude other unmarried non-blood-related residents. For convenience of discussion, we use the word

"household" to describe the British and German sharing units in our analysis, although they only approximate the CPS household definition. In the SIR for Japan, household is defined in a manner similar to the CPS—as all persons sharing the same housing unit, regardless of any familial relationship.

Adjusting for inflation. While summary measures of the income distribution used here (90/10 ratio and Gini coefficients) are insensitive to the fluctuations in the units of the currency, as is the shape of the income distribution, comparisons of real changes in average income and in the movement of the income distribution over time are sensitive to these fluctuations. Here we use the Consumer Price Index-X (CPI-X) to adjust for inflation in the United States because it is the official measure of inflation used by the United States Bureau of the Census.

We use the International Monetary Fund Consumer Price Index for Germany, Great Britain and Japan. All incomes are converted to 2000 monetary units.

Defining the Older Population. Our age dichotomy is somewhat arbitrary. We divide our total sample into persons aged 65 and over and persons younger than age 65.

Estimating Income and Social Security Taxes for Current Population Survey (CPS) Households. The CPS does not question its respondents about their federal income or social security tax payments. Rather, Unicon Group at RAND simulates these payments. However, the RAND simulations of tax payments do not adjust reported income for changes in top coding. The CPS top codes all sources of income (e.g. wages and salaries, interest, etc.). Since the nominal income of the population rises each year, the share of the income distribution that is affected by top coding will change. This is also the case when the Census Bureau periodically changes the nominal value of the top codes. As a result, taxes simulated by RAND are not adjusted for differences in top coding over time. To address this issue, we impose consistent top coding solutions on each source of income, and sum over each of these sources to generate our measure

of an individual's income in a given year. We do this by top coding income at the same percentile of the income distribution from that source for all years. That is, we determine in which year the largest portion (lowest percentile) of the income distribution from that source was affected by this censoring, then top code all years to reflect that portion for each source of income. In this way, all sources of income are consistently top coded at the same point in the distribution in all years (See Burkhauser, Couch, Houtenville, and Rovba, 2004 for a more detailed discussion of this process and a table showing the income sources, share of the population affected by the top code and the most constrained year).⁴

We develop an alternative federal income and social security tax estimation using the National Bureau of Economic Research TAXSIM Model that approximates the income and social security tax burdens 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 these taxes. (A data appendix available from the authors provides greater details as does Rovba, 2006).

4 Results

4.1 Trends in Income and Income Inequality

Table 1 shows American, British, German, and Japanese mean and median after-tax income as well as the 90/10 ratio and Gini values for the peak years of their respective business cycles for the entire population and for older and younger persons. (Income and inequality values for all years are available from the authors upon request, as are before—pre-tax, post-transfer— income values.)

For the United States after-tax income (both mean and median) increased over both the 1980s and 1990s business cycles. Real mean household size-adjusted after-tax income increased

by 10.93 percent over the 1980s (Column 4) and by 7.27 percent over the 1990s while median after-tax income increased by 5.95 percent and 7.10 percent respectively over these periods. Hence, average after-tax income increased substantially over both United States business cycles. But after-tax income growth was much more equally shared in the 1990s than in the 1980s. Income inequality rose substantially over the business cycle of the 1980s whether measured by the 90/10 ratio (23.67 percent) or by the Gini coefficient (14.17 percent). In contrast, income inequality fell over the 1990s business cycle whether measured by the 90/10 ratio (-6.82 percent) or the Gini coefficient (-2.24 percent) (Burkhauser, Couch, Houtenville and Rovba, 2004, using before-tax income, find similar trends).⁵

Real after-tax income increased even more in Great Britain over the 1990s than in the United States measured by mean (20.61 percent) or median (20.84 percent) and after-tax income inequality fell measured by the 90/10 ratio (-6.78 percent) or the Gini coefficient (-3.59 percent). In contrast, while real after-tax mean (median) income in Germany increased by about the same amount as in the United States, 7.07 percent (5.62 percent), after-tax income inequality grew dramatically whether measured by a change in the 90/10 ratio (9.59 percent) or in the Gini coefficient (8.18 percent). As a result, after-tax income inequality in Germany, which was substantially below after-tax income inequality in Great Britain at the beginning of the 1990s business cycle, was much closer to it at the end. But the level of after-tax income inequality in both Great Britain and Germany still was considerably below the level of after-tax income inequality in the United States. In Japan, mean (median) real income increased over the 1990s by 6.04 (5.73) percent, while the magnitudes of the percentage changes in income inequality were near those experienced in 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.

As Table 1 also shows, changes in after-tax income levels and within-group income inequality of older and younger persons also varied considerably across the four countries. Mean (median) after-tax income of older persons in the United States grew dramatically over the 1980s business cycle both absolutely—19.95 (16.96) percent—and relative to younger persons—from 83.3 to 90.7 (see last row of columns 1 and 2). While real mean (median) after-tax income was higher at the end of the 1990 business cycle than at the start—it grew by 2.31 (5.45) percent—the mean after-tax income of older persons fell relative to younger persons—from 90.7 to 86.0 (see last row of columns 2 and 3). In Japan, over the business cycle of the 1990s, relative after-tax income of older persons fell from 94.1 to 89.8 percent. In contrast, the average real after-tax income of older persons in both Great Britain and Germany grew substantially over the 1990s business cycle and relative to their younger populations (last row of columns 6, 7, 9, and 10).

In all four countries, after-tax income inequality fell among older persons over the 1990s. The decline in income inequality was highest in Japan. In the United States this decline, while modest, was in sharp contrast to the substantial increase in inequality over the 1980s.

The growth in the average after-tax income of younger people over both United States business cycles was approximately the same. Average after-tax income also increased at younger ages in Great Britain, Germany, and Japan in the 1990s with the greatest increase by far among younger Britains.

The changes in after-tax income inequality among younger persons in the four countries were quite different over their 1990s business cycles. Unlike the substantial increases in after-tax income inequality experienced among younger persons in the United States in the 1980s, after-tax income inequality among younger persons in the United States fell as measured by both the

90/10 ratio (-7.61 percent) and Gini coefficient (-2.10 percent) in the 1990s. In Great Britain, after-tax income inequality also fell substantially over the 1990s business cycle, while in Germany and Japan it rose substantially among younger persons, especially in Germany. Hence, by the end of their 1990s business cycles, there was about the same level of after-tax inequality among younger Germans as was the case for younger Britains.

Comparing after-tax income values and relevant measures of inequality in Table 1 to before-tax average incomes and corresponding 90/10 ratios and Gini coefficients in Appendix Table 1A, we observe the inequality reducing effect of taxation. After-tax income inequality is lower than before-tax income inequality, whether measured by 90/10 ratio or Gini coefficient, for every sub-population and country in our analysis. Taxes also have a moderate equalizing effect on relative well-being of older populations. While the mean before-tax income of older to younger persons, for instance, in the United States in 2000 is 75.6 percent in Table 1A, the corresponding figure for after-tax income in Table 1 is 86.0 percent. Similar findings apply to our other three countries.

4.2 Measuring Changes in the Income Distribution Using Kernel Density Estimation

We now more fully explore how the distribution of after-tax income changed in each of these countries by estimating the probability density function of household size-adjusted after-tax income of their populations using Epanechnikov kernels with adaptive bandwidths. Kernel estimators are well established in the statistics and econometrics literatures, see: Silverman (1986). For a technical discussion of the kernel density method employed here in the context of measuring economic well-being, see Burkhauser, Cutts, Daly and Jenkins (1999) and Burkhauser, Couch, Houtenville and Rovba (2004).

The first panel of Figure 1 shows that in 1979 the distribution of after-tax 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.

However, between the two peak years of the 1990s business cycle, 1989 and 2000, the entire United States after-tax income distribution moved to the right. More formally, the income distribution in 2000 attained *first order stochastic dominance* over the 1989 distribution.⁶ 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 shows the after-tax income distribution of older Americans. In 1979 the distribution has the traditional inverted U shape with an even greater mass of the population bunched near the mode. As was the case for the more general population, by 1989 the middle mass fell with the vast majority becoming unequally richer. Over the 1990s business cycle there was much less movement overall. The smaller decline in the middle mass around the mode of the distribution spilled only somewhat to the right, creating a bulge in the distribution.

The third panel of Figure 1 shows the after-tax income distribution of younger Americans. In 1979, the distribution has the traditional inverted U shape and is closer in shape to the overall population than was the distribution for older Americans. This is also the case for the other two

distributions. Over the 1980s business cycle, the middle mass around the mode spilled primarily into the upper tail, but the entire distribution moved to the right over the 1990s business cycle.

Figure 2 captures the change in the after-tax income distribution for Great Britain over their 1990s business cycle. As Table 1 showed, Great Britain experienced substantial economic growth. The first panel of Figure 2 shows that the 2000 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. The older (panel 2) and younger (panel 3) populations also shifted to the right over the 1990s business cycle. In all three populations, 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 after-tax 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 after-tax income distribution in Germany and Japan over their 1990s business cycles.

In 1991, the beginning year of the German business cycle, their after-tax income distribution (panel 1 of Figure 3) 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 after-tax income distribution in Germany at the end of their 1990s business cycle in 2001 did not attain first order stochastic dominance over the 1991 income distribution. 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 rightward and becoming richer with a smaller but important share becoming poorer.

While panel 2 of Figure 3 shows that the after-tax income distribution of older Germans at the end of the 1990s business cycle, like that of older Britains, did attain first order stochastic dominance over the distribution at the beginning of the business cycle, panel 3 of Figure 3 shows

that the spillage of the middle mass away from the mode of the distribution of younger Germans over the 1990s business cycle more closely resembled the movement for younger Americans over their 1980s business cycle with a small but important group becoming poorer.

The after-tax income distribution in Japan at the end of their 1990s business cycle in 2001 also did not attain first order stochastic dominance over the after-tax income distribution at the beginning of the business cycle in 1989. Panel 1 of Figure 4 shows that by the end of the 1990s business cycle, the overall 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 very small group spilling toward the lower tail of the distribution.

While panel 2 of Figure 4 shows that the movement in the after-tax income distribution of older Japanese comes very close to achieving first order stochastic dominance over the 1990s business cycle, panel 3 of Figure 4 shows that the spillage of the middle mass away from the mode of the after-tax income distribution for younger Japanese closely resembled that of younger Americans over the 1980s business cycle and younger Germans over the 1990s business cycle. In all three cases, a small but important segment of the younger population became poorer.

Kolmogorov-Smirnov Tests of the Significance of Distributions Shifts. We use the Kolmogorov-Smirnov statistic to test whether the shifts in the distributions described above were statistically significant. This test considers the null hypothesis that the distribution in one period is equal to the distribution in another period or $H_0: F_1(x) = F_2(x)$. In practice, the cumulative distribution functions $F_1(x)$ and $F_2(x)$ may be calculated directly from the data or from the estimated kernel densities. We use the empirical cumulative distribution functions in our tests since they are easier to calculate and do not depend on our choice of kernel or bandwidth.

Table 2 provides calculations of the Kolmogorov-Smirnov statistic for the pair-wise comparisons over the years covered by our study for the four countries. 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 after-tax income distribution between peak-to-peak business cycle years in all four countries for the entire population, as well as for older and younger individuals.

4.3 Tracking the Disappearing Middle of the After-Tax Income Distribution

We use a test based on the binomial distribution to more precisely examine how the spillage out of the middle of the after-tax 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. To do so we first define the left and the right tails of the distribution. In the United States, for 1979 and 1989 after-tax income densities, we define the left intersection, and the left tail, as the point in the distribution at which the empirical after-tax income density in 1989 drops below the empirical after-tax income density in 1979. As can be seen in panel 1 of Figure 1, this intersection point is at \$7,812 for the entire population. The right intersection point, which defines the start of the right tail, is the point in the distribution at which the after-tax income frequency density in 1989 rises above the after-tax income frequency density in 1979. This intersection point is at \$31,693. The intersections for other pairs of densities are defined in a similar way. (See panel 1 of Figures 2, 3, and 4.)

Table 3 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) and Germany (columns 5 and 6) and Japan (columns 9 and 10) and their standard errors.⁷

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 after-tax income inequality rose in these countries.

Table 3 shows that the movement out of the middle for young persons was even greater in the United States (7.87 percent), Germany (10.99 percent), and Japan (8.65 percent) than for the population as a whole. Furthermore, the share of the middle that dropped into the left tail was also greater in the United States (26.18 percent), Germany (22.47 percent), and Japan (14.22). Nonetheless, in all countries the overwhelming majority of the increase in inequality was caused by younger people becoming unequally richer.

Significance Tests of Changes in the Tails of the Distribution. We test the statistical significance of the density changes in the tails of the after-tax income distribution reported in column 3 for the United States, column 7 for Germany, and column 11 for Japan using a binomial-based test statistic to determine whether the density masses contained in the left (or right) tails of two distributions differ. Specifically, letting p_1 and p_2 denote the probability that a randomly chosen individual will have an income in the tail of the distribution in years 1 and 2,

respectively, we test whether these two proportions are the same using: $Z_p = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{V(\hat{p}_1) + V(\hat{p}_2)}}$.

The variances of the estimated proportions are given by: $V(\hat{p}_i) = \hat{p}_i(1 - \hat{p}_i) \sum_{j=1}^n \frac{w_{ij}^2}{n_i^2}$, for each year $i = 1, 2$. The Z_p statistic is asymptotically distributed standard normal. In all cases, we strongly reject the null hypothesis that the masses in the tails are the same for our paired years.

5 Conclusion

We find major differences in how after-tax income growth was distributed within our four countries over their 1990s business cycles. The real household size-adjusted after-tax income distributions of the United States and of Great Britain at the end of their 1990s business cycle achieved first order stochastic dominance over their after-tax income distributions at the beginning. Hence, unlike their experiences in the 1980s, all people in the United States and Great Britain shared the gains of economic growth in the 1990s. Moreover, in contrast to the 1980s, measured after-tax income inequality in the 1990s fell in both countries.

In contrast, measured after-tax income inequality in Germany and Japan grew substantially over their 1990s business cycles. Like the United States in the 1980s, the middle mass of the distribution fell around the mode. While the greatest share 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 over the 1980s. 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.

In all four countries, average after-tax income of older persons grew in the 1990s but the growth in Great Britain and in Germany was greater both absolutely and relative to their younger populations. And in all four countries after-tax income inequality fell among their older populations over the period.

While average after-tax income of younger persons also grew in all four countries over the 1990s, only in the United States were the gains greater among this population. It was in this subpopulation that the differences in how after-tax income growth was shared are greatest across the four countries. The after-tax income distributions among younger Americans and Britains at the end of the 1990s business cycle achieved first order stochastic dominance over their income distributions at the start. This was not the case for younger Germans or Japanese. In addition, after-tax income inequality fell among younger Americans and Britains but rose among younger Germans and Japanese. The middle mass of the after-tax income distribution of younger Germans and Japanese fell with the vast majority spilling to the right. But a statistically significant but small share fell to the left. Once again the comparison with events in Germany and Japan in the 1990s and the United States in the 1980s are remarkably similar. In the United States 74 percent of the decline is explained by younger Americans becoming richer compared to 78 percent in Germany and 86 percent in Japan.

This paper has focused on measuring what have been quite different changes in the after-tax income distributions of four major OECD 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.⁸

In Germany it may be that reunification, which occurred in 1989, not only dramatically changed the geography of reunited Germany but may have changed its political and economic makeup relative to that in its pre-unification western states. This paper captures income distribution changes over reunified Germany's first business cycle. It remains to be seen if this was an inevitable short term outcome, given the significantly unequal market skills of the eastern and western states' populations, which will quickly fade away. Or, if it was the first round of a much 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 (Vogel 1979, 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 the level of after-tax 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 they 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/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.

In this paper we used kernel density estimation to look behind summary measures of after-tax income inequality to see how the entire distribution of after-tax income shifted over the 1990s business cycle. We distinguished between increases in inequality caused by the middle of the distribution falling into the two tails, from increases in inequality caused by the population as a whole becoming unequally richer. We did so because, other things equal, declines in after-tax income inequality are preferred to increases in after-tax income inequality. But increased inequality in a country where economic growth is making everyone richer is surely preferred to an outcome where the rich are getting richer at the expense of the rest of the population.

Appendix Table 1A. Before-Tax Household Size-Adjusted Income and Income Inequality, by Age 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) |
| All Persons | | | | | | | | | | | | | | |
| Mean | 28,697 | 31,708 | 34,334 | 10.49 | 8.28 | 14,160 | 16,818 | 18.77 | 23,015 | 25,178 | 9.40 | 3,738 | 3,897 | 4.26 |
| Median | 25,195 | 26,597 | 28,500 | 5.56 | 7.15 | 12,602 | 15,008 | 19.09 | 20,894 | 22,366 | 7.05 | 3,262 | 3,398 | 4.17 |
| 90/10 | 6.351 | 7.719 | 7.656 | 21.54 | -0.82 | 5.027 | 4.574 | -9.01 | 3.895 | 4.584 | 17.69 | 4.355 | 5.051 | 15.98 |
| Gini | 0.352 | 0.387 | 0.387 | 9.94 | 0.00 | 0.316 | 0.304 | -3.80 | 0.271 | 0.302 | 11.44 | 0.305 | 0.326 | 7.00 |
| Older Persons (aged 65 and older) | | | | | | | | | | | | | | |
| Mean (A) | 21,216 | 25,988 | 26,728 | 22.49 | 2.85 | 8,627 | 11,182 | 29.62 | 15,931 | 18,251 | 14.56 | 3,408 | 3,860 | 13.25 |
| Median | 16,069 | 19,082 | 20,191 | 18.75 | 5.81 | 6,874 | 9,330 | 35.73 | 13,735 | 15,985 | 16.38 | 2,740 | 3,308 | 20.74 |
| 90/10 | 6.081 | 6.708 | 6.586 | 10.31 | -1.82 | 3.576 | 3.498 | -2.18 | 3.470 | 3.240 | -6.63 | 5.510 | 4.999 | -9.27 |
| Gini | 0.391 | 0.418 | 0.405 | 6.91 | -3.11 | 0.292 | 0.282 | -3.42 | 0.265 | 0.264 | -0.38 | 0.352 | 0.328 | -6.79 |
| Younger Persons (aged 64 and younger) | | | | | | | | | | | | | | |
| Mean (B) | 29,611 | 32,491 | 35,367 | 9.73 | 8.85 | 15,597 | 18,482 | 18.50 | 24,304 | 26,696 | 9.84 | 3,813 | 3,913 | 2.64 |
| Median | 26,372 | 27,778 | 29,902 | 5.33 | 7.65 | 14,324 | 16,987 | 18.59 | 22,399 | 23,926 | 6.82 | 3,359 | 3,440 | 2.40 |
| 90/10 | 6.141 | 7.759 | 7.67 | 26.35 | -1.15 | 4.628 | 4.204 | -9.16 | 3.640 | 4.590 | 26.10 | 4.025 | 5.093 | 26.54 |
| Gini | 0.342 | 0.380 | 0.381 | 11.11 | 0.26 | 0.290 | 0.281 | -3.10 | 0.258 | 0.295 | 14.34 | 0.293 | 0.325 | 11.01 |
| Ratio (A)/(B) | 0.717 | 0.800 | 0.756 | | | 0.553 | 0.605 | | 0.656 | 0.684 | | 1.201 | 1.009 | |

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

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

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Table 1. After-Tax Household Size-Adjusted Income and Income Inequality, by Age 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) |
| All Persons | | | | | | | | | | | | | | |
| 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 | 3.10 | 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 | 0.250 | 8.18 | 0.298 | 0.315 | 5.84 |
| Older Persons (aged 65 and older) | | | | | | | | | | | | | | |
| Mean (A) | 19,078 | 22,884 | 23,413 | 19.95 | 2.31 | 8,146 | 10,683 | 31.16 | 14,289 | 16,259 | 13.79 | 3,048 | 3,150 | 3.35 |
| Median | 15,805 | 18,486 | 19,493 | 16.96 | 5.45 | 6,819 | 9,279 | 36.07 | 12,908 | 14,740 | 14.19 | 2,486 | 2,679 | 7.76 |
| 90/10 | 5.21 | 5.61 | 5.41 | 7.72 | -3.60 | 3.30 | 3.25 | -1.70 | 3.15 | 3.01 | -4.38 | 5.36 | 4.73 | -11.75 |
| Gini | 0.344 | 0.373 | 0.351 | 7.14 | -4.03 | 0.262 | 0.258 | -1.57 | 0.241 | 0.239 | -1.15 | 0.342 | 0.327 | -4.46 |
| Younger Persons (aged 64 and younger) | | | | | | | | | | | | | | |
| Mean (B) | 22,911 | 25,237 | 27,222 | 10.15 | 7.87 | 12,413 | 14,862 | 19.73 | 17,937 | 19,113 | 6.56 | 3,241 | 3,507 | 8.20 |
| Median | 21,472 | 22,643 | 24,335 | 5.46 | 7.47 | 11,522 | 13,897 | 20.61 | 16,758 | 17,663 | 5.40 | 2,900 | 3,137 | 8.17 |
| 90/10 | 4.55 | 5.81 | 5.37 | 27.72 | -7.61 | 3.67 | 3.46 | -5.73 | 2.97 | 3.43 | 15.45 | 4.00 | 4.38 | 9.54 |
| Gini | 0.290 | 0.340 | 0.332 | 15.52 | -2.10 | 0.257 | 0.251 | -2.46 | 0.225 | 0.249 | 10.89 | 0.287 | 0.308 | 7.41 |
| Ratio (A)/(B) | 83.3 | 90.7 | 86.0 | | | 65.6 | 71.9 | | 79.7 | 85.1 | | 94.1 | 89.8 | |

Source: Authors' estimations based on data from the March CPS Annual Demographic Files (1980-2001) in the United States, 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).

- 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. Kolmogorov-Smirnov Test of Differences in Income Distributions Across Paired Years.

| Group | United States | | | Great Britain | Germany | Japan |
|---------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| | 1979 versus 1989 | 1989 versus 2000 | 1979 versus 2000 | 1990 versus 2000 | 1991 versus 2001 | 1989 versus 2001 |
| Total Population | 5.85 | 3.90 | 5.95 | 7.98 | 21.73 | 8.65 |
| Aged 64 and younger | 4.75 | 2.85 | 4.68 | 3.63 | 22.69 | 6.95 |
| Aged 65 and older | 2.30 | 2.50 | 3.58 | 15.40 | 8.79 | 4.85 |

Source: Authors' estimations based on data from the March CPS Annual Demographic Files (1980-2001) in the United States, 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).

Note: All test statistics are significant at 1 percent level.

Table 3. Change in the Distribution of the Population Mass over Paired Years in the United States, Germany, and Japan.

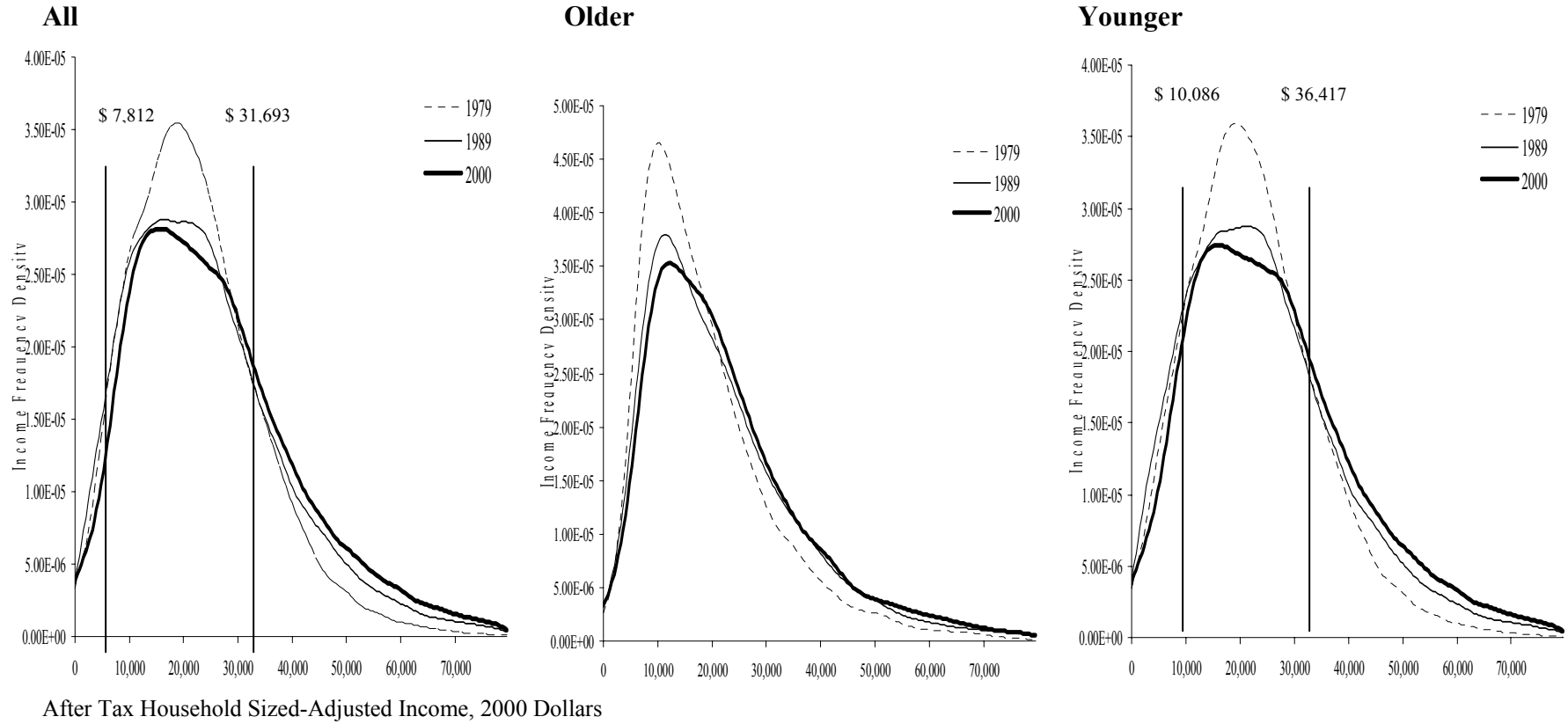
| Income Distribution Group ^a | United States | | | | Germany | | | | Japan | | | |
|--|--------------------------|--------------------------|--------------------------------|----------------------------|--------------------------|--------------------------|--------------------------------|----------------------------|--------------------------|---------------------------|---------------------------------|-----------------------------|
| | 1979 ^b (1) | 1989 ^b (2) | Difference ^c (3) | Share of the Middle (4) | 1991 ^b (5) | 2001 ^b (6) | Difference ^c (7) | Share of the Middle (8) | 1989 ^b (9) | 2001 ^b (10) | Difference ^c (11) | Share of the Middle (12) |
| All Persons | | | | | | | | | | | | |
| Less than left intersection | 5.24 (0.053) | 6.50 (0.062) | -1.26 (0.082) | -17.54 | 4.69 (0.109) | 5.63 (0.092) | -0.94 (0.142) | -11.42 | 7.18 (0.068) | 7.60 (0.069) | -0.42 (0.094) | -6.80 |
| Middle of distribution | 77.86 (0.099) | 70.68 (0.114) | 7.18 (0.151) | 100.00 | 74.17 (0.243) | 65.94 (0.201) | 8.23 (0.316) | 100.00 | 69.37 (0.112) | 63.19 (0.150) | 6.18 (0.186) | 100.00 |
| Greater than right intersection | 16.90 (0.089) | 22.82 (0.106) | -5.92 (0.138) | -82.46 | 21.14 (0.231) | 28.43 (0.193) | -7.29 (0.301) | -88.58 | 23.45 (0.096) | 29.21 (0.125) | -5.76 (0.142) | -93.20 |
| Younger Persons (aged 64 and younger) | | | | | | | | | | | | |
| Less than left intersection | 14.13 (0.084) | 16.19 (0.095) | -2.06 (0.127) | -26.18 | 9.96 (0.163) | 12.43 (0.142) | -2.47 (0.216) | -22.47 | 10.12 (0.073) | 11.35 (0.096) | -1.23 (0.123) | -14.22 |
| Middle of distribution | 69.30 (0.115) | 61.43 (0.130) | 7.87 (0.174) | 100.00 | 64.89 (0.273) | 53.90 (0.226) | 10.99 (0.354) | 100.00 | 62.90 (0.140) | 54.25 (0.158) | 8.65 (0.170) | 100.00 |
| Greater than right intersection | 16.57 (0.095) | 22.38 (0.113) | -5.81 (0.148) | -73.82 | 25.15 (0.252) | 33.67 (0.216) | -8.52 (0.332) | -77.53 | 26.98 (0.102) | 34.40 (0.112) | -7.42 (0.156) | -85.78 |

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).

Note: ^a See Figures 1, 3, 7, and 9 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.

Figure 1. Distribution of After-Tax Household Size-Adjusted Income in United States in Peak Business Cycle Years



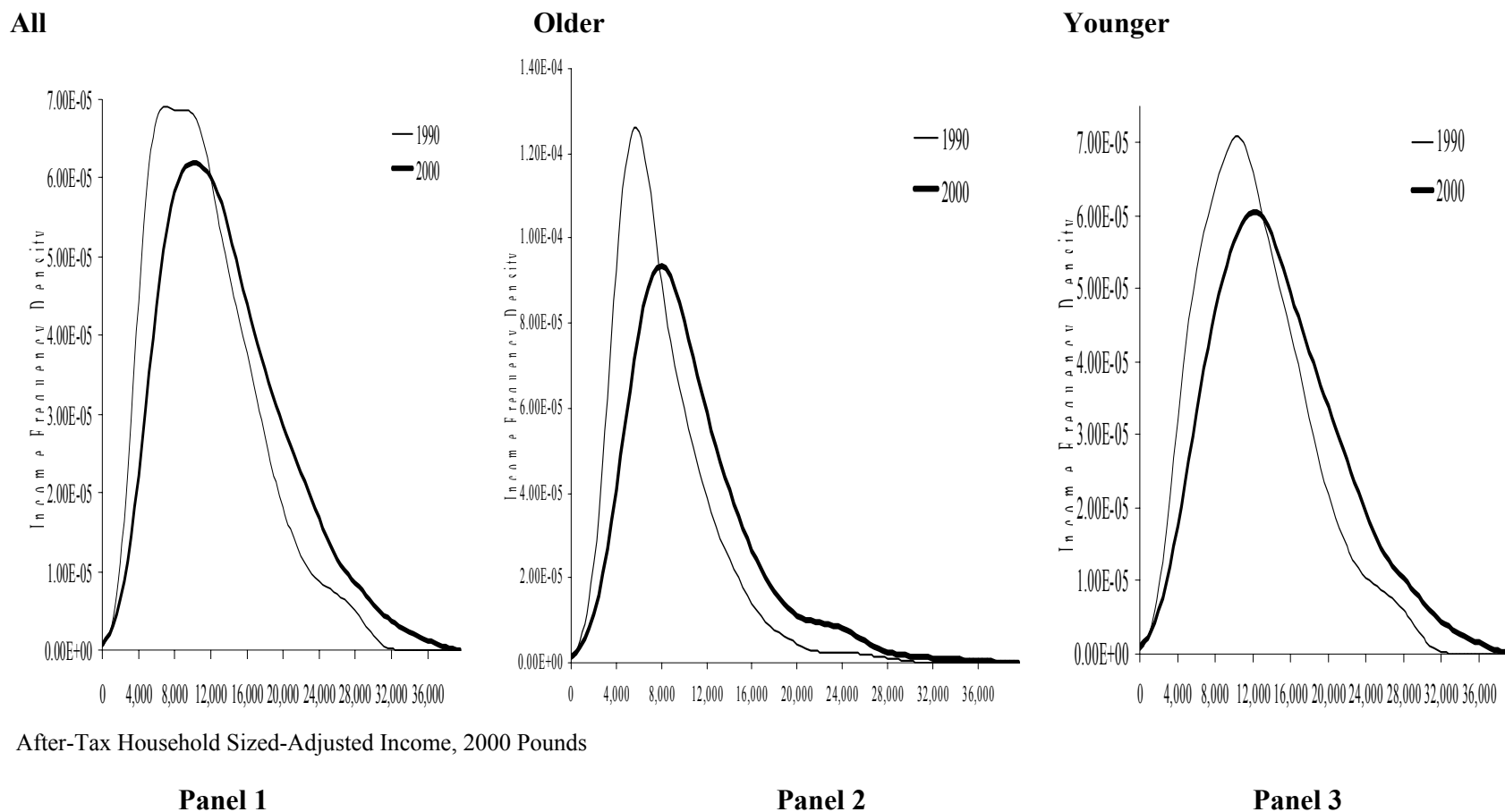
Panel 1

Panel 2

Panel 3

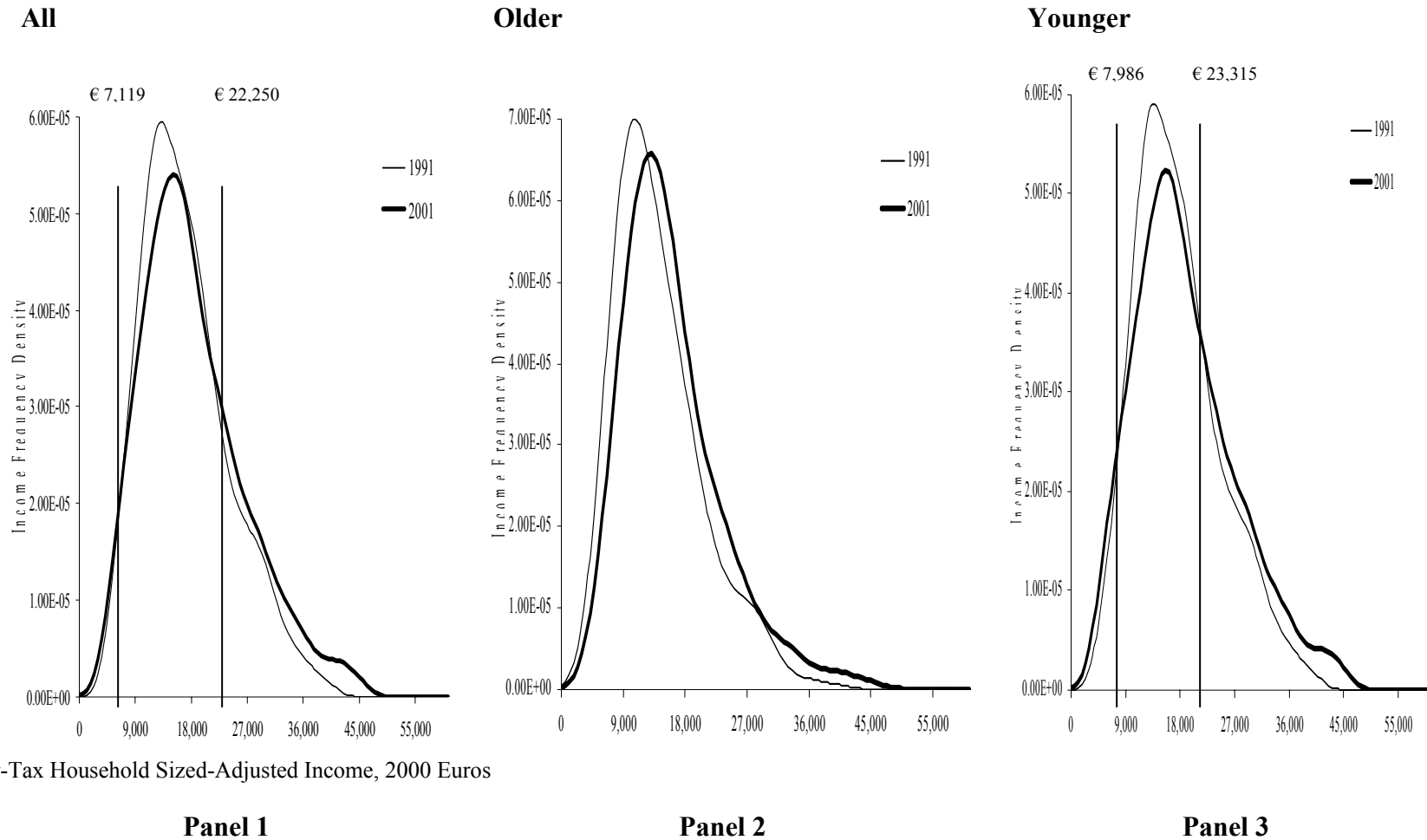
Source: Authors' estimations based on data from the March CPS Annual Demographic Files, 1980, 1990, and 2001.

Figure 2. Distribution of After-Tax Household Size-Adjusted Income in Great Britain in Peak Business Cycle Years



Source: Authors' estimations based on data from the British Household Panel Survey, 1991 and 2001.

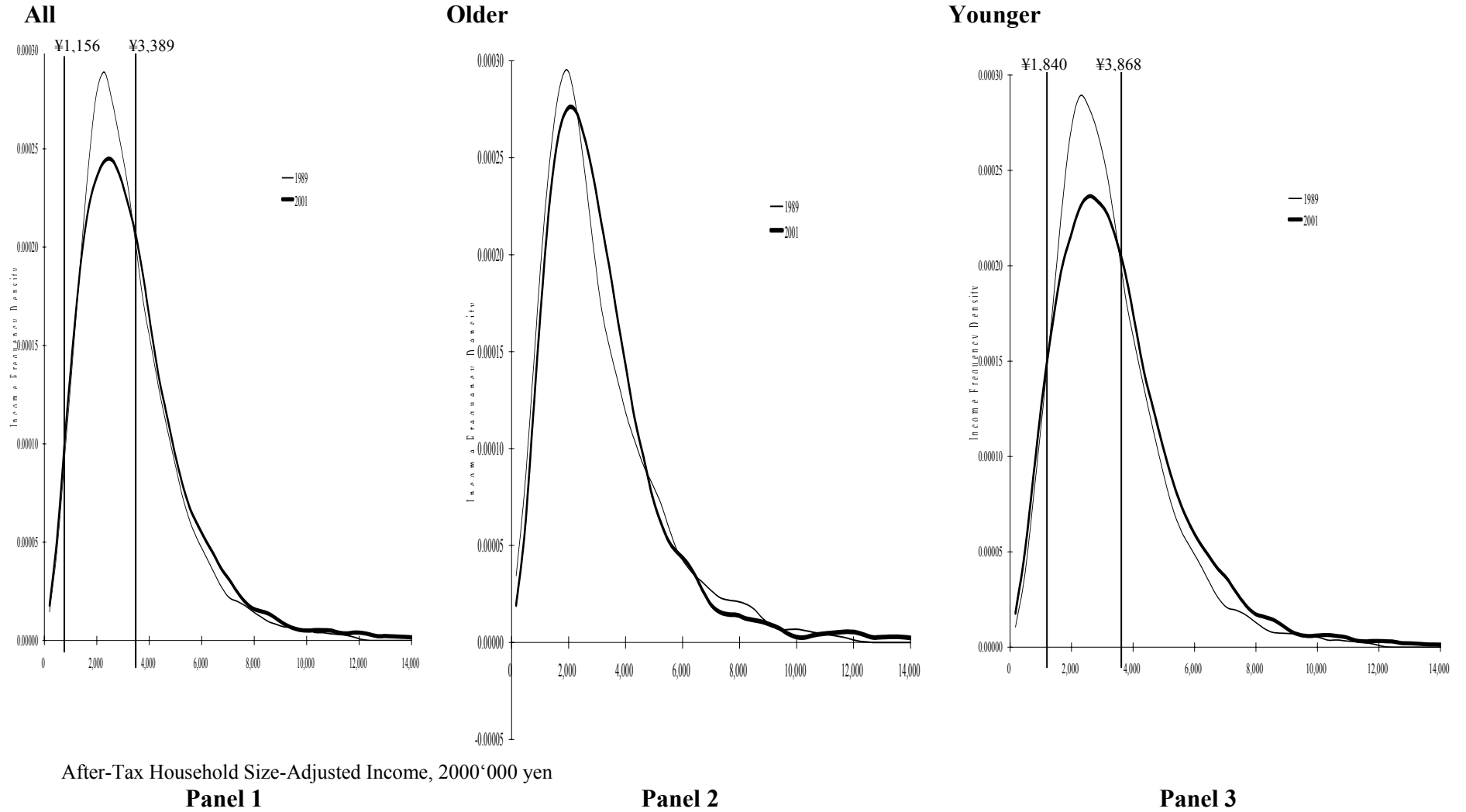
Figure 3. Distribution of After-Tax Household Size-Adjusted Income in Germany in Peak Business Cycle Years



After-Tax Household Sized-Adjusted Income, 2000 Euros

Source: Authors' estimations based on data from the German Socio-Economic Panel, 1992 and 2002.

Figure 4. Distribution of After-Tax Household Size-Adjusted Income in Japan in Peak Business Cycle Years



After-Tax Household Size-Adjusted Income, 2000'000 yen

Panel 1

Panel 2

Panel 3

Source: Authors' estimations based on data from the Japanese Survey of Income Redistribution, 1990 and 2002.

Endnotes

1. The starting and ending years of a business cycle are somewhat arbitrary. Rather than define them directly by changes in macroeconomic growth, we use peaks in income which will, in general, lag macroeconomic growth. This rule is straightforward in the United States and Great Britain where there are distinguishable peak years in average income. For Germany, income years 1991 and 1992 are similar. We chose 1991, though its average income was slightly lower than 1992, since it was closer to the peak year as defined using standard macroeconomic growth data. In Japan, differences in average income were much less pronounced. We chose 1989 and 2001 because they roughly correspond to peak years based on OECD methodology using a composite index of wage and salary income, employment, the industrial production index, manufacturing and trade sales, and quarterly gross domestic product. (See: Artis, Bladen-Hovell and Zhang, 1995). Our findings are not sensitive to reasonable changes to the peak years we choose to compare. While we have calculated average after-tax income and income inequality for all years in our study, here we focus on similar years in the business cycle.
2. Over time the CPS has improved its ability to capture the top part of the income distribution but even the restricted access CPS is subject to censoring at the top and can't capture the top 1 percent or so of the income distribution. (See: Feng, Burkhauser and Butler, 2006; Burkhauser, Feng, and Jenkins, 2007.) Hence the CPS can not capture changes at the very top of the distribution that may impact on both the level and trend in income inequality. Piketty and Saez (2003) using United States federal income tax data argue that increases in the very top of the income distribution have significantly increased income inequality in the United States. Bach, Corneo, and Steiner (2007) find that, like the CPS in the United States, the

GSOEP does not capture the very top of the German income distribution. Using German income tax data together with GSOEP data they find levels and trends in German income inequality over the period 1992-2001 are greater than those found using the GSOEP data alone.

3. The formula used in this calculation is: $Y_a = Y_u / F^\theta$, where Y_a is the household size-adjusted income available to each household member, Y_u is total unadjusted household income, F is household size and θ is the household size scale elasticity. We assume $\theta = 0.5$. As discussed in Karoly and Burtless (1995, p. 382), this implies returns to scale such that a four person household requires only twice as much total unadjusted household income as a one person household for each of its members to attain the same level of economic well being as the person in the one person household.
4. Our consistently top coded income measure produces Gini coefficients that are significantly lower than those for the full sample since we are systematically cutting off the upper tail of the distribution of income in all years, but as Burkhauser, Couch, Houtenville, and Rovba (2004) show, there is no significant difference in the trends between the Gini coefficients produced by the Census Bureau based on their internal CPS data and our Gini coefficients both before the major change in their top coding rules in 1992 and afterward. (See: DeNavas-Walt and Cleveland 2002, p.20-22, Table A-3, for internal Census Gini values.) Hence we believe our income inequality trends provide an accurate measure of income inequality in the United States between 1979 and 2000 for the bottom 98 or 99 percent of the income distribution.

5. Researching using LIS equivalized CPS data to capture trends in income inequality in the United States will find that the LIS methods of trimming the data yield trends in after-tax income inequality using Gini values in the 1990s that are closer to those found in the uncorrected CPS public use data. (LIS website: [//www.lisproject.org/keyfigures/ineqtable.htm](http://www.lisproject.org/keyfigures/ineqtable.htm)) That is, their Gini values are implausibly high after 1994 because they do not correct for major changes in top coding and other issues of censoring. (Burkhauser, Couch, Houtenville, and Rovba, 2004)

6. First order stochastic dominance is formally defined as follows: Consider two income distributions y_1 and y_2 with cumulative distribution functions (CDFs) $F(y_1)$ and $F(y_2)$. If $F(y_1)$ lies nowhere above and at least somewhere below $F(y_2)$ then distribution y_1 displays first order stochastic dominance over distribution y_2 : $F(y_1) \leq F(y_2)$ for all y . Alternatively, this can be expressed by using the inverse function $y=F^{-1}(p)$ where p is the share of the population with income less than a given income level. First order dominance is attained if $F_1^{-1}(p) \geq F_2^{-1}(p)$ for all p . The inverse function $F^{-1}(p)$ is known as a Pen's Parade (Pen, 1971), which plots income against cumulative population, usually using ranked income qualities. The dominant distribution is one whose Parade lies nowhere below and at least somewhere above the other. First order stochastic dominance of distribution y_1 over y_2 implies that any social welfare function that is increasing in income, will record higher levels of welfare in distribution y_1 than in distribution y_2 (Saposnik, 1981, 1983).

7. We can estimate the proportion of interest \hat{p} from the kernel density estimates or directly from the data. We have used the latter method in order to avoid complicated reliance on the asymptomatic properties of the kernel estimators. Standard errors for the estimated

population proportions are also included and are calculated according

to $s_p = \sqrt{\hat{p}(1 - \hat{p})\left(\frac{1}{n^2} \sum_{i=1}^n w_i^2\right)}$, where \hat{p} is the estimated proportion of interest.

8. See Burkhauser, Couch, Houtenville and Rovba (2004) and Couch and Daly (2004) for a more detailed discussion. Trends in Great Britain appear to be similar to those in the United States (see Goodman and Shephard, 2002 for a detailed discussion).