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Income Inequality in the 1990s: Comparing the United States, Great Britain and Germany

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576

**Richard V. Burkhauser
Ludmila Rovba**

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the United States, Great Britain and Germany**

Berlin, April 2006



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Discussion Papers 576

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Income Inequality in the 1990s

Comparing the United States, Great Britain and Germany

Berlin, April 2006

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Abstract

Using data from the March Current Population Surveys in the United States, the Household Panel Survey in Great Britain and the Socio-Economic Panel in Germany we find gains from economic growth in the United States over their 1990s business cycle (1989-2000) were more equitably distributed than were the gains over their 1980s business cycle (1979-1989). Furthermore, they were more equitably distributed than were the gains in Germany over their 1990s business cycle (1991-2001). However, gains from economic growth in Great Britain over their 1990s business cycle (1990-2000) were the most equitably distributed.

Our results hold using both summary measures of inequality as well as kernel density estimations. In the United States and Great Britain the entire income distribution moved upward in the 1990s. In Germany, as was the case in the United States over their 1980s business cycle, there was a drop in the middle of the income distribution and increases in both tails. In the United States, younger persons (aged 64 and younger) fared better than older persons (aged 65 and older) while the opposite was the case in Great Britain and Germany. Income inequality fell in all three countries among the older population. But it rose in Germany, remained about the same in the United States and fell in Great Britain among their younger populations.

JEL Classification: D3

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

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1 Introduction

Real income growth and how it is distributed are important measures of the overall change in a country's economic welfare. While there has been significant growth in average income in the United States over the second half of the 20th Century, changes in income inequality, whether measured at the family or household level have been more varied (Bradbury 1996, Karoly 1992, and Lynch 2003, Burkhauser, Crews, Daly and Jenkins 1996, Burkhauser, Cutts, Daly and Jenkins 1999). The variance in the distribution of income narrowed continuously through the middle of the 1970s but then widened throughout the 1980s. Burkhauser, Couch, Houtenville and Rovba, (2004a) using a household size-adjusted measure of income confirm that income inequality rose substantially over the business cycle of the 1980s (1979-1989). But they also show that this was not the case over the business cycle of the 1990s (1989-2000). While income inequality rose over the first part of the 1990s, it fell thereafter. By 2000, income inequality returned approximately to its 1989 level.¹

We extend this literature by comparing the growth and dispersion of household size-adjusted income through the 1990s in the United States with that of two other major industrialized countries—Great Britain and Germany. In doing so, we recognize that both income and income inequality vary over the business cycle. While we have calculated average income and income inequality values for all years in our study, we only report these values for similar years in the business cycle.² When we compare levels of income and inequality at the peaks of the business cycle in these countries, we draw four conclusions:

- Average household size-adjusted income increased over the business cycle of the 1990s in all three countries but more so in Great Britain than in the United States or Germany.
- Income inequality, which had widened throughout the business cycle of the 1980s in the United States, remained approximately the same over the business cycle of the 1990s while falling in

¹ In the United States Current Population Survey, one can choose two methods to define an economic sharing unit. The family (all married or blood relatives who live in a common dwelling) or the household (all residents living in a common dwelling). These are the sharing units most often used by those estimating income inequality or poverty rates in the United States. Income within the sharing unit is assumed to be shared equally and some degree of returns to scale in the use of that income is assumed to be experienced by those who live together. Each individual in the sharing unit is then assigned a family or household size-adjusted income value. Burkhauser, Crews, Daly and Jenkins (1999) show that changes found by researchers in the distribution of income in the 1980s are similar using either a family or household sharing unit. We use the household unit as our sharing unit for the United States Current Population Survey. We use an expanded family sharing unit for the BHPS and GSOEP which in addition to all married and blood relatives also includes co-habitators. But for ease of explication in this paper, we will call this sharing unit a "household".

Great Britain and rising in Germany. At the end of the 1990s, income inequality in Germany and Great Britain was approximately the same and substantially lower than income inequality in the United States.

- Unlike the business cycle of the 1980s, the entire distribution of income shifted upward over the business cycle of the 1990s in the United States. Great Britain experienced a similar upward shift. In Germany, the shift in the income distribution looked much like the United States shift in the 1980s, a dramatic decline in the middle with most people becoming richer but a small but statistically significant share becoming poorer.
- The pattern of income gains between the older (65 and older) and younger (64 and younger) populations in these countries varied with younger persons gaining relative to older persons in the United States but the opposite occurring in Great Britain and Germany. Income inequality fell in all three countries at older ages but rose substantially at younger ages in Germany, while remaining approximately the same in the United States and falling in Great Britain.

² Tables containing yearly mean and median income values as well as income inequality measures for all years are available from authors upon request.

2 Data

The data used in this paper come from the United States March Current Population Survey's Annual Social and Economic Supplement (CPS) and the Cross-National Equivalent Files (CNEF), prepared at Cornell University (Burkhauser, Butrica, Daly and Lillard, 2001). We compare longer term trends in average income and income inequality in three countries – the United States, Great Britain and Germany. 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.

We use the March Current Population Annual Demographic Surveys (CPS) from 1980 through 2001 to calculate the household size-adjusted income of individuals living in United States households.³ There have been two major business cycles over this period. While we use data from all years, we focus most of our comparisons on 1979, 1989, and 2000, each of which is a business cycle peak year in the United States.⁴ By examining these peak years, we control for the state of the business cycle. Following others, we use the CPS household definition to define the sharing unit for our population and also assume that household income is equally shared.

Income from each source (e.g. wages and salaries, interest, etc.) in the CPS is top coded and those individuals with income above the top coding threshold are assigned a top coded value. Since the nominal income of the population rises each year, the share of the income distribution that is affected by top coding changes. This is also the case when the United States Census Bureau periodically changes the nominal value of the top codes. As a result, measures of inequality which require all observations, such as the Gini coefficient, are more likely to be influenced by top coding decisions than are percentile-based measures such as the 90/10 ratio (the ratio of the income of the person at the 90th percentile to the person at the 10th percentile) which are only affected to the degree that top

³ We measure the size-adjusted income of all people residing in households in the CPS. But our unit of analysis is the person. Younger and older persons may live in the same household. In this case, they will receive the same household size-adjusted income value but that value will be included in the average for the age group of the individual.

⁴ The starting and ending years of a business cycle are to some degree arbitrary. In the United States and Great Britain we use what are distinguishable peak years in average income to define our peak years of the 1980s and 1990s business cycles. For Germany, income years 1991 and 1992 are very similar. We chose 1991 even though its average income was slightly lower than 1992 since it was closer to the peak year as defined using standard macroeconomic growth data. Because employment and income lag changes in economic growth, these years do not necessarily match business cycles defined by changes in macroeconomic growth.

codes in some of the sources affect those whose total income is below the relevant comparison percentile.

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. We do this 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 et al. 2004a, 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.)⁵

For calculation of income and income inequality measures in Great Britain and Germany we use the Cross-National Equivalent Files (CNEF). The CNEF includes data from nationally representative household panels for four countries: the British Household Panel Survey (BHPS), Canadian Survey of Labor and Income Dynamics (SLID), the German Socio-Economic Panel (GSOEP), and the United States Panel Study of Income Dynamics (PSID). The CNEF data include standard demographic information, 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. One advantage of the CNEF data is the provision of harmonized measures of household income before and after the impact of the complete government tax-and-transfer system in each country. We use data from the February 2004 CNEF release which includes income years 1990-2000 for Great Britain and income years 1983-2001 for Germany. Households from the eastern states of Germany were included in the German data beginning with income year 1989. 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 income distribution

⁵ Burkhauser, Butler, Feng and Houtenville (2004b) argue that despite the changes in the methods the Census Bureau has used to collect and report earnings between 1975 and 2001 (see Ryscavage 1995, Polivka 1996, and Jones and Weinberg 2000) in the March CPS data, these data can be used to consistently estimate trends in earnings inequality. Burkhauser et al. (2004a) extend the top coding procedure Burkhauser et al (2004b) used to capture earnings to capture household size-adjusted income. We use those same procedures here. Our 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 et al. (2004a) 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.) Burkhauser et al. (2004a) results mirror the results found by Burkhauser et al (2004b) with respect to earnings. Hence we believe our income trends provide an accurate measure of income inequality in the United States between 1979 and 2000.

in Germany and Great Britain.⁶ We use the CPS data here rather than the PSID since we want to compare our results to Burkhauser et al. (2004a). We exclude SLID data because it does not cover the full 1990s business cycle. Because the 1990s business cycles in Great Britain and Germany occurred over slightly different years, we will focus on 1990 and 2000 in Great Britain and 1991 and 2001 in Germany.⁷

⁶ Feng, Burkhauser and Butler (2005) show that a rule-of thumb trimming of the top 2 percent of the public use version of the CPS yields population samples whose levels and trends in wage earnings inequality are similar to those using the consistently top coded methods used here.

⁷ Income values for all years are available from authors upon request.

3 Measuring Economic Well-Being

Economists conceptualize economic well-being in terms of utility or life satisfaction. But they measure economic well-being either in terms of consumption or income. While consumption-based measures more closely approximate the theoretical construct of economic well-being, survey data on individuals seldom include detailed measures of consumption. Hence, the most commonly used alternative measure of economic well-being and the one we use in this study, is pre-tax post-transfer income. That is, income from all sources not adjusted for taxes paid. This is the most common measure of economic well-being used in the United States. As a measure of economic well-being, income will be correlated with consumption, although the degree of correlation will be smaller among the subsample of the older population with substantial wealth.

To control for differences in the number of people living in a household and hence the share of household income they control, 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. Operationally, it has been shown that measured levels and trends in inequality are not very sensitive to reasonable alternative scale economy assumptions. However, levels of overall income and the relative incomes of groups within the population are sensitive to the assumption made about household economies of scale. (See Burkhauser, Smeeding and Merz 1996; Burkhauser, Giles, Lillard and Schwarze 2003). We assume a scale elasticity of 0.5. Burkhauser, Smeeding and Merz (1996) note that this is the *Unit* dominant one used in the cross-national literature.⁸

3.1 Sharing

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. Atkinson, Rainwater, and Smeeding (1995) argue that using the blood or marital relationship definition rather than the less restrictive common residence definition produces a bleaker picture of the income dist-

⁸ The formula used for this calculation is $Y_a = Y_u / F^\theta$. Here, Y_a is the adjusted household income used in the analysis. Y_u is the unadjusted household income. F is household size. θ is the adjustment for household size. We assume $\theta = 0.5$. As discussed in Karoly and Burtless (1995, p. 382), this implies that a four person household needs twice as much income as a one person household to attain the same level of consumption.

tribution because it categorizes a larger number of individuals as single person sharing units even when they reside and share the benefits of living with others. 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 BHPS and GSOEP sharing units in our analysis, although they only approximate the CPS household definition.

3.2 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. 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. Boskin, Dulberger, Gordon, Grilliches, and Jorgenson (1996) offer the most systematic criticism of the CPI-X used in most measures of economic well-being in the United States and propose alternative indices for the 1980s that are between 1.0 and 1.5 percentage points below the CPI-X. While using alternative cost-of-living measures affects the magnitude of our results, (e.g., a lower CPI will increase the real gains in economic well-being over time), they do not alter our major points. We use the International Monetary Fund Consumer Price Index for Great Britain and Germany. All incomes are converted to 2000 monetary units.

3.3 Defining the Older Population

Our age dichotomy is somewhat arbitrary. A major social policy questions in each of these countries is the degree that older (and a more likely to be retired population) fare relative to the younger population over the business cycle. This may vary, for instance, based on how social security benefits are adjusted with economic growth. We divide our sample into persons over and under age 65. In all three countries this is about the age of normal retirement in their social security program. We include children in our younger population. While children are also not likely to be in the labor force, they usually live in households with adults who are younger than age 65 and in the labor force.

4 Trends in Income and Income Inequality

Table 1 shows mean and median income as well as the 90/10 ratio and Gini coefficients for the United States, Great Britain, and Germany over the peak years of their respective business cycles for the entire population and for older and younger persons⁹.

The values for the United States are replicated from Burkhauser et al. (2004a). They show that household size-adjusted income (both mean and median) increased over both the 1980s and 1990s business cycles. Real mean household size-adjusted income increased by 10.49 percent over the 1980s (Column 4) and 8.28 percent over the 1990s while median income increased by 5.56 percent and 7.15 percent respectively over these periods. Hence, average income increased substantially over both United States business cycles. But the fruits of economic growth were 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 (21.54 percent) or by the Gini coefficient (9.94 percent). In contrast, while income inequality rose over the early years of the 1990s business cycle, it fell during the growth years at the end of the cycle. Hence, on net, there was virtually no change in income inequality between 1989 and 2000 whether measured by the 90/10 ratio (-0.82 percent) or the Gini coefficient (0.00 percent).

⁹ Income and inequality values for all years are available from the authors upon request.

Table 1:
Household Size-Adjusted Income and Income Inequality, by Age in the United States, Great Britain, and Germany.

	United States ^a				Great Britain ^b				Germany ^c		
	1979 (1)	1989 (2)	2000 (3)	Percent Change 1979-1989 (4)	1989-2000 Percent Change (5)	1990 (6)	2000 (7)	Percent Change (8)	1991 (9)	2001 (10)	Percent Change (11)
	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
Median	25,195	26,597	28,500	5.56	7.15	12,602	15,008	19.09	20,894	22,366	7.05
90 / 10 Ratio	6.351	7.719	7.656	21.54	-0.82	5.027	4.574	-9.01	3.895	4.584	17.69
Gini Coefficient	0.352	0.387	0.387	9.94	0.00	0.316	0.304	-3.80	0.271	0.302	11.44
	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
Median	16,069	19,082	20,191	18.75	5.81	6,874	9,330	35.73	13,735	15,985	16.38
90 / 10 Ratio	6.081	6.708	6.586	10.31	-1.82	3.576	3.498	-2.18	3.470	3.240	-6.63
Gini Coefficient	0.391	0.418	0.405	6.91	-3.11	0.292	0.282	-3.42	0.265	0.264	-0.38
	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
Median	26,372	27,778	29,902	5.33	7.65	14,324	16,987	18.59	22,399	23,926	6.82
90 / 10 Ratio	6.141	7.759	7.67	26.35	-1.15	4.628	4.204	-9.16	3.640	4.590	26.10
Gini Coefficient	0.342	0.380	0.381	11.11	0.26	0.290	0.281	-3.10	0.258	0.295	14.34
Ratio (A) / (B)	0.717	0.800	0.756			0.553	0.605		0.656	0.684	

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

Real average household size-adjusted income increased even more in Great Britain over the 1990s than in the United States whether measured by mean (18.77 percent) or median (19.09 percent) and income inequality fell either measured by the 90/10 ratio (-9.01 percent) or the Gini coefficient (-3.80 percent). In contrast, while real mean (median) income in Germany increased by about the same amount as in the United States, 9.40 percent (7.05 percent), income inequality grew dramatically whether measured by a change in the 90/10 ratio (17.69 percent) or in the Gini coefficient (11.44 percent). The magnitudes of these percentage changes were near those experienced in the United States in the 1980s. As a result, income inequality in Germany, which was substantially below income inequality in Great Britain at the beginning of the 1990s business cycle, was by the end approximately equal to income inequality in Great Britain. But the level of income inequality in both Great Britain and Germany still were considerably below the level of income inequality in the United States.

Table 1 also reports changes in the income level and within group income inequality of older and younger persons in the three countries. Mean (median) income of older persons in the United States grew dramatically over the 1980s business cycle both absolutely--22.49 (18.75) percent--and relative to younger persons—from .717 to .800 (see last row of columns 1 and 2). While real mean (median) income was higher at the end of the 1990 business cycle than at the start—it grew by 2.85 (5.81) percent, the mean income of older persons fell relative to younger persons—from .800 to .756 (see last row of columns 2 and 3). In contrast, the average real income of older persons in both Great Britain and Germany grew substantially over the 1990s business cycle and relative to their younger populations (see last row of columns 6 and 7 and of 9 and 10). In all three countries, income inequality fell among older persons over the 1990s. In the United States this decline was in sharp contrast to substantial increases over the 1980s.

The growth in the average income of younger people over both United States business cycles was approximately the same. Average income also increased at younger ages in Great Britain and Germany in the 1990s. But the changes in income inequality among younger persons in the three countries were quite different over their 1990s business cycles. Unlike the substantial increases in income inequality experienced among younger persons in the United States in the 1980s, income inequality among younger persons in the United States either slightly fell as measured by the 90/10 ratio (-1.15 percent) or remained about the same as measured by the Gini coefficient (0.26 percent increase) in the 1990s. In Great Britain, income inequality fell substantially over the 1990s business cycle, while in Germany it rose substantially among younger persons. By the end of their

1990s business cycles, there was greater inequality among younger persons in Germany than was the case for younger people in Great Britain.

5 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. (See Atkinson, 1983, for a discussion of these inequality measures.) 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. Table 1 showed that changes in income inequality as measured by a percentage change in the 90/10 ratio or the Gini coefficient differed in magnitude and even in sign over the period of our analysis. For example, income inequality as measured by the 90/10 ratio fell slightly over the 1990 business cycle among younger people in the United States, while income inequality for this same population as measured by the Gini coefficient rose slightly.

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. One type, a "squashing down" in the middle combined with a "stretching" at each end, is typically discussed in the literature. But this is only one possibility, as our results will show. Changes in modality are also revealed by changes in "clumping" at different points along the income scale. For these reasons we use kernel density estimation here to evaluate how the income distribution changed in the United States, Great Britain and Germany for the total population as well as for the older and younger subpopulations.

In their simplest forms, kernel estimators are smoothed histograms. Data in a neighborhood around a point are used to estimate the distribution of a variable of interest (e.g., income) over a population. However, while histograms restrict observations to any one neighborhood group, kernel estimators theoretically allow an observation to be included in an infinite number of neighborhood groups, which results in a smoothing of the distribution shape. In practice, an observation is included in a finite number of groups, where the number of groups is equal to the sample size. The idea underlying kernel density estimation is a viewing window that slides over the data; the estimate of the density depends on the number of observations that fall within the window as it passes along the income scale.

Kernel estimators are well established in the statistics and econometrics literatures; an excellent reference on kernel estimators is Silverman (1986). For a more 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 et al. (2004a).

Table 1 used summary measures of the income distribution to show first, that the distribution of 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 experienced substantial economic growth in the 1990s without increases in income inequality, Great Britain was able to do so while decreasing income inequality and Germany 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 the probability density function of household size-adjusted income of their populations.¹⁰

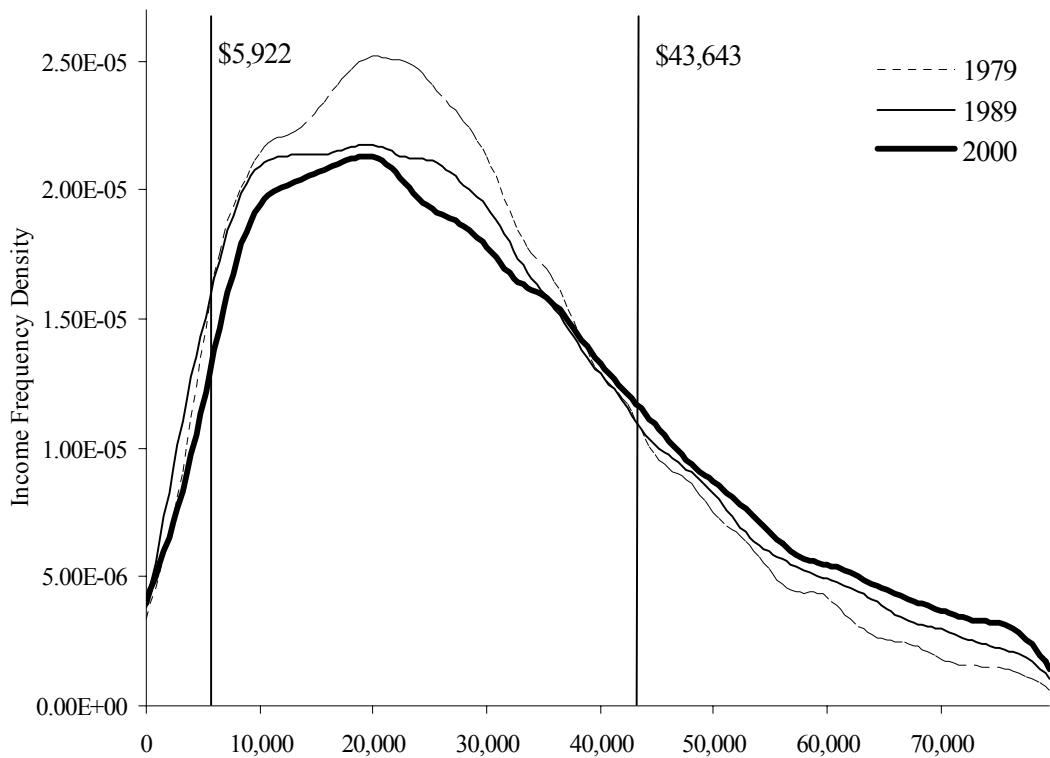
Figure 1 shows that in 1979 the distribution of household size-adjusted income in the United States had the traditional inverted U shape with the great mass of the population bunched around the mode of the distribution. But by the end of the 1980s business cycle in 1989, the distribution had become much 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. Later we will demonstrate using the same methods developed in Burkhauser et al. (1999) that, while the number of people in the middle of the distribution fell significantly, the great majority became unequally richer as they spread out along the right tail of the distribution.¹¹

In contrast, the entire income distribution moved to the right in the United States 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.

¹⁰ These estimates are based on Epanechnikov kernels with adaptive bandwidths.

¹¹ Burkhauser et al. (1999) used data from the CPS to look at how the income distribution changed over the 1980s business cycle in the United States and data from the Households Below Average Income sub file of the United Kingdom Family Expenditure Survey to do the same for the United Kingdom over their 1980s business cycle. We use a consistently top coded version of the CPS data to replicate their findings for the United States here as well as the finding of Burkhauser et al. (2004a) for the 1990s business cycle. Our data for Great Britain comes from the BHPS whose first income year is 1991. Burkhauser et al. (1999) found that income inequality in both the United States and the United Kingdom increased over this period with the middle mass of the distribution falling into the two tails. But in both countries, the vast majority of the declining middle mass became unequally richer.

Figure 1:
Total United States Income Distributions in Peak Business Cycle Years

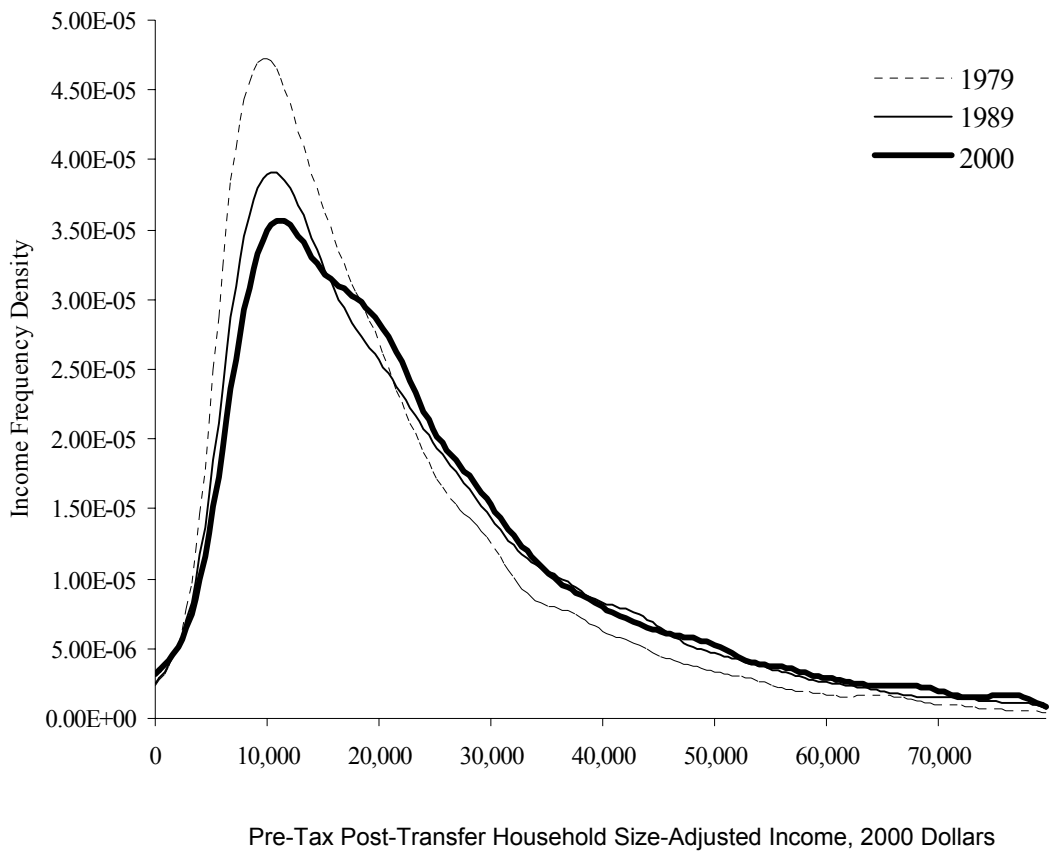


Pre-Tax Post-Transfer Household Sized-Adjusted Income, 2000 Dollars

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

Figure 2, shows the income distribution of the older United States population. Once again, 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 1990 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 noticeable bulge in the distribution.

Figure 2.
United States Income Distributions for Older Persons in Peak Business Cycle Years



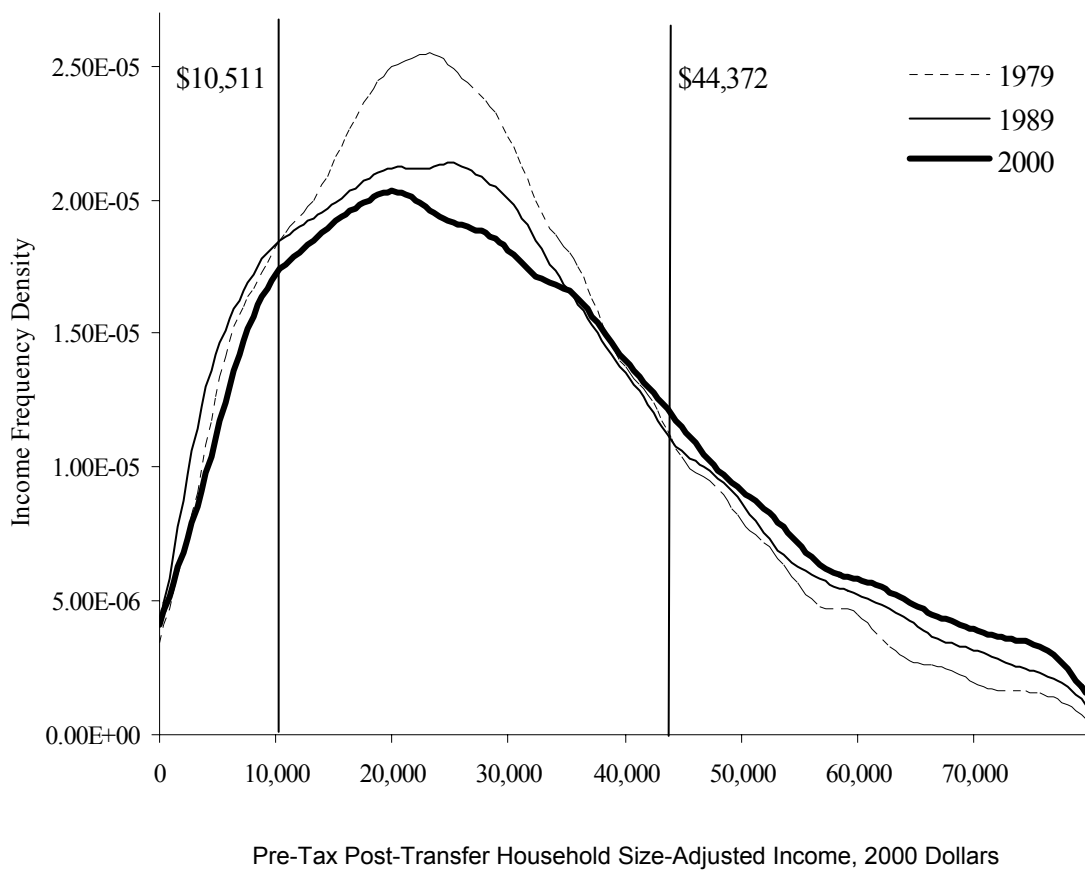
Source: Authors' estimations based on data from the March CPS Annual Demographic Files, 1980, 1990, and 2001.

Figure 3 shows the income distribution of the younger United States populations. In 1979, the distribution has the traditional inverted U shape and is much closer in shape to the overall population than was the distribution for older population in Figure 2. This is also the case for the 1989 and 2000 distributions. Over the 1980s business cycle, the middle mass around the mode spilled primarily into the upper tail, but over the 1990s the entire distribution moved to the right.

Figures 4, 5 and 6 capture the change in the income distribution for Great Britain over their 1990s business cycle. As Table 1 showed, Great Britain experienced substantial economic growth. Figure 4 shows that 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 2000 distribution. The older (Figure 5) and younger (Figure 6) populations also shifted to the right over the 1990s. 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. None-the-less, the income distribution movements in Great Britain and

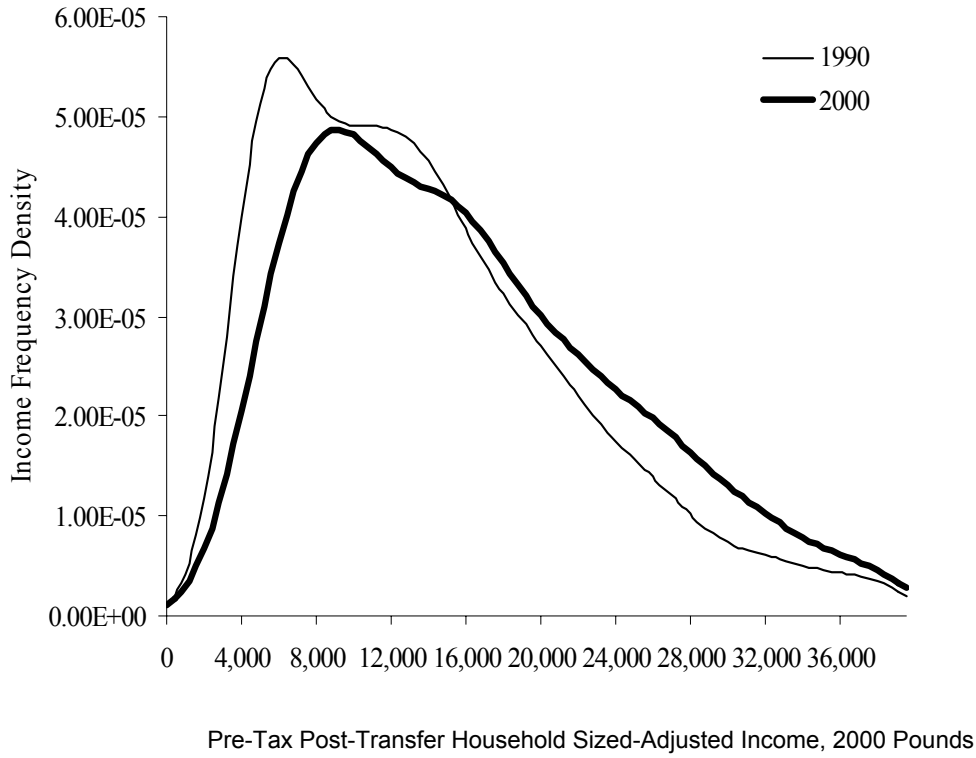
the United States were very similar over their 1990 business cycles. And as can be seen in Figure 7, stand in stark contrast to the movement in the income distribution in Germany over its 1990s business cycles.

Figure 3:
United States Income Distributions for Younger Persons in Peak Business Cycle Years



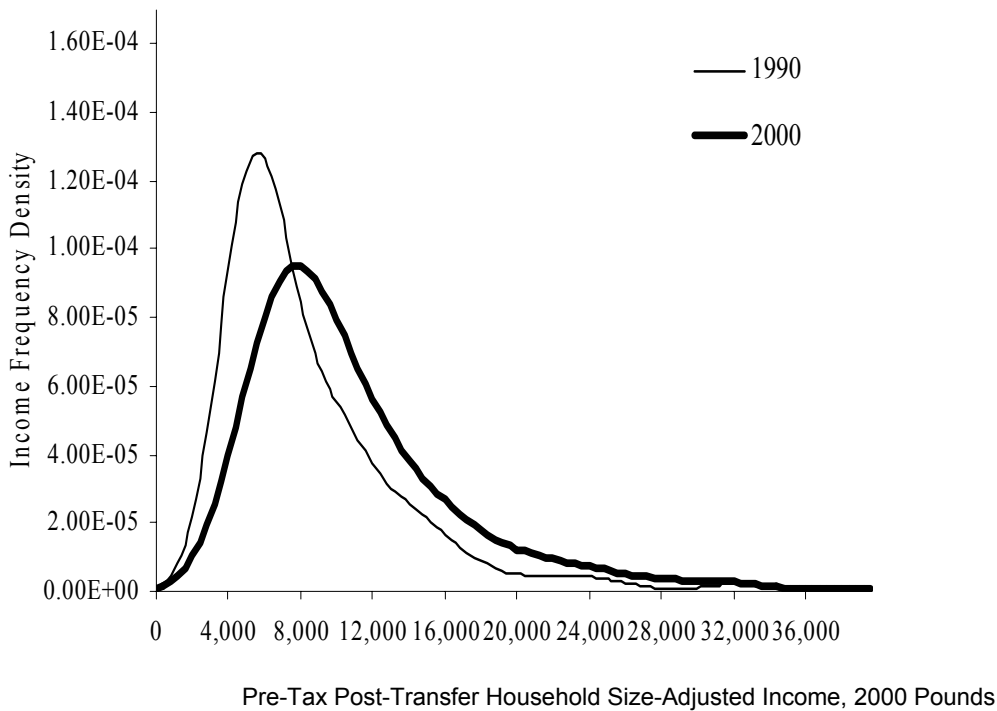
Source: Authors' estimations based on data from the March CPS Annual Demographic Files, 1980, 1990, and 2001.

Figure 4:
Total Great Britain Income Distributions in Peak Business Cycle Years



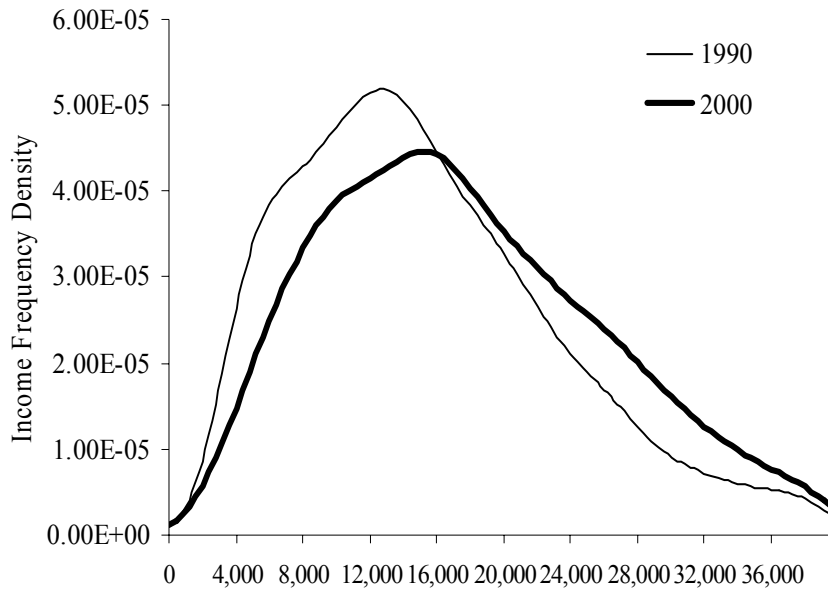
Source: Authors' estimations based on data from the British Household Panel Survey, 1991 and 2001.

Figure 5:
Great Britain Income Distributions for Older Persons in Peak Business Cycle Years



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

Figure 6:
Great Britain Income Distributions for Younger Persons in Peak Business Cycle Years



Pre-Tax Post-Transfer Household Size-Adjusted Income, 2000 Pounds

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

In 1991, the beginning year of their business cycle, the distribution in Germany 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 over their 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 to the right and becoming unequally richer and a smaller but important share becoming poorer.

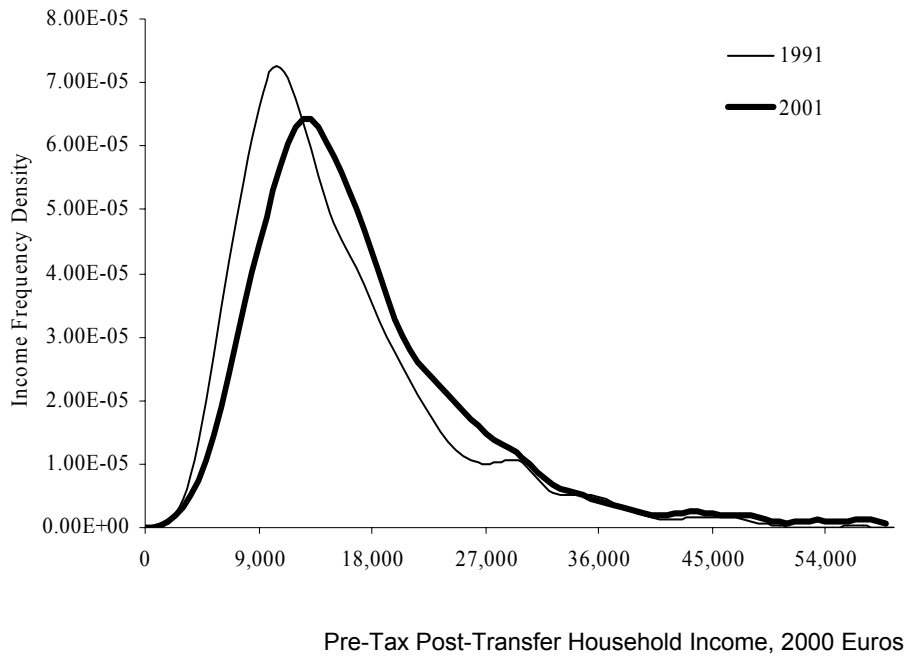
Figure 7:
Total German Income Distribution in Peak Business Cycle Years



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

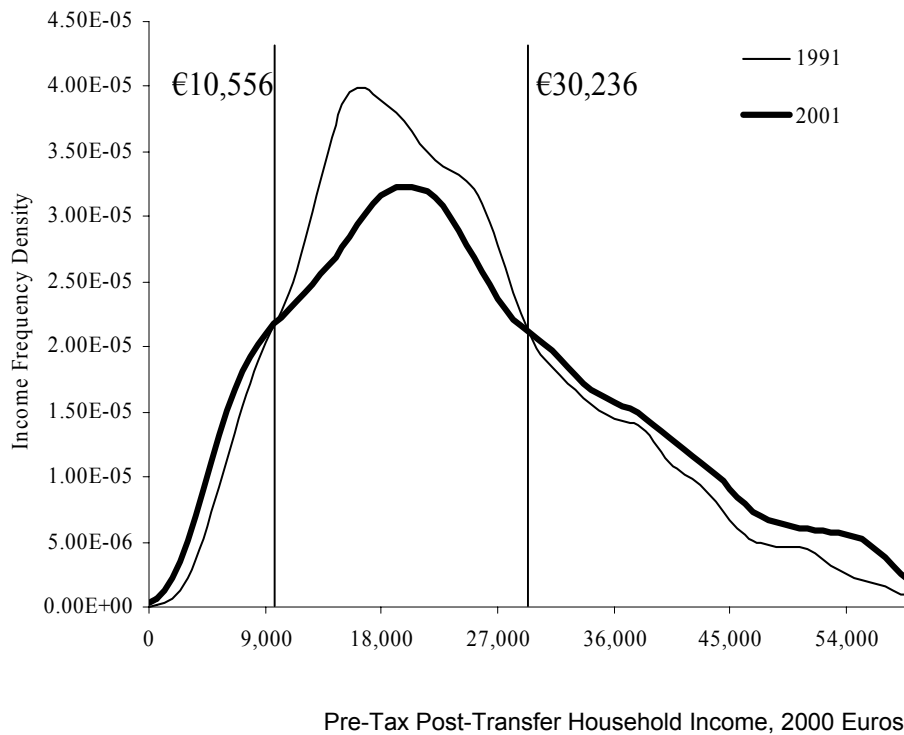
In contrast, Figure 8 shows that the income distribution in the older German population at the end of their 1990s business cycle, like that of Great Britain's, did attain first order stochastic dominance over the distribution at the beginning. However, Figure 9 shows that the spillage of the middle mass away from the mode of the income distribution for younger Germans over their 1990s business cycle more closely resembled the movement for younger persons in the United States over their 1980s business cycle with a small but important group becoming poorer.

Figure 8:
German Income Distributions for Older Persons in Peak Business Cycle Years



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

Figure 9:
German Income Distributions for Younger Persons in Peak Business Cycle Years



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

5.1 Kolmogorov-Smirnov Tests of the Significance of Distributions Shifts

In this section we will more precisely measure the statistical significance of the movements in the income distribution we have described above and especially focus on the relative importance of movement out of the middle and into the two tails of the distribution in the United States over the 1980s business cycle and in Germany over the 1990s business cycle.

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 as 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 three 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 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 three countries for the entire population, as well as for older and younger individuals.

Table 2:
Kolmogorov-Smirnov Test of Differences in Income Distributions Across Paired Years

Group	Kolmogorov-Smirnov Test statistic				
	United States		Great Britain	Germany	
	1979 versus 1989	1989 versus 2000	1979 versus 2000	1990 versus 2000	1991 versus 2001
Total Population	5.550	3.100	5.750	7.752	22.323
Aged 64 and younger	3.875	2.800	4.375	3.334	23.929
Aged 65 and older	2.275	2.000	3.575	13.391	8.281

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

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.

5.2 Where the Middle went during the 1980s in the United State and during the 1990s in Germany

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 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 distribution. In the United States, for 1979 and 1989 income densities, we define the left intersection, and the left tail, as the point in the distribution of household size-adjusted income at which the empirical income density in 1989 drops below the empirical income density in 1979. As can be seen in Figure 1, this intersection point is at \$5,922 for the entire population. The right intersection point, which defines the start of the right tail, is the point in the distribution of household size-adjusted real income at which the income frequency density in 1989 rises above the income frequency density in 1979. This income intersection point is at \$43,643 for the entire population. The intersections for other pairs of densities are defined in a similar way. (See Figures 3, 7 and 9.)

Table 3 shows the proportion of the population contained in the left tail, middle and right 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 their standard errors.¹²

In the United States 6.06 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 6.06 percent (84.82 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 (7.73 percent) slid into the two tails. But once again the vast majority (88.49 percent) became richer. None-the-less in both the United States (15.18 percent) and in Germany (11.51 percent) a small minority became poorer as income inequality rose in both countries.

Table 3 shows that the movement out of the middle for young persons was even greater in the United States (6.78 percent) and Germany (10.67 percent) than for the population as a whole. Furthermore the share of that middle that dropped into the left tail was also greater in both the United States (21.39 percent) and Germany (20.90 percent). None-the-less, in both countries the over-

¹² The proportions \hat{p} can be estimated from the kernel density estimates or directly from the data. We have used the latter method in order to avoid complicated reliance on the asymptotic 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.

whelming majority of the increase in inequality was caused by younger people becoming unequally richer.

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

Income distribution group ^a	United States			Germany				
	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)
	All Persons							
Less than left intersection	5.49 (0.053)	6.41 (0.062)	-0.92 (0.082)	-15.18	4.14 (0.109)	5.03 (0.092)	-0.89 (0.142)	-11.51
Middle of distribution	76.98 (0.099)	70.92 (0.114)	6.06 (0.151)	100.00	72.57 (0.243)	64.84 (0.201)	7.73 (0.316)	100.00
Greater than right intersection	17.53 (0.089)	22.67 (0.106)	-5.14 (0.138)	-84.82	23.29 (0.231)	30.13 (0.193)	-6.84 (0.301)	-88.49
	Younger Persons (aged 64 and younger)							
Less than left intersection	13.23 (0.084)	14.68 (0.095)	-1.45 (0.127)	-21.39	8.84 (0.163)	11.07 (0.142)	-2.23 (0.216)	-20.90
Middle of distribution	68.97 (0.115)	62.19 (0.130)	6.78 (0.174)	100.00	64.83 (0.273)	54.16 (0.226)	10.67 (0.354)	100.00
Greater than right intersection	17.80 (0.095)	23.13 (0.113)	-5.33 (0.148)	-78.61	26.33 (0.252)	34.77 (0.216)	-8.44 (0.332)	-79.10

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 and the Socio-Economic Panel (1992-2002) in Germany.

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.

5.3 Significance Tests of Changes in the Tails of the Distribution

To more rigorously demonstrate this, we test the statistical significance of the density changes in the tails of the income distribution reported in column 3 for the United States and column 7 for Germany 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. For all pair-wise comparisons, we strongly reject the null hypothesis that the masses in the tails are the same for our paired years.

6 Conclusion

The economies of the United States, Great Britain and Germany all grew over their 1990s business cycles, propelling their average household size-adjusted income measured either at the mean or median upward. But the fruits of that economic growth were distributed differently across the three countries. The household size-adjusted income distribution of the United States and of Great Britain 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 in the 1980s. Burkhauser et al. (1999) first showed and we confirm here that over their 1980s business cycle, the middle of the United States income distribution fell, with the vast majority of people becoming unequally richer, and a statistically significant but relatively small share becoming poorer. Burkhauser et al. (1999) report similar findings for the United Kingdom over their 1980s business cycle. 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 income inequality remained about the same in the United States and even fell in Great Britain over this period.

In contrast, measured income inequality in Germany 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 is very similar in magnitude to that of the United States during the 1980s. About 85 percent of the decline in the middle in the United States over the 1980s was accounted for by people becoming richer while about 88 percent was accounted for by a movement to the right in Germany.

In all three countries, the average household size-adjusted 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 three countries income inequality fell among their older populations over the period.

While the average household size-adjusted income of younger persons also grew in all three countries over the 1990s, only in the United States were the gains greater among this popula-

tion. It was in this subpopulation that the differences in how the fruits of economic growth were shared are greatest across the three countries. In both the United States and Great Britain the income distribution among younger people at the end of the 1990s business cycle achieved first order stochastic dominance over their income distribution at the start, while this was not the case in Germany. In the United States income inequality remained about the same, in Great Britain it fell and in Germany it increased. In Germany, the middle mass of the income distribution of their younger population 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 in the 1990s and the United States in the 1980s are remarkably similar. In the United States 78.6 percent of the decline is explained by younger people becoming richer. In Germany 79.1 percent of the decline is so explained.

This paper has focused on measuring what have been quite different changes in the income distribution of three major industrial countries over their 1990s business cycle. The causes for these differences are not clear. In the United States, the confluence of significant economic growth and work-based welfare reforms dramatically improve 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 than in the 1980s.¹³

In Germany it may be that reunification which occurred in 1989 not only dramatically changed the population of Germany relative to the population living in the former western states of Germany but may have changed the political and economic makeup relative to that in the pre-unification western states. This paper is capturing the changes in the income distribution over reunified Germany's first 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 only the first round of a much longer term trend in a country where the greater inequality in market

¹³ See Burkhauser et al. (2004a) and Couch and Daly (2004) for a review of the literature on this issue. The trends in Great Britain appear to be similar to those of the United States (see Goodman and Shephard, 2002 for a fuller discussion).

skills created with unification will continue to yield increases in income inequality for generations to come.

We use kernel density estimation to look behind summary measures of income inequality to see how the entire distribution of income shifted over the 1990s business cycle in three major industrialized countries. In doing so, we distinguish between an increase in inequality caused by the middle of the distribution falling into the two tails and one caused by each member of the population becoming unequally richer. We do so because while, other things equal, declines in income inequality are preferred to increases in income inequality, increased inequality in a country where economic growth is making everyone richer is preferred to the case where the rich are getting richer at the expense of the rest of the population.

A similar analysis should be done for Japan. Based on summary income inequality measures, cross-national studies show that income inequality in Japan was not only substantially below that of the United States at the start of the 1980s, but was also substantially below the level of income inequality found in European countries (Atkinson, Rainwater, and Smeeding, 1995; Jacobs, 2000). But like the three countries discussed here, income inequality in Japan has increased since then. (Atkinson et al., 1995; Fukawa, 2002; Jacobs, 2000; Smeeding, 1997; Tachibanaki, 1996 and Terasaki, 2002). By the middle of the 1990s, Japanese income inequality as measured by the Gini coefficient, while still below the United States, was at the income inequality level of European countries. (Smeeding 1997).

What is not known is how the shape of the Japanese distribution changed over this period. Did the middle of the Japanese income distribution fall as was the case in the United States in the 1980s and in Germany in the 1990s with most of their middle class becoming richer, or was a large part of the Japanese population entirely left out of the economic growth that occurred over this period? How did vulnerable populations—older persons, single mothers, those receiving welfare benefits etc.—fare relative to the rest of the population? Further analysis is required to answer these questions.

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