

## Winners and Losers over the 1990s Business Cycles in Germany, Great Britain, Japan, and the United States

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### Abstract

This paper uses kernel density estimation to show how after-tax household size-adjusted income changed between the peak years of the 1990s business cycle in Germany, Great Britain, Japan, and the United States. Great Britain and the United States experienced substantial growth in average income, a decline in inequality, and a movement of their income distributions to the right. In contrast, Germany and Japan had less income growth, together with 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 experienced over its 1980s business cycle.

*JEL Classification: D3*

### 1. Introduction

Using kernel density estimation Burkhauser, Cutts, Daly, and Jenkins (1999) confirm previous studies showing that pre-tax post-transfer income inequality increased in Great Britain and the United States over the business cycle of the 1980s while the middle of their distributions decreased. But they also find 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. We update and improve this work by looking at how

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these two countries as well as Germany and Japan fared over the 1990s business cycle and by comparing post-tax post-transfer income to take into account these very different tax systems.

## 2. Data

Data for Germany and Great Britain come from the Cross-National Equivalent Files (CNEF), prepared at Cornell University. Data for Japan come from the Survey on Income Redistribution collected by the Japanese Ministry of Health, Labour and Welfare. Data for the United States come from the March Current Population Survey's Annual Social and Economic Supplement (CPS) collected by the United States Bureau of the Census. Since each country's business cycle peaks occurred over slightly different years, the calendar years we compare will differ slightly across countries.<sup>1</sup> By examining these peak years, we control for the state of the business cycle. We also control for outliers in all four data sets.<sup>2</sup>

## 3. Measuring Economic Well-Being

Following the international literature we assume a scale elasticity of 0.5 for our household sharing. We focus on household post-tax post-transfer income – income from all sources (labor earnings, income from investments and savings, public and private pensions, and transfers) minus total household taxes

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<sup>1</sup> 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, 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/Zhang, 1995). Our findings are not sensitive to reasonable changes to the peak years we choose to compare.

<sup>2</sup> 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 in the German, British and Japanese data. Because the public use CPS data has top coded values differently over time, we use the most severe yearly top code over the entire period of our analysis as discussed in Burkhauser, Couch, Houtenville and Rovba (2004). They show that a rule-of-thumb trimming of the top two percent of the public use version of the CPS yields population samples whose levels and trends in income inequality are similar to those using the consistently top coded method.

and social insurance contributions. Non-money transfers are not included. For the United States we use the TAXSIM Module, provided by the NBER, to estimate income tax payments based on consistently top-coded income variables in the CPS for the years 1979 through 2000. Post-tax income is calculated in CNEF data for Germany and Great Britain. The Japanese data captures these values directly. (See the Data Appendix of Burkhauser/Oshio/Rovba, 2006 for greater detail.)

#### 4. Trends in Income and Income Inequality

The top panel of Table 1 shows mean and median post-tax post-transfer income as well as the 90/10 ratio and Gini coefficients for Germany, Great Britain, Japan and the United States over the peak years of their respective business cycles for the entire population. Household size-adjusted after-tax income (both mean and median) increased over both the 1980s and 1990s business cycles in the United States. But the fruits of economic growth were much more equally shared in the 1990s than in the 1980s whether measured by the 90/10 ratio or the Gini coefficient.<sup>3</sup>

After-tax income increased even more in Great Britain over the 1990s than in the United States and inequality fell. In contrast, while after-tax income in Germany increased by about the same amount as in the United States, inequality grew dramatically whether measured by a change in the 90/10 ratio or in the Gini coefficient. As a result, inequality in Germany, which was substantially below inequality in Great Britain at the beginning of the 1990s business cycle, was by the end approximately equal to inequality in Great Britain. But inequality in both countries still was considerably below inequality in the United States. In Japan, after-tax income also increased over the 1990s, but so did inequality—the percentage changes in inequality were near those experienced in Germany during the 1990s. As a result, by the end of the 1990s business cycle Japan was closer to the level of income inequality in the United States than to that in Great Britain or Germany.

The second panel in Table 1 reports the same inequality measures but does so for pre-tax post-transfer income. This type of income is typically used in inequality measures for the United States. Doing so in cross-national comparative studies not only ignores the importance of tax policies in reducing inequality but also their relative importance in doing so across countries. Note that the tax systems in all four countries are progressive in that post-tax

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<sup>3</sup> While the data on Germany and Great Britain are from panels, the data on the United States and Japan are not. Hence we are making inferences about how income inequality changed in a population over a business cycle by comparing a country's income distribution at the beginning and at the end of its business cycle rather than by showing how the income of specific individuals changed over the business cycle.

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

	United States <sup>a)</sup>					Great Britain <sup>b)</sup>			Germany <sup>c)</sup>			Japan <sup>d)</sup>		
	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)
<b>Post-tax Post-transfer</b>														
Mean	22,494	24,954	26,767	10.93	7.27	11,539	13,917	20.61	17,377	18,605	7.07	3,205	3,399	6.04
Median	20,892	22,135	23,707	5.95	7.10	10,583	12,788	20.84	16,146	17,054	5.62	2,829	2,991	5.73
90/10	4.71	5.82	5.42	23.67	–6.82	3.89	3.63	–6.78	3.1	3.39	9.59	4.24	4.65	9.64
Gini	0.301	0.344	0.336	14.17	–2.24	0.274	0.264	–3.59	0.231	0.25	8.18	0.298	0.315	5.84
<b>Pre-tax Post-transfer</b>														
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

*Notes:* <sup>a)</sup> Income values are in 2000 United States dollars, <sup>b)</sup> Income values are in 2000 British pounds, <sup>c)</sup> Income values are in 2000 euros, <sup>d)</sup> Income values are in 2000 yens.

post-transfer income is more equally distributed than is pre-tax post-transfer income in all years. Furthermore, over the 1990s business cycle the percentage increases in pre-tax post-transfer inequality measured by 90/10 ratio and Gini coefficient values are much greater in Germany and Japan than are the percentage increases for those same values using after-tax income. Likewise, in Great Britain and the United States, the percentage declines in pre-tax post-transfer income inequality over this period are less for these values than for 90/10 ratio and Gini coefficient values using after-tax income.<sup>4</sup>

### 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 with a single value. Because few distributions with known properties can be completely described by one or even two parameters, the use of these summary indices produces an incomplete view of the underlying distribution of interest.

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

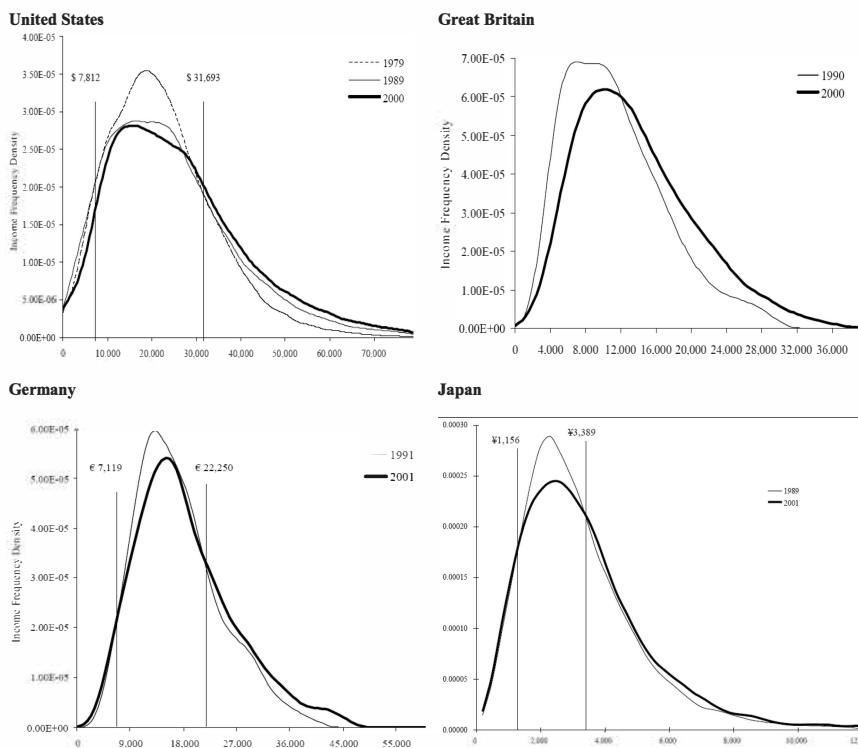
Table 1 used summary measures of the income distribution. We now more fully explore how the distribution of income changed in each of these countries by estimating their probability density functions based on Epanechnikov kernels with adaptive bandwidths of the post-tax post-transfer household size-adjusted income of their populations.

The first panel of Figure 1 shows that in 1979 the distribution of income in the United States had the traditional inverted U shape with the great mass of the population bunched around the mode of the distribution. But by the end of the 1980s business cycle in 1989, the distribution had become much flatter. The middle mass of the distribution around the mode fell (fewer people were in the middle of the distribution) with the vast majority spilling toward the higher tail of the distribution and a much smaller but still important group spilling toward the lower tail of the distribution. In contrast, the entire United States income distribution moved to the right between 1989

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<sup>4</sup> Comparisons of pre-tax post-transfer income and of post-tax post-transfer income of this type assume no behavioral change.

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 every percentile gained at the same rate, all percentiles of the distribution gained. (Pen, 1971 and Saposnik, 1983 provide a fuller discussion of the use of cross sectional data to make inferences about changes in the income distribution.)



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

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

The second panel of Figure 1 captures the change in the income distribution for Great Britain over their 1990s business cycle. As in the United States, the

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

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

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

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

*Where the Middle went during the 1980s in the United States and during the 1990s in Germany and Japan.* We use a test based on the binomial distribution to examine how the spillage out of the middle of the income distribution in the United States over the 1980s business cycle and in Germany and Japan over the 1990s business cycle was distributed between the two tails of the distribution. 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.

We first define the left and the right tails of the distribution. In the United States for the 1979 and 1989 income densities we define the left intersection, and the start of the left tail, as the point where the income density in 1989 drops below the income density in 1979. As can be seen in Panel 1 of Figure 1, this occurs at \$7,812. The right intersection point, which defines the start of the right tail, is the point at which the income density in 1989 rises above the income density in 1979—\$31,693. The intersections for Germany and Japan are defined in a similar way based their own values in Figure 1.

Table 2 shows the proportion of the population contained in the left tail, middle, and right tail as defined by the peak-to-peak year density function intersections for the United States (columns 1 and 2), Germany (columns 5 and 6), and Japan (columns 9 and 10) and their standard errors. In the United States 7.18 percent (column 3) of the entire distribution slid out of the middle of the distribution over the 1980s business cycle. But the vast majority of that 7.18 percent (82.46 percent) became richer. Over the German business cycle of the 1990s an even greater percentage of the middle mass around the mode of the distribution (8.23 percent) slid into the two tails. But once again the vast majority (88.58 percent) became richer. In Japan, over the 1990s business cycle, 6.18 percent of the middle mass moved to the tails, mostly to the right tail (93.20 percent). Nonetheless, in the United States (17.54 percent), in Germany (11.42 percent), and in Japan (6.80 percent) a small minority became poorer as income inequality rose.

## 6. Conclusion

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



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

Income Distribution Group <sup>a)</sup>	United States				Germany				Japan			
	1979 <sup>b)</sup>	1989 <sup>b)</sup>	Dif- ference <sup>c)</sup>	Share of the Middle	1991 <sup>b)</sup>	2001 <sup>b)</sup>	Dif- ference <sup>c)</sup>	Share of the Middle	1989 <sup>b)</sup>	2001 <sup>b)</sup>	Dif- ference <sup>c)</sup>	Share of the Middle
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
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

Notes: <sup>a)</sup> See Figure 1 for the exact income values at the point of intersection of each density pair. <sup>b)</sup> Standard errors are in parentheses. All distribution changes are significant at 1 percent level according to tests based on  $Z_p$  statistic. <sup>c)</sup> Standard deviations are in parentheses.

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

In contrast, 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 around the mode fell. While the greatest share of the middle mass slid to the right, as people became unequally richer, a statistically significant but smaller share became poorer. More remarkably, the relative movement out of the middle and into the two tails in Germany and Japan is very similar in magnitude to that of the United States. About 83 percent of the decline in the middle in the United States over the 1980s was accounted for by people becoming richer compared to about 89 percent in Germany and about 93 percent in Japan. It remains to be seen whether this is the start of a longer term movement toward convergence in income distributions of these four major industrial countries.

### References

- Artis, M. J./Bladen-Hovell, R. C./Zhang, W. (1995):* Turning points in the international business cycle: An analysis of the OECD leading indicators for the G7 countries, *OECD Economic Studies* 24, 125 -165.
- Burkhauser, R. V./Cutts, A. C./Daly, M. C./Jenkins, S. P. (1999):* Testing the Significance of Income Distribution Changes Over the 1980s Business Cycle: A Cross-National Comparison, *Journal of Applied Econometrics* 14, 253 – 272.
- Burkhauser, R. V./Couch, K. A./Houtenville, A. J./Rovba, L. (2004):* Income Inequality in the 1990s: Re-Forging a Lost Relationship? *Journal of Income Distribution* 12 (3–4), 8–35.
- Burkhauser, R. V./Oshio, T./Rovba, L. (2006):* How the Distribution of After-Tax Income Changed Over the 1990s Business Cycle: A Comparison of the United States, Great Britain, Germany and Japan, *Cornell University Working Paper*.
- Pen, J. (1971):* *Income Distribution*, New York.
- Saposnik, R. (1983):* On Evaluating Income Distributions: Rank Dominance, the Suppes-Sen Grading Principle of Justice and Pareto Optimality, *Public Choice* 40, 329–36.