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Islam,MR and Madsen,JB 1970, Is income inequality persistent? Evidence using panel stationarity tests, 1870-2011, Economics letters, vol. 127, pp. 17-19.

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Is Income Inequality Persistent? Evidence using Panel Stationarity Tests, 1870-2011

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Abstract. Using data on inequality for 21 OECD countries over the period 1870-2011 this paper tests the Piketty hypothesis that income inequality is likely to grow in the 21st century. It is shown that the null hypothesis of trend stationarity of inequality cannot be rejected at conventional significance levels, suggesting that shocks to income inequality are likely to be temporary.

Keywords: inequality, persistence, multiple structural breaks, cross-sectional dependence

JEL classifications: C12, D63

1. Introduction

In his influential book, *Capital in the Twenty-First Century*, Piketty (2014) forwards the thesis that the increasing inequality experienced in the advanced countries since the beginning of the 1980s will continue in this century; essentially because the returns to assets exceed GDP growth rates. Furthermore, inheritance payouts, which are currently taxed at low or zero rates, and intergenerational earnings persistence through human capital investment create persistence in inequality (see, e.g., D'Addio, 2007; Holter, 2014, Piketty, 2014). This hypothesis stands in contrast to the predictions of standard neoclassical growth models and the natural rate of unemployment hypothesis that income distribution tends towards a constant in the long run.

Constructing annual data on inequality for 21 advanced countries over the period 1870-2011 this paper tests the Piketty hypothesis of whether we can expect persistently increasing inequality in the 21st century. To this end we test whether income inequality, proxied by the Gini coefficient and the top 10% income share, follows a trend stationary process and thus shocks to inequality will have transitory effects only. To our knowledge this is the first paper to test the Piketty hypothesis and to use long panel data spanning 142 years.

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2. Empirical estimates

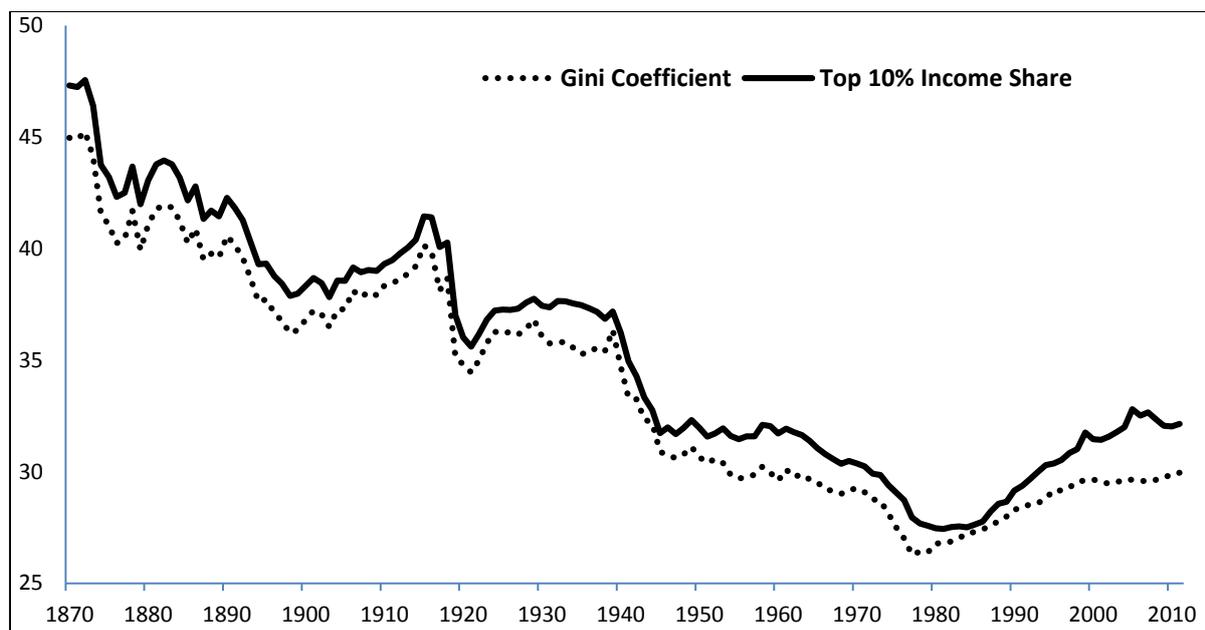
The Carrion-i-Silvestre *et al.* (2005) KPSS test for stationarity in variance of panel data is employed to test for inequality persistence. This approach allows for up to five structural breaks at unknown dates for each individual country, which is important for our sample since structural changes are likely to occur over a 142 year timespan. We compute the bootstrap distribution following Maddala and Wu (1999) with 10,000 replications to take account of cross-sectional dependence in the estimates of the KPSS test statistics in order to reduce the bias and increase the power of the tests (Baltagi *et al.*, 2007; O'Connell, 1998). If our inequality series follow a trend stationary process the shocks to inequality will have transitory effects, however, the shocks become permanent with a unit root process, i.e. $I(1)$.

2.1 Data

The data used in this paper are the natural logarithms of Gini coefficients and top 10% income shares for 21 high income OECD countries over the period 1870-2011. The sample consists of Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. We compile Gini coefficients and top 10% income shares data from 'The Standardized World Income Inequality Database' and 'The World Top Incomes Database'. The top-income share data are not available for all countries considered here and they start later than 1870, mostly after 1910, and the Gini data are only available after 1960 from these sources. We backdate the Gini coefficients and top 10% income share using labor's income share following the lead of De La Escosura (2008) as detailed in the Online Appendix. Labor's income share is constructed as compensation to employees adjusted for imputed payments to the self-employed and divided by nominal GDP.

The Gini and top 10% income share averaged across countries, which are displayed in Figure 1, show a strong correlation between the two measures, suggesting that our results may not be sensitive to choice of inequality measure. The path of inequality in the post-1910 period is well-known and is dominated by the jumps during and immediately after WWI and WWII towards a more equal income distribution as discussed in depth in Piketty (2014). The jump over the period 1890/95-1898 is less well-known and may have been triggered by increasing unionization and, particularly, deflation-induced real wage hikes under the assumption of sticky nominal wages.

Figure 1. Trends in Gini Coefficient and Top 10% Income Share in 21 OECD Countries (1870-2011)



Notes: See text for country sample and data sources. The figures are unweighted averages.

Although most countries experienced declining inequality from 1870 to 1980, some countries have experienced larger changes in inequality than others and the relative positions of countries have changed over time. In the Nordic countries (Denmark, Finland, Norway and Sweden), which have long been considered as some of the most equal societies in the world, the top 10% income share in 1870, on average, was 54.4. The corresponding number in 1870 was 43.7% in the US, a country that has long been considered as a highly unequal society. In 2011 the top 10% income share was 41.5% in the US, which is not far from the 1870 figure, while it has declined sharply to 25.4% in the Nordic countries. Finally, we consider the trend in Figure 1 as deterministic with possible breaks and, therefore, test whether the series are $I(0)$ around this potentially breaking trend.

2.2 Results

Table 1 reports stationarity test statistics for the Gini coefficient. Breaks for individual structural changes took place for 10 countries between 1895 and 1898, for 11 countries between 1918 and 1920, for 11 countries between 1939 and 1946, and for 11 countries between 1974 and 1986 (the results for individual countries are reported in Table A1 of the Online Appendix). These breaks are consistent with the breaks identified in Figure 1. The panel $LM(\lambda)$ test statistics corresponding to homogenous and heterogeneous long run variances are 0.425 and 0.847 when constants are included in the tests, and 0.001 and 0.683 when constants and trends

are included in the tests, which are smaller than the bootstrap critical values at 90% of the distribution or more; thus failing to reject the null of stationarity at conventional significance levels. Thus, the results cannot reject the null hypothesis of trend stationarity and, therefore, suggest, that inequality in the OECD countries is non-persistent.

Table 1. KPSS test statistics with multiple structural breaks on ln(Gini) for 21 OECD countries, 1870-2011

	KPSS test statistics	Bootstrap Distribution (allowing for cross-sectional dependence)							
		1%	2.5%	5%	10%	90%	95%	97.5%	99%
Panel A: Panel stationarity test (intercept only)									
LM(λ) (hom)	0.425	-0.437	-0.212	-0.001	0.243	2.443	2.767	3.051	3.397
LM (λ) (het)	0.847	0.104	0.388	0.604	0.861	3.201	3.595	3.950	4.410
Panel B: Panel stationarity test (intercept and trend)									
LM(λ) (hom)	0.001	1.266	1.707	2.062	2.430	5.046	5.438	5.820	6.230
LM (λ) (het)	0.683	2.241	2.460	2.659	2.900	4.705	4.979	5.205	5.470

Notes: LM (λ) (hom) and LM (λ) (het) denote the Carrion-i-Silvestre *et al.* (2005) KPSS test assuming homogeneity and heterogeneity, respectively. The long-run variance is estimated using the quadratic spectral kernel with automatic spectral window bandwidth selection.

The results of applying stationarity test statistics to the top 10% income share are reported in Table 2. Again, consistent, with the breaks identified in Figure 1, structural changes took place between 1895 and 1898 for 11 countries, between 1918 and 1920 for 12 countries, between 1939 and 1946 for 12 countries, and between 1974 and 1986 for 12 countries (see Table A2 of Online Appendix). The test statistics do not reject the null hypothesis of trend stationarity of the top 10% income share, again suggesting that inequality in the OECD countries is non-persistent.

Table 2. KPSS test statistics with multiple structural breaks on ln(Top 10) for 21 OECD countries, 1870-2011

	KPSS test statistics	Bootstrap Distribution (allowing for cross-sectional dependence)							
		1%	2.5%	5%	10%	90%	95%	97.5%	99%
Panel A: Panel stationarity test (intercept only)									
LM(λ) (hom)	-0.592	3.137	3.680	4.147	4.724	10.285	11.272	12.051	12.862
LM (λ) (het)	-0.346	4.439	4.787	5.127	5.495	8.371	8.811	9.211	9.724
Panel B: Panel stationarity test (intercept and trend)									
LM(λ) (hom)	1.323	1.352	1.564	1.764	2.033	3.938	4.211	4.460	4.727
LM (λ) (het)	2.339	1.775	1.930	2.083	2.295	3.721	3.947	4.118	4.368

Notes: See notes to Table 1.

The Bai and Carrion-i-Silvestre (2009) panel unit root tests, which allow multiple structural breaks and cross-sectional dependence, are applied as robustness checks. The null hypothesis of unit root is strongly rejected for both of our inequality measures, as shown in Table A3 of the Online Appendix; thus giving further support to the findings above. Finally, Westerlund's

(2014) approach is used to test for general unconditional heteroscedasticity in our inequality series since time varying unconditional variance may be an important source of structural instability. The results, which are reported in Table A4 in the Online Appendix, give clear evidence of stationarity in the average unconditional cross-sectional variance of detrended inequality. Therefore, the post-1980 increasing inequality, as pointed out by Piketty (2014), is likely to have been driven by a deterministic trend and not by a stochastic trend.

3. Conclusion

This paper has investigated the persistency of income inequality for a sample of 21 high income OECD countries over the period 1870-2011 using the Carrion-i-Silvestre *et al.* (2005) panel stationarity test which allows multiple structural breaks that may differ across countries. The test results provide strong support for trend stationarity of Gini coefficients and top 10% income shares across OECD countries at conventional significance levels, suggesting that factors influencing income inequality are likely to have transitory effects on income inequality. Hence, the increasing inequality after 1980 as suggested by Piketty (2014) is unlikely to have been driven by a stochastic trend.

The implication of these results is that there are mechanisms that bring income shares towards a constant level in the long run. As implied by neoclassical models of economic growth, increasing capital accumulation brought about by an increasing share of income going to capital will reduce the returns to capital due to the diminishing returns to capital and reduce capital's income share, unless, as pointed out by Piketty (2014), the elasticity of substitution between capital and labor exceeds one. Similarly, the natural rate hypothesis implies that capital deepening will increase demand for labor, lower unemployment and increase labor's share and, consequently, reduce the returns to capital.

Acknowledgements

Helpful comments and suggestions from a referee, Heather Anderson, Josep Carrion-i-Silvestre, and Joakim Westerlund are gratefully acknowledged. The authors are grateful to Josep Carrion-i-Silvestre for kindly providing the GAUSS codes to implement panel stationarity and unit root tests.

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