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TRENDS IN INCOME INEQUALITY, INTERTEMPORAL  
VARIABILITY, AND MOBILITY RISK  
IN THIRTY COUNTRIES

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**EUROPEAN UNIVERSITY INSTITUTE, FLORENCE**  
**MAX WEBER PROGRAMME**

*Trends in Income Inequality, Intertemporal Variability,  
and Mobility Risk in Thirty Countries*

**AUSTIN NICHOLS AND PHILIPP REHM**

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## **Abstract**

We apply a novel decomposition of panel data on individual incomes in 30 countries and find the US is exceptional in its increases of income risk over the last decades. Income risk is decomposed into long-run inequality, intertemporal variability around individual-specific growth rates (volatility), and variation in individual-specific growth rates (mobility risk) using a decomposable generalized entropy measure. We also measure the degree to which the government tax and transfer system lowers long-run inequality, intertemporal variation, and mobility risk, and again the US is exceptional, with the tax and transfer system lowering the risk of net income less in the US than in other developed countries we examine. We further find that growth rates are positively associated with long-run mean incomes in most countries, implying growth tends not to be pro-poor, and that volatility tends to be higher for those with higher long-run mean incomes, so that form of risk may be progressively distributed.

## **Keywords**

Income inequality, Income variability, Income mobility, Welfare, OECD countries, Measurement

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## 1. Introduction

There has been a renewed interest in recent years in income inequality, but also in economic mobility (both moving up and moving down), and income volatility or intertemporal variability risk – the year-to-year variations in the income that families may or may not be able to smooth over. However, a unified approach to measuring these phenomena has proved elusive. We use an aggregate measure of income risk (Nichols 2008, 2010) for incomes measured over both people and time. The aggregate measure can be de-composed into an *inequality component* measuring the dispersion in mean incomes, a *volatility component* measuring the average dispersion of the fluctuations about person-specific trends, and a *mobility risk component* measuring the dispersion of person-specific trends. We apply this de-composition to panel data from 30 different countries to compare and characterise levels of, and trends in, inequality, volatility (intertemporal variability around trend), and mobility risk (variation in individual trends). We also examine the regressivity of income growth in these data.

## 2. Background

Inequality at a point in time is of little intrinsic interest if incomes are changing rapidly over time; it is long-run income inequality that reflects the disparities of interest. Incomes may be changing due to short-lived transitory shocks, or more permanent changes, but either kind of change induces greater volatility in the income stream and greater relative<sup>1</sup> mobility. Some view these changes as mitigating inequality (frequently citing Schumpeter 1955 or Friedman 1962), but if these changes reflect income risk, they lower the well-being for any risk-averse person, holding constant the mean level of income. This paper inclines towards the latter viewpoint, characterising the observed changes in income as reflecting underlying risk.

Greater absolute mobility, or higher average growth in real incomes, may change our interpretation of increasing inequality or variability in incomes. A doubling of real incomes may make us less worried about increasing trends in volatility combined with constant relative mobility and increasing inequality, though the change in measured (scale-invariant) inequality due to a doubling of incomes is nil. In this paper, we will focus exclusively on measuring

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<sup>1</sup> Growth in incomes relative to average growth is called “relative mobility” so both volatility and mobility may result in reranking of individuals within the income distribution in any one period or over time.

inequality, volatility (intertemporal variability around trend), and mobility; we will not characterise their welfare consequences.<sup>2</sup> However, we will discuss the connections between higher incomes, and higher average growth in real incomes, and the measured riskiness of incomes.

**Inequality** in observed incomes is not inequality in well-being, or important outcomes such as mortality rates. Even if we regard income<sup>3</sup> as a valid measure of well-being, inequality of observed incomes is a poor measure of inequality of income distributions. Measured inequality is positive when all incomes are drawn from the same distribution. That is, if every individual in society has income in every period that is a random draw from the same distribution (implying equality of opportunity) the inequality of observed outcomes across individuals will be non-zero, and overstate inequality of opportunity.

On the other hand, inequality estimates in survey data are typically biased downward. Breunig (2001) shows that the bias of the  $GE_2$  estimator<sup>4</sup> (estimating half the squared co-efficient of variation, or the general entropy measure with parameter 2), used in the rest of this paper, has the sign of three times the co-efficient of variation (CV) less twice the population skewness. So for income distributions that exhibit large positive skew, the bias of the  $GE_2$  estimator is usually negative. This property also holds if we imagine having population data on income and estimating an inequality parameter for the super-population, or family of populations from which the current population data are drawn. So if the inequality of incomes in the hypothetical population or super-population is positive, we will typically under-estimate this positive level of inequality.

Thus there may be two offsetting biases: variation in observed outcomes may overstate variation in potential outcomes, but measured variation in observed outcomes may understate potential variation in observed outcomes. In other words, population inequality (of outcomes)

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<sup>2</sup> See, for example, Atkinson (1970) and Gottschalk and Spolaore (2002) for connections to social welfare; we follow the lead of Sen (1973) in pursuing descriptive measures.

<sup>3</sup> Many authors have pointed out that well-being is multidimensional and cannot be characterized using a simple scalar variable like observed income; see, for example, Atkinson and Bourguignon (1982), Maasoumi (1986), Bourguignon and Chakravarty (2003), and Osberg and Sharpe (2005).

<sup>4</sup> The  $GE_2$ , or variance divided by twice the squared mean, has desirable properties described by, e.g., Shorrocks (1984). On its bias and MSE, see also Breunig and Hutchinson (2008). On alternatives to  $GE_2$ , see, e.g., Atkinson (1970), Blackorby *et al.* (1981), Cowell (1995, 2000).



may overstate inequality of opportunity, but sample inequality may understate population inequality. However, these biases are unavoidable, and there is good reason to think they are small given a large sample over many years.

Strictly speaking, **volatility** is also never observed. As the volatility of share prices is estimated using historical data on changes in price, so income volatility is often measured as variation in income over time. However, this reflects behavioural changes, measurement error, and both short-term and long-term real changes in income. Some authors attempt to de-compose variability of income over time into permanent and transitory shocks, but this requires specifying a model of income dynamics that applies to all individuals (see, e.g., Lillard and Weiss 1978, Moffitt and Gottschalk 1995, Baker 1997). It is unlikely that such a model would survive empirical tests of its restrictions in a more flexible model that nests it (for example by treating the additional implications of the model not strictly required to identify parameters as over-identifying restrictions in a Generalised Method of Moments framework). In short, income exhibits individual heterogeneity in levels and growth rates which are not independent of the history of income levels and gains. In contrast, the approach adopted in this paper imposes no distributional assumptions on income at a point in time or on income growth (though linear trends are measured, these are conceived as short-run approximations to arbitrary individual-specific paths of income over time).

**Mobility** has been defined in many different ways, and the term encompasses many different concepts, such as relative and absolute mobility, or structural and exchange mobility.<sup>5</sup> One measure of mobility (Shorrocks 1978a; Fields 2007) depends on the reduction in inequality due to averaging or summing individual incomes across time. This definition implicitly assumes that the sum (or average) of income is the key factor in determining well-being, and that the effects of variation in income around the mean have negligible welfare consequences. Other definitions of mobility rely on transition matrices between states (Shorrocks 1978b; Geweke et al. 1986; Alcalde-Unzu et al. 2006), but these founder on several well-known difficulties associated with transition matrices. For example, when using transition matrices, the definition of the categories (e.g., quintiles or deciles) that characterise states will affect the results. As another example, the

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<sup>5</sup> Fields and Ok (1999) offer a review of this broad field of research. Benabou and Ok (2001) define desirable mobility as progressive income growth and Mazumder (2008) attempts to measure only upward mobility.

current state is typically not a sufficient statistic for transition probabilities as is required for a Markov process (meaning that the transition matrix for any given pair of periods does not fully characterize the process).

### 3. Methods

Inequality and volatility are always characterised as a measure of dispersion, or variability, of a distribution. The overarching idea of the method is that we want to measure variability in income using panel data, observations both across individuals and across time. Imagine measuring income of three individuals a, b, and c for three years 1, 2, and 3. We can arrange the observations first by time:

$$| a_1 b_1 c_1 | a_2 b_2 c_2 | a_3 b_3 c_3 |$$

or first by individual:

$$| a_1 a_2 a_3 | b_1 b_2 b_3 | c_1 c_2 c_3 |$$

which suggests two de-compositions by group, in which the group is defined by a time index  $t$  or alternatively by an individual index  $i$ . The natural choice (Shorrocks 1984) of inequality measure for de-compositions by group is the generalised entropy measure  $GE_2$ , equal to half the squared co-efficient of variation.

Suppose we observe  $L$  people,<sup>6</sup> indexed by  $i$  running from 1 to  $L$ , observed at  $T$  points in time, for  $N=LT$  observations on income  $y$ . Consider first a de-composition by population subgroup following Shorrocks (1984) in which the population is all person-years, and sub-groups are people:

$$GE_2 = \frac{1}{2\bar{y}^2} \left[ L^{-1} \sum_{i=1}^L T^{-1} \sum_{t=1}^T (\bar{y}_i)^2 - \bar{y}^2 \right] + \frac{1}{2\bar{y}^2} \left[ L^{-1} \sum_{i=1}^L T^{-1} \sum_{t=1}^T y_{it}^2 - (\bar{y}_i)^2 \right] = B_i + W_i$$

in which  $\bar{y}_i$  indicates the within-person sample mean of income over all the time periods observed, and  $\bar{y}$  is the sample mean of income over all persons and time periods. The first term  $B_i$  represents variation across individuals in their mean income over some time period of  $T$  years, *i.e.*,  $T$ -year inequality. The second term  $W_i$  represents variation of individual income around

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<sup>6</sup> Another choice of analysis unit is of course possible, for example, family or household, but these are much less convenient when dealing with panel data, since composition may change over time.

mean income. Correcting for estimation error in individual-specific means as in Nichols (2008), the revised de-composition can be written as:

$$GE_2 = \left( B_i - \frac{W_i}{T-1} \right) + \left( \frac{T}{T-1} \right) W_i = I + D$$

These components are inequality in individual-specific mean incomes over time (I) and variance of deviations over time around the individual-specific means (D).

We can further de-compose the second term D (“deviations”) into a component due to individual trends in income, and a component due to variations around the trend. This is most intuitively understood by imagining regressing individual income on an individual-specific time trend and a constant, and letting the sum of squared residuals be defined as the component due to variations around the trend. The difference between the second term D and the mean over individuals of the individual-specific sum of squared residuals (or variation in de-trended and de-measured income) is the individual-specific variance of predicted income over T years, which is proportional<sup>7</sup> to the mean across the individuals of the squared individual-specific trend (all divided by twice mean income squared).

Write:

$$GE_2 = I + \left( D - \frac{1}{2\bar{y}^2} \left[ L^{-1} \sum_{i=1}^L \left( \frac{r_i^2 (T^2 - 1)}{12} \right) \right] \right) + \frac{1}{2\bar{y}^2} \left[ L^{-1} \sum_{i=1}^L \left( \frac{r_i^2 (T^2 - 1)}{12} \right) \right]$$

or

$$GE_2 = I + (D - M) + M = I + V + M.$$

As above, *I* stands for “inequality”, meaning long-run inequality. We call the terms *V* for “volatility” and *M* for “mobility risk”, though, of course, other measures of these concepts are also possible. *V* now captures squared deviations around the linear individual-specific trend in income. *M* measures the extent to which incomes grow or fall over time; it represents the

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<sup>7</sup> Specifically, the variance of predicted values is the squared growth rate times the variance of the time index, where the time index *t* is always defined so that it has mean zero, so that the constant term measures mean income.

expected squared trend in incomes. We can also additively de-compose this into components which are proportional to the variance of the trends and the expected trend squared. Write:

$$GE_2 = I + V + M = I + V + R + A.$$

In which  $R$  is “relative mobility risk” and  $A$  is “absolute mobility risk” (proportional to the squared mean of the estimated trends across all individuals, a constant).  $R$  measures how much incomes **differentially** grow or fall over time, or the dispersion of individual-specific trends in income; if  $T=5$ , this measure is simply twice the variance of trends. If everyone experienced the same average income growth over time (i.e.  $r_i=E(r_i)$  for all  $i$ ), then  $R=0$ . Thus,  $R$  actually measures “relative mobility risk” or the variance of individual growth rates in income. This is not related *per se* to mean growth rates of income (level of absolute mobility), nor the covariance of growth rates with mean levels of income (distinguishing pro-rich or pro-poor growth). However, term  $A$  is negligible in all the estimates presented here, since it is the squared mean across individuals of individual-specific growth rates in income divided by mean income squared and is therefore very small relative to  $R$  and would not be visible on a graph of trends over time.

Estimating linear growth rates in individual incomes even over short time periods is not completely uncontroversial. Often researchers assume a constant percentage rate of growth in incomes over time, or regress log income on time. This assumption does not match the empirical distribution of income growth, however, and drops any observations with zero or negative income in a period (which limits the sample to those with lower variation over time).

We can embed the above calculations in a regression framework using panel data by writing a fixed-effects model with individual-specific linear time trends:

$$y_{it} = u_i + r_i t + e_{it}$$

in which  $u_i$  is an individual fixed effect,  $r_i$  is an individual growth rate, and  $e_{it}$  is the idiosyncratic error. We then estimate  $I$  by the variance of estimated fixed effects (with or without the adjustment for estimation error),  $V$  as the mean squared residual from the regression (plus the adjustment), and  $R$  as the variance of predicted values, measuring, in essence, the variance of the co-efficients on  $t$ . These are all to be divided by twice mean income in the sample to obtain  $GE_2$  measures.

Note that this measure does not characterise the progressivity of income growth or the change in income inequality over the period of  $T$  years. Studying successive  $T$ -year periods, we can decompose changes in inequality, volatility, and mobility across periods. However, a straightforward set of measures of change within the  $T$ -year period involves the correlation of the estimates of the individual-specific mean of income  $u_i$  with individual-specific volatility  $\text{var}(e_{it}^2)$  and individual-specific mobility  $r_i$ . To the extent that the individual mean level of income  $u_i$  is correlated with the individual volatility  $\text{var}(e_{it}^2)$ , we can say that idiosyncratic risk is progressively distributed, suggesting that individuals may be making a risk-return trade-off (or, possibly, much volatility may be regarded as positive shocks relative to baseline income). To the extent that the mean level of income  $u_i$  is correlated with mobility,  $r_i$  income growth can be said to be pro-rich, and, in that case, income inequality is rising during the  $T$ -year period.

To measure  $T$ -year inequality, volatility, and mobility, we need only  $T$  years of data on each individual in a survey (and to use weighted means, instead of the unweighted means in the previous formulas). For example, we can use five years from a longer panel and measure 5-year inequality as the inequality across individuals in 5-year averages of income. But this would say nothing about the trend in inequality.

If we want to measure trends in inequality, volatility, and mobility, we must have a much longer panel. Given a panel of a specific fixed length, for example  $2T$  years of panel data, we can imagine computing a single  $2T$ -year measure of inequality and other components using a very small balanced panel (only for those individuals observed in every survey year), or using the first  $T$  years to construct one estimate and the second non-overlapping period of  $T$  years (beginning in year  $T+1$  and running to year  $2T$ ) to construct another estimate. Changes in  $T$ -year inequality, volatility, and mobility are then immediately apparent. More generally, with  $2T$  years of data, we can construct  $T+1$  estimates, for each period of  $T$  contiguous years.

#### 4. Data

We rely on a variety of national and international panel data to estimate income inequality, volatility, and mobility risk.<sup>8</sup> For the United States, we use the Panel Study of Income Dynamics

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<sup>8</sup> This manuscript makes use of several licensed data-sets that require the following disclaimers: (i) We employ EU-SILC data (European Commission, Eurostat), cross sectional files from 2006 (rev. 03-10) and 2008 (rev. 03-

(PSID) for survey years 1970 to 2009 (income years 1969 to 2008). Because the PSID moved to a biennial survey in 1997, it makes sense to exclude every other year in earlier years as well, so that the concepts are the same in every year. A T-year estimate then covers 2T-1 calendar years, due to skipping every other calendar year in retrieving T years of data. Thus, with data from 1970 to 2009, we can, for example, construct 5-year estimates from 1978 (using 1970, 1972, 1974, 1976, and 1978 data and assigning estimates to the last year of data used) to 2009 (using 2001, 2003, 2005, 2007, and 2009 data), with gaps in 1997, 1999, 2001, and 2003.

For Australia (Household Income and Labour Dynamics in Australia – HILDA, 2001 to 2008), Canada (Canadian Survey of Labour and Income Dynamics - SLID), Germany (German Socio-Economic Panel – SOEP, 1984 to 2008), South Korea (Korea Labour and Income Panel Study – KLIPS, 1998 to 2007), Switzerland (Swiss Household Panel – SHP, 1999-2008), and the United Kingdom (British Household Panel Study – BHPS, 1991 to 2007) we rely on national panel data that have been made comparable in the Cross-National Equivalent File (CNEF).<sup>9</sup>

We rely on the European Union Statistics on Income and Living Conditions (SILC, ~2004-2007) for data on Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, and Spain.<sup>10</sup> With the exception of Luxembourg, the SILC panels have a maximum length of 4 years.

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11), made available to Rehm by the European University Institute. Eurostat has no responsibility for the results and conclusions of this article. (ii) This article uses the HILDA-CNEF dataset, an equivalised subset of data from the Household, Income and Labour Dynamics in Australia (HILDA) survey provided through the CNEF project at Cornell University. The HILDA Project was initiated and is funded by the Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this article, however, are those of the authors and should not be attributed to FaHCSIA, the Melbourne Institute or Cornell University. (iii) This study has been realized using the data collected by the Swiss Household Panel (SHP) [made available via the CNEF project at Cornell], which is based at the Swiss Centre of Expertise in the Social Sciences FORS. The project is financed by the Swiss National Science Foundation.

<sup>9</sup> For the UK, Germany, and Switzerland, we have access to the original data sources. For the sake of comparability, however, we will rely on the CNEF.

<sup>10</sup> We do not use the SILC data for Germany and the UK, since we take them from the CNEF.

We construct two main concepts of family income: market income (gross income) and disposable income (net income), adjusted for family size.<sup>11</sup> The calculation of gross and net income varies somewhat across our data-sources.

In the PSID, gross income includes labour and property income, and excludes employer-provided DB pension benefits, Social Security and other social insurance payments (unemployment and worker's compensation), the cash value of means-tested transfers and cash-equivalent in-kind benefits (e.g., food stamps). Gross income does not include tax liabilities. Net income adds in the excluded social insurance and transfer income, and subtracts tax liabilities (and adds in tax credits, for those whose net tax liability is negative). Taxes are imputed using TAXSIM.<sup>12</sup>

For the data from the CNEF, we simply employ the constructed variables for household pre-government income [i11101] (which represents the combined income before taxes and government transfers of the head, partner, and other family members) and household post-government income [i11102] (the combined income after taxes and government transfers of the head, partner, and other family members).

SILC contains detailed income data. Market income is the sum of [py010g] "employee cash or near cash income", [py050g] "cash benefits or losses from self-employment", [hy040g] "income from rental of a property or land", and [hy090g] "interest, dividends, profit from capital investments in unincorporated business". To calculate disposable income, we add transfer income ([py090g] unemployment benefits, [py100g] old-age benefits, [py110g] survivor benefits, [py120g] sickness benefits, [py130g] disability benefits, [py140g] education-related allowances, [hy050g] family/children related allowances, [hy060g] periodic payments to people with insufficient resources, referred to as benefits to reduce "social exclusion not elsewhere classified", [hy070g] housing allowances, [hy080g] regular inter-household cash transfer received, and [hy110g] income received by people aged under 16). We deduct taxes and alimony payments ([hy120g] regular taxes on wealth, [hy130g] regular inter-household cash transfer paid,

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<sup>11</sup> We employ the OECD-modified equivalence scale, which assigns a value of 1 to the household head, of 0.5 to each additional adult member (15 years or older) and of 0.3 to each child (Haagenars *et al.* 1994). See for example Coulter, Cowell, and Jenkins (1992) and Cowell and Jenkins (1995) on equivalence scales; we find that various alternative family size adjustments alter results very little.

<sup>12</sup> Version 9 at <http://www.nber.org/~taxsim> (see, also, Feenberg and Coutts, 1993).

[hy140g] tax on income and social contributions). Person-level variables are aggregated to the household level.

Top-coded income could represent a major threat to these de-compositions, since the GE2 index emphasises variation in larger incomes (whereas a 90/10 ratio would be largely immune to this threat); however, empirically, it does not appear to be a large issue (Nichols 2008). Therefore, and for the sake of comparability, we top- and bottom-code our equivalised gross and net family incomes at p1 and p99, respectively.

A longer period  $T$  is desirable for better estimates of the volatility component, but clearly if we wish to measure trends, a shorter period is preferable (so that we may compute more estimates across periods of length  $T$ ). Note that  $T$  must be at least 3 for each individual in order for that individual's observations to be used, and we will use  $T=3$  and  $T=5$  in this paper.

To address the problem of panel attrition over time, we use the first year panel weights (adjusting for attrition from the survey up to that point) and calculate an adjustment factor to differentially adjust weights by  $1/(1-p)$  where  $p$  is the estimated probability of attrition from a logit of attrition on initial income quintile dummies; logit regressions using more characteristics to predict the probability of attrition produce qualitatively similar results.

Another concern is that the variance of the idiosyncratic error term used to characterise volatility also captures measurement error, but this is, in a deep sense, inevitable - one cannot observe short-run variation in income and know whether it represents true short-run variation in income or mis-reported or mis-measured income. This applies even to administrative earning records or to datasets with merged administrative records and survey responses (which we have for some countries in the SILC). The only approaches to estimate volatility and measurement error components separately require structural models of income distributions that can usually be rejected (in the statistical sense) by the very data used to fit them. To the extent that measurement error is increasing over time, any upward trend in volatility may represent increases in the volatility of true income, or increases in the volatility of measured income with no change in the volatility of true income.

We engaged in several benchmarking exercises, to obtain a sense of how our income concepts compare to official data. We draw benchmark data from the OECD's "Growing Unequal" report (OECD 2008) and other sources. Since it is often impossible to figure out how, exactly, the



published results are calculated (in terms of exact income components, treatment of top- and bottom-codes and negative incomes treated, and the range of years to which the data refer), and since most of the official EU data are based upon the same data sets we use, the benchmarks are not much more than plausibility checks.

But the results are very encouraging, as two figures in the Appendix demonstrate. The figures provide scatter-plots of Gini co-efficients published by the OECD *vs.* single-year Gini co-efficients calculated by us, for 1995, 2000, and 2005. Note that the OECD data refer to ages 18-65, while our estimates are for ages 25-60. Appendix Figure 1 displays net income data; Appendix Figure 2 displays gross income data. While there are some cases that are somewhat off the 45-degree line, there is a remarkably close overlap, especially for the net income data.

## **5. Results**

Looking first at long-run inequality, the impact of accounting for taxes is readily apparent comparing gross (market) and net (disposable) income results for the US (Figure 1) and Canada (Figure 2). After-tax incomes are substantially less unequal, with long-run inequality index values about one third to two thirds as large as those for pretax incomes. This is to be expected, given the progressivity of the tax-transfer system.

The pattern over time of the ratio of pre-tax inequality to after-tax multi-period inequality exhibits remarkable stability, at about 70 per cent in most years in the US and about 45 to 50 per cent in Canada, and is remarkably similar using different accounting periods of three and five years. Only in Korea and Switzerland is the ratio larger than in the US. Government intervention in these 3 countries does not reduce inequality by much. However, in most countries, the ratio of pre-government inequality to after-government multi-period inequality is lower than in Canada, suggesting that government intervention substantially reduces long-run inequality.

The impact of accounting period  $T$  was also found to be modest relative to the differences across pre-tax and post-tax estimates of inequality in Nichols (2008), though there is a clear ordering, where longer accounting periods produce lower estimates of long-run inequality. This is to be expected, as Shorrocks (1978) and other scholars have noted, since there is some regression to the mean over time.

The impact of taxes and transfers on estimated volatility and mobility risk is similar to the impact on inequality, with net income measures about 70 per cent of gross income measures in the US and about 60 per cent in Canada. Volatility estimates are roughly 50 per cent as large for post-government income as for pre-government income in most countries, though Cyprus, Switzerland, Korea, and Iceland exhibit higher ratios. In other words, taxes and transfers cut volatility roughly in half. The impact of government intervention on mobility risk estimates is nearly the same percentage reduction in estimated risk as in the volatility measure (roughly 50%). Both reductions are most likely due to the progressivity of the tax and transfer systems.

Overall, these estimates suggest that long-run inequality increased by about 50 per cent over the last 25 years in the US, but substantially less in Canada. Similarly, volatility risk appears to have increased by about 40 to 60 per cent and mobility risk by about 30 to 50 per cent over the same period in the US but much less in Canada. The aggregate risk measure, summing inequality, volatility, and mobility risk, has also increased by approximately 50 per cent over the last 25 years in the US. The aggregate measure is shown as a stacked area graph in Figure 3 for the US and Figure 4 for Canada.

In the other 28 countries, the levels of long-run inequality, volatility, and mobility risk have increased only slightly in most cases (Figure 5), with most countries exhibiting a modest statistically significant upward trend or a statistically insignificant trend (including both downward and upward trends that do not differ significantly from no trend). However, looking at gross income (income before taxes and transfers), the difference between the US and other countries is much less clear; many countries have comparable rates of increase in gross income risks but much lower rates of increase in net income risks, which suggests that tax and transfer systems have done more in other countries to mitigate increases in gross income risk over time than it has in the US.

The reductions in long-run inequality, volatility, and mobility risk due to the tax and transfer system, comparing a measure based upon gross (market) income to one based upon net (disposable) income, have changed over time, so we focus on mean levels of risk reduction in the following comparisons.

The reductions in risk due to the tax and transfer system are highly related to the overall level, with a strong positive relationship between mean reduction in long-run inequality due to the tax-

transfer system and mean long-run inequality (Figure 6) and a strong positive relationship between mean reduction in long-run volatility due to the tax-transfer system and mean long-run volatility (Figure 7).

In addition, the relationship between mean reduction in long-run inequality and mean reduction in long-run volatility due to the tax-transfer system exhibits a clear positive relationship (Figure 8) but the US is a clear outlier, with modest reductions in long-run inequality but very large reductions in volatility when moving from gross to net income definitions. One would expect such a positive relationship from the Meltzer-Richard model – this preliminary result casts some doubts on the so-called “Robin Hood paradox” (Lindert 2004). However, these correlations are largely driven by mechanical relationships between level and reduction, and correlation of the level of inequality and volatility. Proportional reductions do not exhibit such a clear relationship, though there is a different mechanical bias introduced when dividing by the level (Borjas 1980).

The regressivity of income growth within each three- or five-year period can be measured as the correlation or covariance of mean income  $u_i$  (mean over five years) and individual-specific growth rates  $r_i$ , as explained above (Figure 9). This is measured quite apart from the inequality, volatility, and mobility risk discussed in the previous section, though it is clearly related to trends in these measures; see Jenkins and Van Kerm (2006) for additional relevant discussion of pro-poor growth. We find that pro-poor growth is the exception – the correlation between income growth and income levels is negative only in France, Austria, and Italy. However, these findings have to be interpreted with some caution because our data cover different time-periods in different countries.

Volatility, on the other hand, is strongly positively related to mean income (Figure 10). Since excess volatility tends to reduce welfare, the progressive incidence of high volatility has a somewhat equalising effect. In practice, presumably much of the higher volatility at higher mean income levels has to do with risky income sources producing higher mean returns; at any point in time, the richest individuals will tend to be realising high returns from a volatile income source. Some of it also reflects the increased risk tolerance that wealthier individuals may have if their basic needs are assuredly met, so they may gamble on stock market performance with the balance of their resources.

Straightforward extensions to the work which we have presented here include de-composing the inequality, volatility, and mobility measures by income type (Shorrocks 1982) or by population sub-group (Shorrocks 1984), but these are outside the scope of the current paper.<sup>13</sup>

## 7. Conclusions

The de-composition of variability in income across people and time undertaken here produces remarkably stable results across a variety of specifications. Calling total variability in incomes – measured as half the squared co-efficient of variation or  $GE_2$  – a measure of income risk, it can be expressed as the sum of long-run inequality (a measure of income risk from behind the veil of ignorance<sup>14</sup>), volatility or short-run fluctuations around a person-specific time trend, and variation in time trends or “mobility risk”. Other measures of the level of mobility are empirically broadly consistent with the measure we call mobility risk.

All of the results indicate that long-run inequality is the dominant form of net income risk in these data. In most countries, all forms of net income risk seem fairly stable over time in the time periods examined. However, in the US, all forms of net income risk appear to be increasing sharply over time, and more modest growth in risk is observed in Canada and Germany. Other countries do not have sufficient data to conclude much about trends, but there is not even suggestive evidence that other countries have experienced the enormous run-up in net income risk that the US has. The differences are not so stark when examining gross income risk, which suggests that the tax and transfer system of the US has done less to mitigate the increases in gross income risk than other countries’ systems have done.

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<sup>13</sup> We plan to examine the impact of changing population characteristics in a future paper, and to examine the specific features of tax-transfer systems that drive the observed differences further.

<sup>14</sup> On the veil of ignorance, see Harsanyi (1953,1955) and Rawls (1971).

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Figure 1. US Long-run inequality

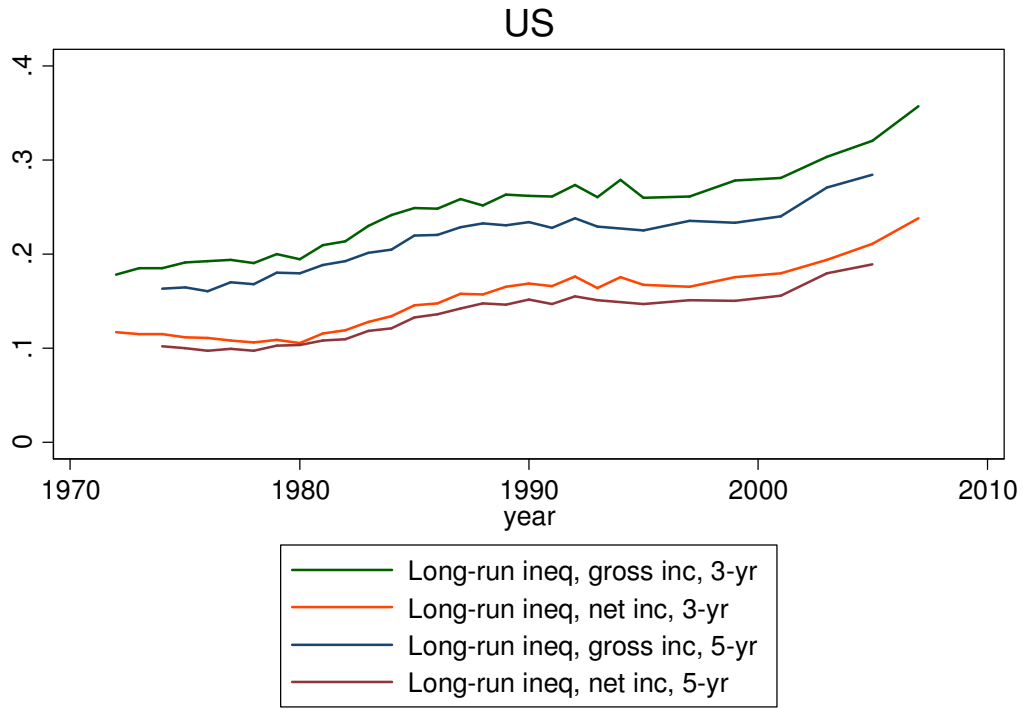


Figure 2. Canadian Long-run inequality

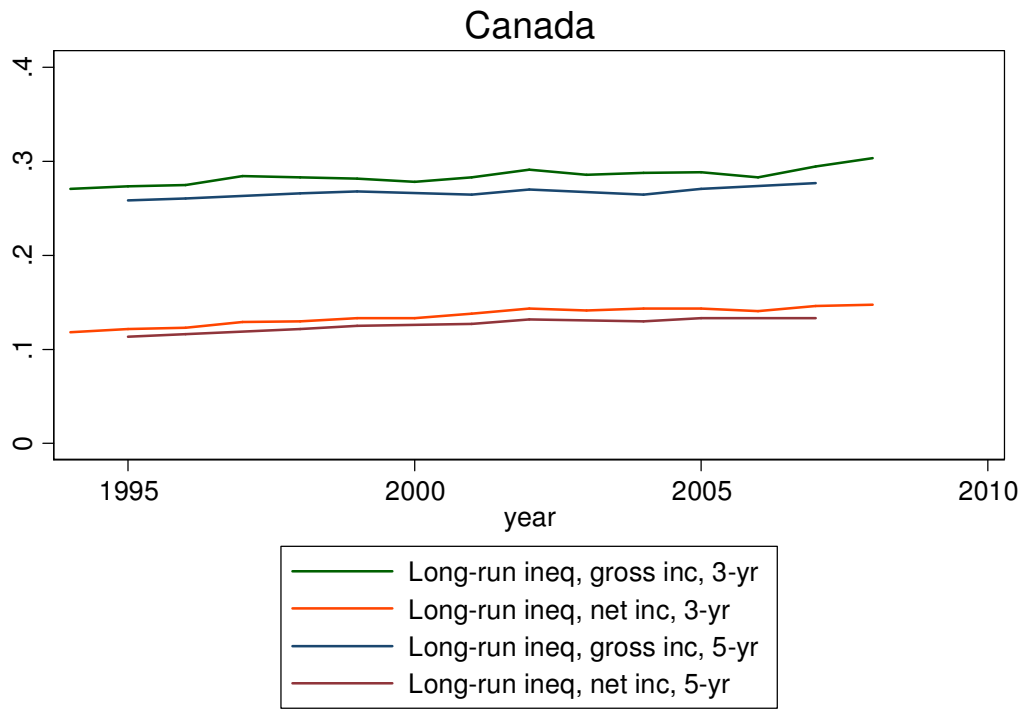


Figure 3. US stacked inequality and intertemporal variability and mobility risk

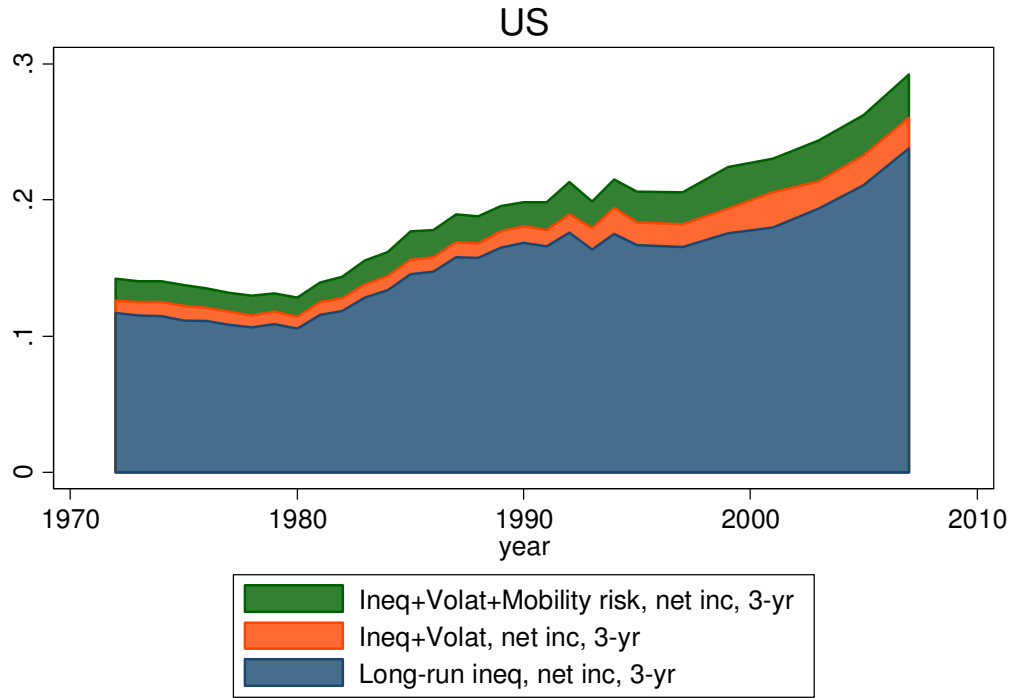


Figure 4. Canadian stacked inequality and intertemporal variability and mobility risk

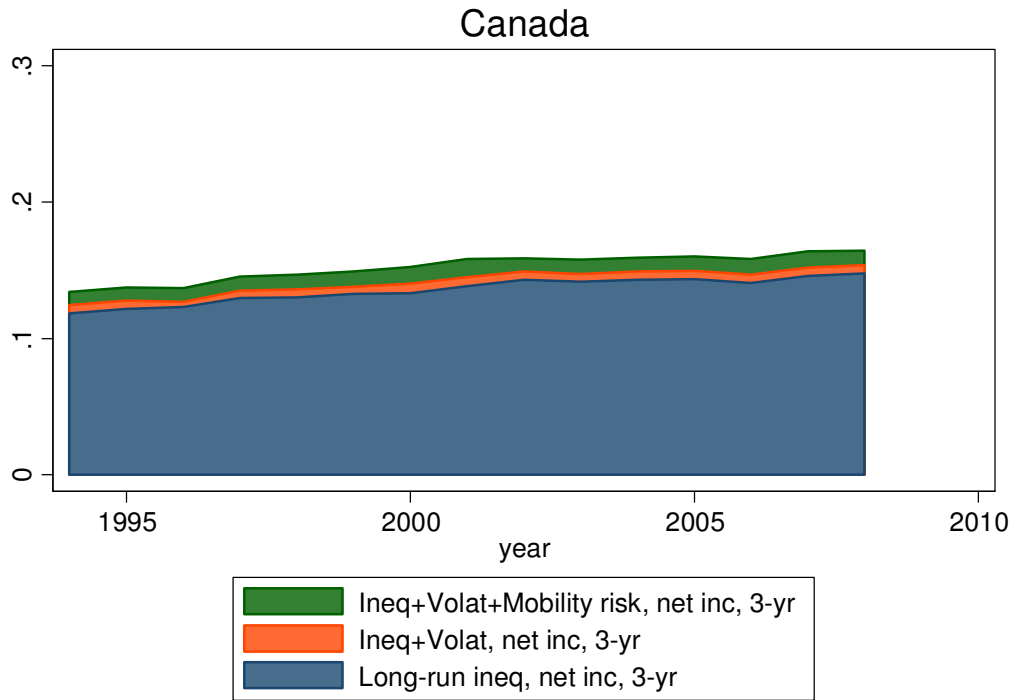


Figure 5. Stacked inequality and intertemporal variability and mobility risk in 30 countries, net income after taxes and transfers

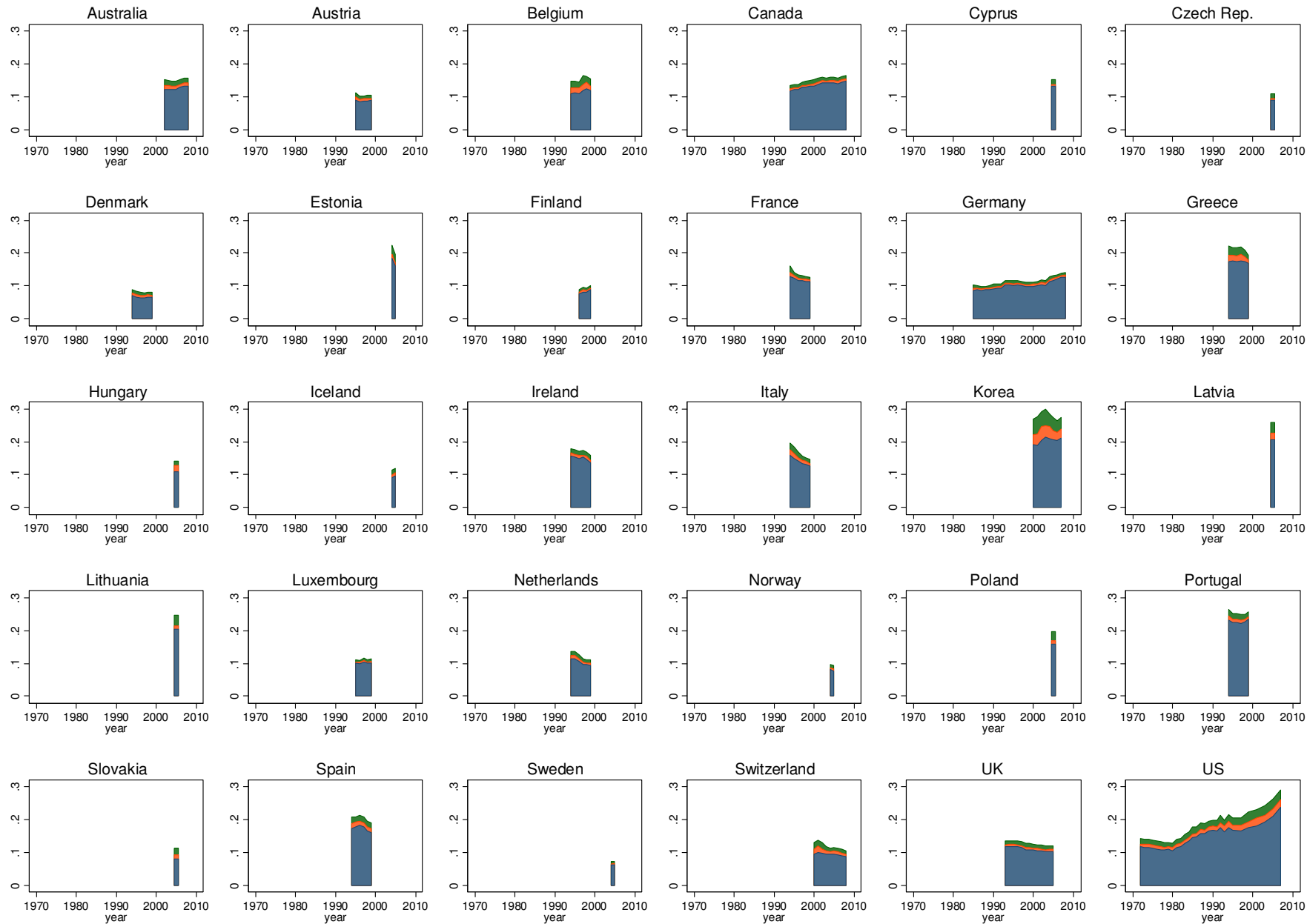


Figure 6. Stacked inequality and intertemporal variability and mobility risk in 30 countries, gross income before taxes and transfers

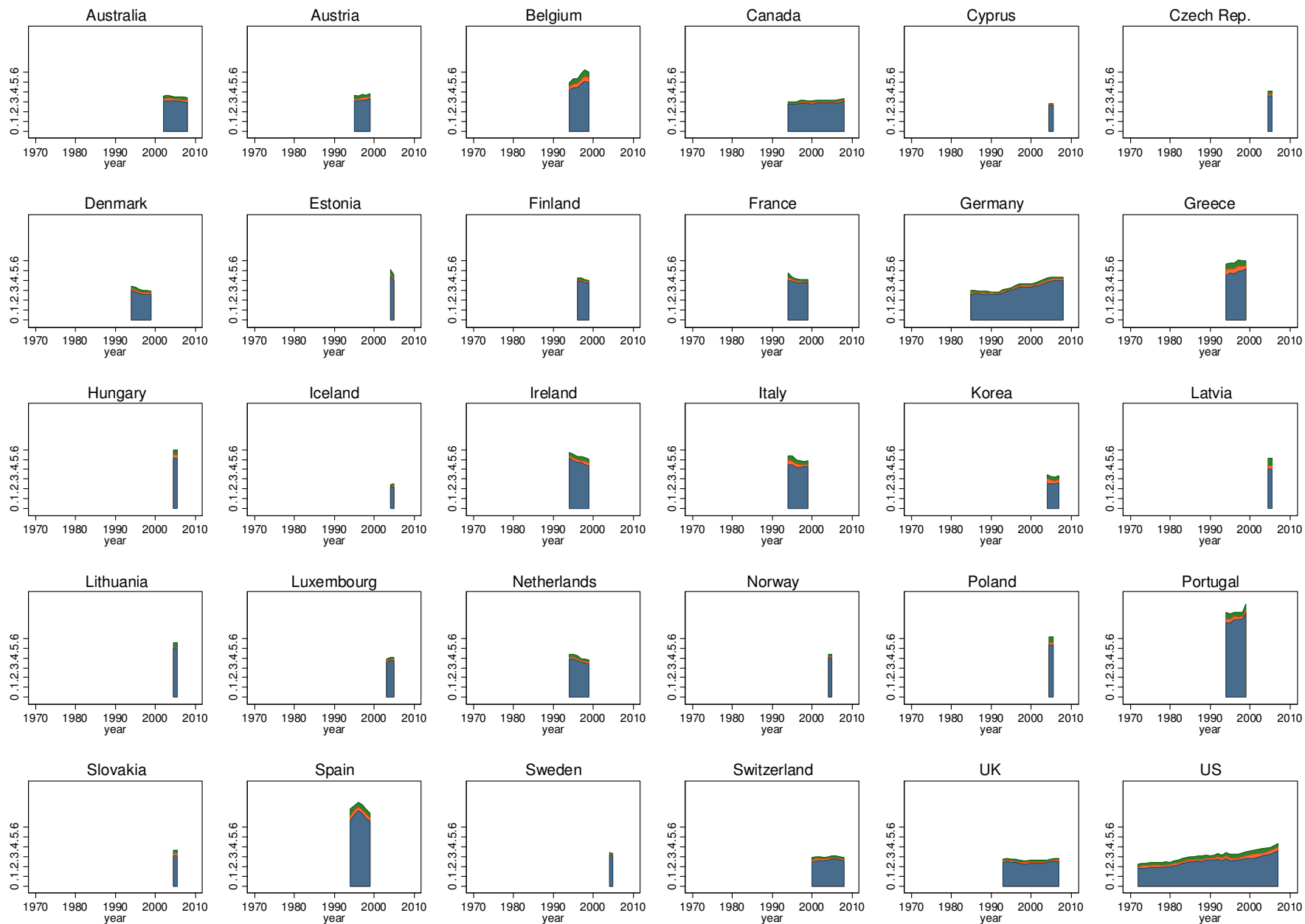


Figure 7. Reduction in intertemporal variability due to taxes and transfers versus reduction in long-run inequality in 30 countries

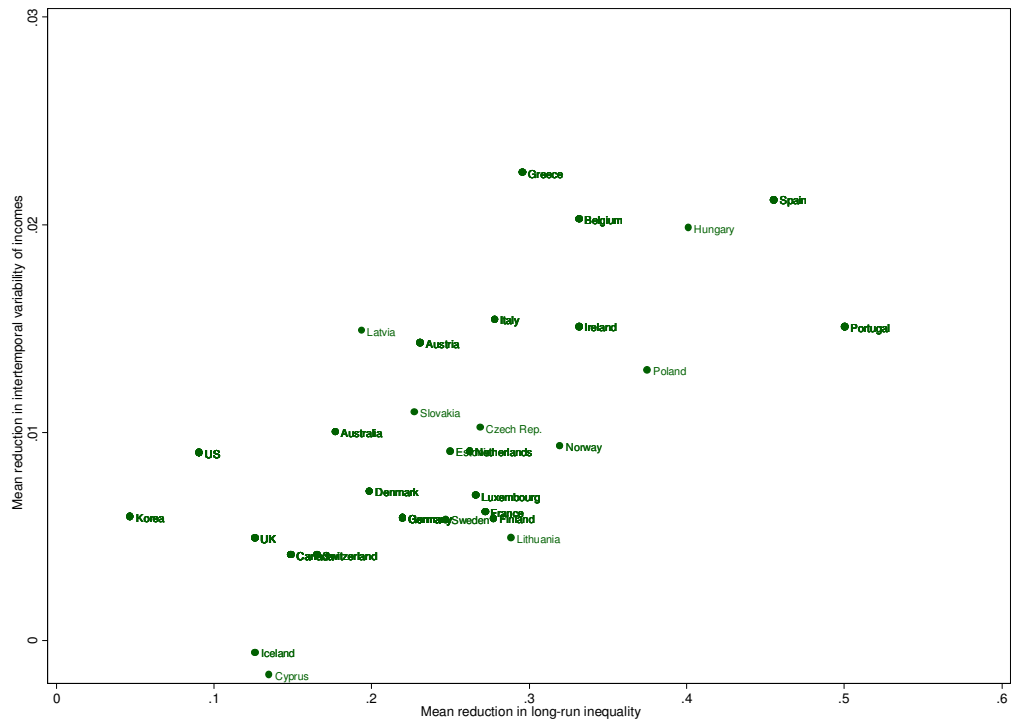


Figure 8. Reduction versus level of intertemporal variability in 30 countries

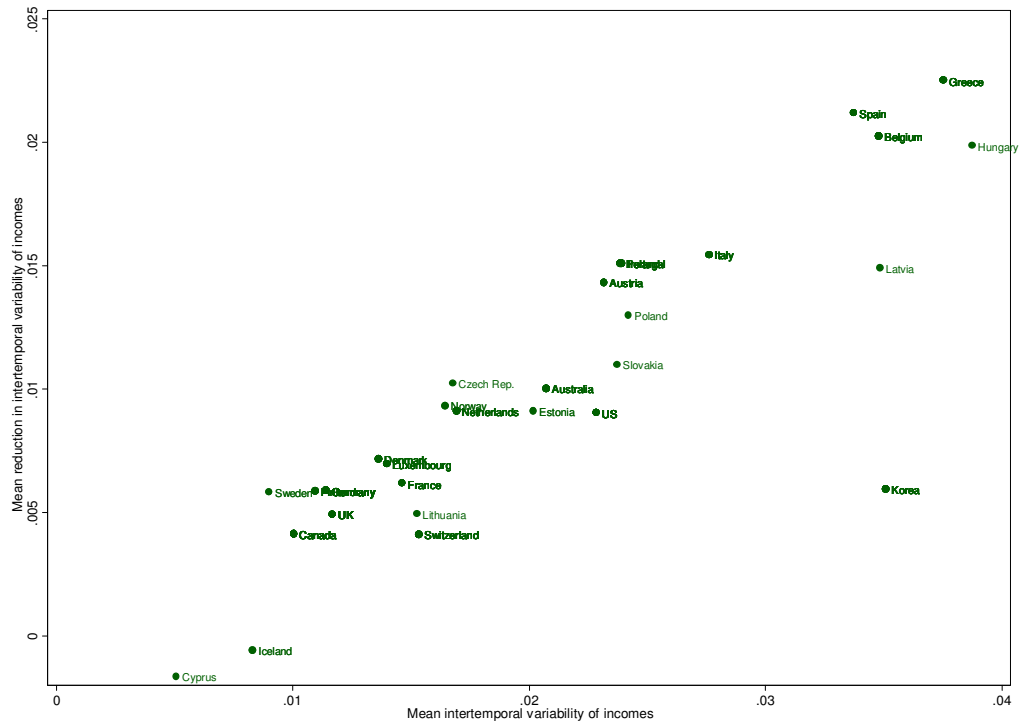


Figure 9. Reduction versus level of long-run inequality in 30 countries

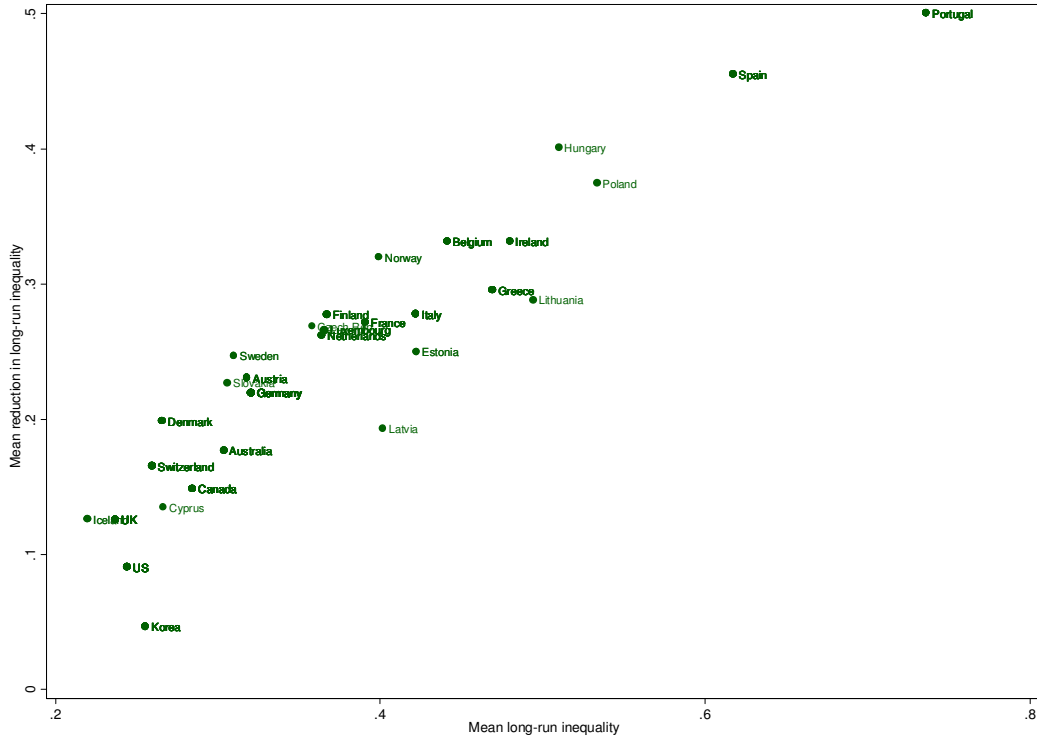
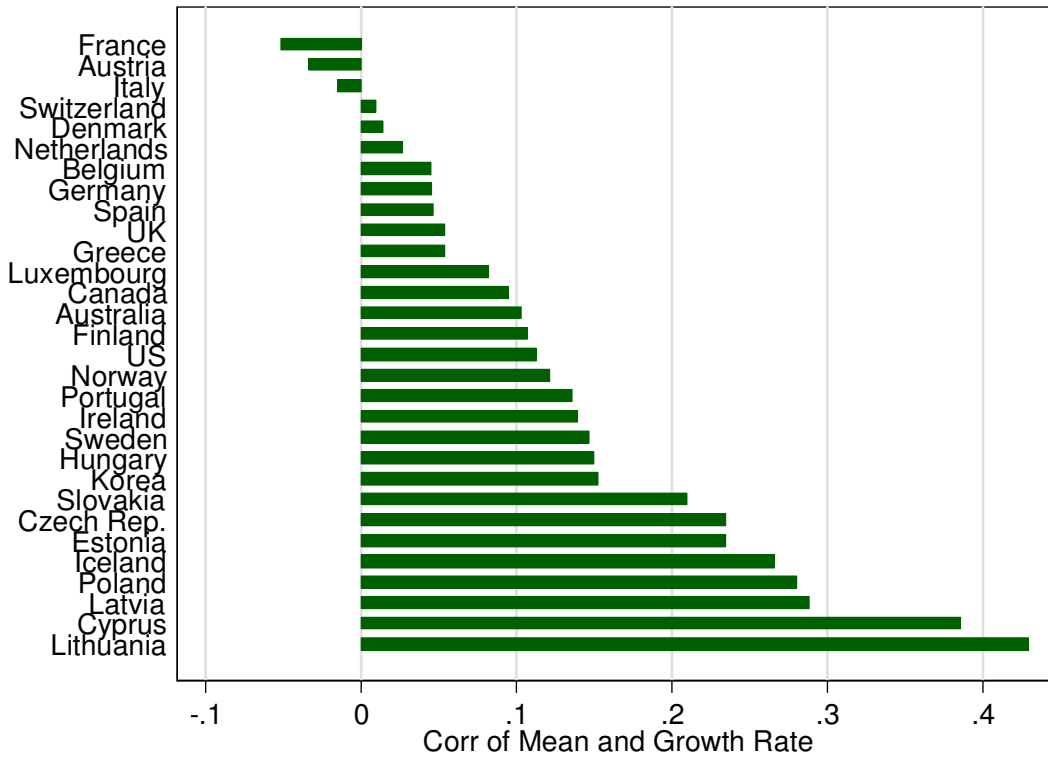


Figure 10. Mean correlation of income levels and growth rates in 30 countries



Appendix. Benchmarking to published estimates

Figure 1a

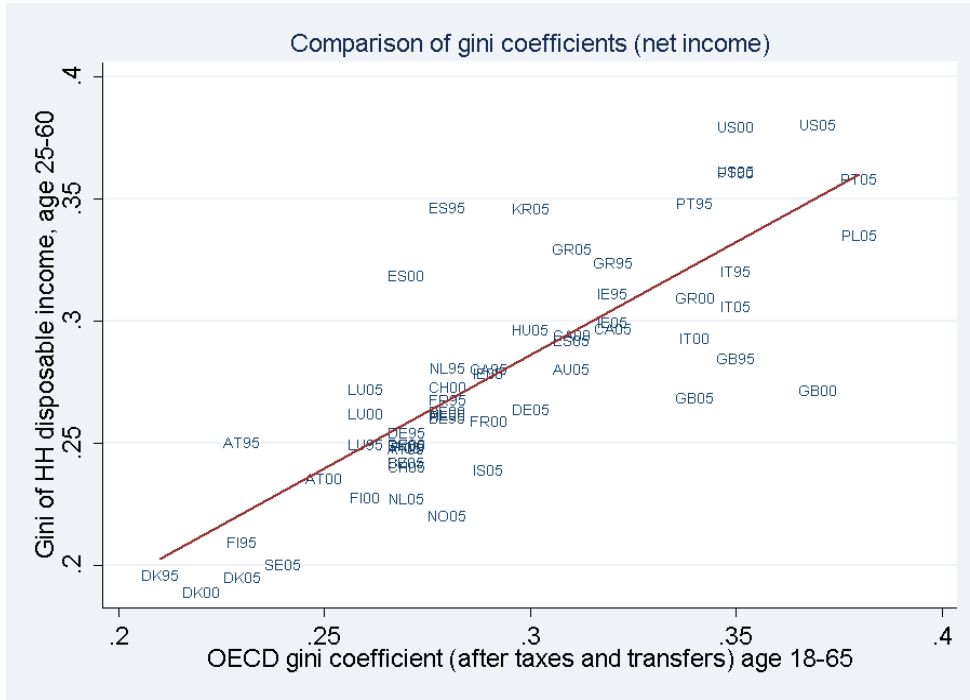


Figure 2a

