Institut de Recerca en Economia Aplicada Regional i Pública
Research Institute of Applied Economics

Document de Treball 2023/10, 32 pàg.
Working Paper 2023/10, 32 pag.

Grup de Recerca Anàlisi Quantitativa Regional
Regional Quantitative Analysis Research Group

Document de Treball 2023/06, 32 pàg.
Working Paper 2023/06, 32 pag.

"Income inequality and redistribution in Scandinavian countries"

Petar Sorić and Oscar Claveria

UBIREA
Research Institute of Applied Economics

AQR
Regional Quantitative Analysis Research Group

Abstract

This paper investigates the adjustment of government redistributive policies in Scandinavian countries following changes in income inequality over the period 1980-2021. We use two complementary measures of inequality: the share of total income accruing to top percentile income holders, as well as the ratio of the share of total income accruing to top decile income holders divided by that accumulated by the bottom 50%. We find that the sign of the relationship between inequality and redistribution is mostly positive and time-varying. We also find significant evidence that redistributive measures in the form of taxes and government transfers adjust more rapidly in an upward than a downward direction, with the exception of Norway. We obtain a significant long-run relationship between both variables in Iceland and Sweden, while in Norway it just holds for the short run.

JEL Classification: C50, D30, E62, H50.

Keywords: Income inequality, Redistributive policy, Taxes, Government transfers.

Oscar Claveira: AQR-IREA Research Group, University of Barcelona. Department of Econometrics, Statistics and Applied Economics. Av. Diagonal 690, 08034 Barcelona, Spain. Tel. (+34) 934 021 825. Email: oclaveria@ub.edu

Petar Sorić: Faculty of Economics and Business, University of Zagreb.

Acknowledgements

A more recent version of this study is published in the journal of Applied Economic Analysis. This research was supported by the project PID2020-118800GB-I00 from the Spanish Ministry of Science and Innovation (MCIN) / Agencia Estatal de Investigación (AEI). DOI: http://dx.doi.org/10.13039/501100011033

1. Introduction

There is a complex relationship between income inequality and redistribution. On the one hand, high levels of income inequality can create social and economic problems such as poverty, social unrest, and decreased economic growth. In response, many governments have implemented redistributive policies such as progressive taxation, social welfare programs, and minimum wage laws to address these issues (Granger et al., 2022). On the other hand, the effectiveness of redistributive policies can be limited by political and economic factors. For example, political resistance from those who would have their wealth redistributed, and the potential for unintended consequences such as disincentivizing work or reducing economic growth (Stiglitz, 2012; 2015).

Over the last decade, and especially as a consequence of the 2008 financial crisis, the level of inequality in income distribution has become one of the fundamental social priorities, and occupies an increasingly prominent place on the political agenda. There is a shared perception of the need to correct the growing inequalities in income distribution, not only between countries but also within countries. The result of this is the increasing implementation of progressive tax systems and social spending to cushion the negative effects of the growing income disparity. However, against this background, it is shocking that, despite the application of redistributive measures, income inequality continues to steadily rise.

In a recent review of the literature examining the link between income inequality and government spending, Anderson et al. (2017) found a moderate negative relationship between government spending and income inequality, and that the redistribution effect tends to be more beneficial for the middle class and is more effective in developed countries. Overall, the authors highlighted that the complex relationship between both variables—which is affected by both 'first-round' and 'second-round' effects—may be affected by reverse causality issues, and stressed the importance of both the variable chosen to measure inequality and the estimation method used.

The main motivation of this paper is to address these issues in the analysis of the long-term relationship between income inequality and the redistributive effect of of government policies via taxes and transfers. There is no consensus regarding the nexus between both variables. While Berg et al. (2018) and Milanovic (2000) found evidence that redistributive efforts tend to be greater in countries with higher income inequality, de Mello and Tiongson (2006) and Benabou (2000) obtained evidence to the contrary. The research focuses on the set of relatively homogeneous economies of the Scandinavian countries during the period between 1980 and 2021. The length of the series allows us to implement different time series analysis techniques that consider the long-run dynamics of the relationship and address the potential existence of non-linearities and reverse causality.

There are different metrics to quantify the level of income inequality. Among them, the most used is the Gini index. However, in recent years it has been highlighted how income inequality is particularly concentrated in the highest income groups. (Atkinson et al., 2011; Piketty and Saez, 2014). Consequently, our analysis focuses on two complementary measures of inequality: the share of total income accruing to top percentile income holders, as well as the ratio of the share of total income accruing to top decile income holders divided by that accumulated by the half bottom of the distribution, which can be regarded as a metric of inequality at the aggregate level.

Regarding the effect of the redistributive measures, we have calculated it as the difference between the two inequality indicators before and after taxes and transfers. This has been possible thanks to the information that the WID project has been generating in recent years, which is freely available to researchers. Despite the inherent limitations of any proxy metric, this database offers numerous advantages over previously available information. On the one hand, it not only offers estimates of the level of inequality for long periods of time, but also does so before and after taxes and transfers. This contribution is what makes it possible to approximate the government effort in mitigating inequality. In addition, the historical series are available for a wide range of countries and on an annual basis, making possible both international comparisons and the application of econometric techniques characteristic of time series analysis.

Thus, we first analyse the differences in the long-run evolution of both income inequality and the redistributive impact of taxes and transfers in Denmark, Iceland, Norway and Sweden during the sample period. Second, we apply a longitudinal analysis by combining different time series techniques to model the dynamic relationship between income inequality and redistribution accounting for the potential existence of reverse causality and an asymmetric adjustment in the face of increases in inequality.

In the next section, we review the existing literature on the link between inequality and redistribution. Next, we present the data, and carry out a graphic and descriptive analysis to shed light on the evolution of both variables in the Scandinavian countries since the 1980s. In section 4, we describe the methodology used in the empirical analysis. Next, the results are presented. Finally, we report the main conclusions of the study.

2. Literature Review

The seminal work of Kuznets (1955) put the issue of inequality in the distribution of income at the center of public debate. The perception during the following decades of equity as an obstacle to economic growth favoured the implementation of non-interventionist policies, consolidating an increasingly diminishing role of governments in the fight against inequality, and relegating interest in this pressing issue. Since then, most of the emphasis has been placed on contrasting Kuznets' hypothesis that during economic growth, per capita income inequality first increases, reaches a peak and then declines. For example, Dawson (1997) found support to Kuznets' hypothesis using data for 36 less developed countries, and Cevik and Correa-Caro (2020) also obtained an inverted U-shaped relationship between income inequality and economic development in China and the panel of BRIC+ countries.

Using a panel data of 21 high-income OCDE countries during the period 1972–2006, Munielo-Gallo and Roca-Sagalés (2013) found that distributive expenditures and direct taxes produced significant reductions in economic growth, reflecting the standard efficiency–equity trade-off associated to certain fiscal policy measures. More recently, using data for 130 countries over the period 1965-2010, Woo (2020) presented evidence that redistribution involved a non-trivial trade-off between equity and long-term growth, which varied with the initial level of market income inequality, and the size of redistribution itself.

Despite this, there is a growing body of studies questioning this trade-off, and presenting new evidence of a positive relationship between equality and growth. Using the Deininger–Squire data set, Tanninen (1999) obtained a negative relationship between inequality and growth on the basis of reduced-form growth equations. In their seminal paper, using data for 140 countries, Berg et al. (2012) showed that growth duration was positively related to the degree of equality of the income distribution, the quality of democratic institutions, commercial openness, and macroeconomic stability. Ravallion (2014) showed that high inequality in developing countries attenuates growth prospects, which in turn makes it harder to reduce inequality. All of this reflects that this is still an open debate.

However, the growing social awareness of the problems associated with inequality, together with the increasing availability of accurate and detailed information on income distribution, have given rise to a resurgence of the debate both from the political and academic spheres.

On the one hand, the estimation of historical series of income distribution for a large number of countries has made it possible to carry out comparative analysis of the evolution of inequality for different economies (Alvaredo et al., 2013; Piketty, 2014; Piketty and Zucman, 2014; Roine and Waladenstörm, 2011). On the other hand, the study of the determinants of inequality has also experienced a growing interest in recent years. Nolan et al. (2015) classified the determinants of income inequality in seven categories: globalization, technological change, macroeconomic shocks and 'financialization'—understood as the growing role of finance—, labour institutions, product market power, demographics and household structure, and finally the redistributive role of governments through taxes and transfers.

Munielo-Gallo and Roca-Sagalés (2013) found that distributive expenditures and direct taxes produced significant reductions in net income inequality. As stated by Joumard et al. (2012), taxes and transfers reduce inequality in disposable income relative to market income. In their study of OECD countries, the authors noted that the effect of taxes and transfers notably varies across countries, and that it depends on three components (size, mix and progressivity), based on which they group all economies in four groups: the Continental-European model, the Anglo-Saxon model, the Nordic model and a lower-income group. The Nordic model is characterised by large and mostly universal cash transfers, a high level of spending on in-kind services and a tax mix that promotes redistribution (Goulart et al., 2022).

Unlike the US, income inequality in the Scandinavian countries has not been as widely analysed. Atkinson and Søgaard (2016) and Roikonen (2022) have carried out a detailed study of inequality in Denmark and Finland respectively. As for Sweden, Roine and Waldenström (2008, 2009) have published longitudinal studies covering a long historical period. However, we have found no comparative studies between the four Scandinavian economies in the literature. The studies that include the different Scandinavian countries analyse them jointly with the rest of the developed countries, but do not delve into the differences between them.

Today, Sweden is one of the least unequal countries in terms of income in the world (Chancel et al., 2022). The top 10% of the population ears just over 30% of national income, while the bottom 50% almost 24%. The top 10% earns on average 6.5 times more than the bottom 50%. However, Sweden was one of the most unequal countries in the early 20th century. The expansion of democracy paved the way for the development of the Swedish welfare state, which led to a large-scale drop in inequality. Nevertheless, inequalities have been rising since the 1980s, and there has been little intergenerational mobility in top incomes (Björklund et al., 2012). A similar pattern has been followed by Denmark (Atkinson and Søgaard, 2016), although the temporal evolution of income inequality in Norway and Iceland shows a turnaround since the 2008 financial crisis. This is analysed in detail in the next section.

3. Data

In this section we present the data that were used in the study. To measure income inequality and redistribution we used annual data from the WID.world, which is the most extensive dataset available on the historical evolution of income inequality. Regarding the choice of metric of inequality, we have used two alternative measures in order to capture different dimensions of the phenomenon. On the one hand, we have used the pre-tax share of income accruing to top 1% income holders (INEQ_1), since many authors have stressed the key role of this segment of the distribution in perpetuating inequality (Stiglitz, 2012; 2015). On the other hand, we have computed the ratio between the pre-tax income accumulated by the top 10% divided by that of the bottom 50% (INEQ_2), in order to have an aggregate measure of income inequality different from the Gini index (Clementi et al., 2019) that considers the other half of the distribution.

By computing both metrics for the post-tax shares, we were able to estimate redistribution (REDI) as the proportion subtracted via taxes and transfers. Therefore, the redistributive effect of taxes and transfers is calculated as the difference between inequality in primary income (i.e., before taxes and government transfers, except pensions and unemployment insurance among adults) and in disposable income (i.e., after taxes and transfers) for both measures of inequality, which are respectively denoted as REDI_1 and REDI_2.

The analysis focused on a set of homogeneous economies, both in order to avoid the issues that arise when comparing very dissimilar economies, and to disentangle the differences between a group of apparently homogeneous economies regarding income inequality and redistribution. Fig. 1 shows the evolution of the long-term dynamics of income inequality (INEQ_1) and of the redistributive effect of taxes and transfers among the top 1% income holders (REDI_1). The graph highlights the growing role of governments in mitigating the effects of income inequality through progressive taxation and public transfers. However, this effort has not been enough to prevent sharp increases in income inequality since the 1980s, especially for top incomes shares in Denmark and Sweden.

The evolution of income inequality in Iceland and Norway seems to be heavily affected by the impact of the 2008 financial crisis, which had a significant impact on Iceland. Prior to the crisis, Iceland had a rapidly growing economy and a thriving financial sector. However, when the global financial crisis hit, Iceland's economy collapsed. Overall, the 2008 financial crisis had a significant and long-lasting impact on Iceland, both economically and politically, which shows on the evolution of the share of income accruing to top income holders. This evidence is linked to the results recently obtained Kohlscheen et al. (2021). In the study, the authors use a panel of 91 countries and find how higher levels of inequality cause greater and more persistent contractions in consumption in the aftermath of economic downturns.

The distribution of both variables is summarised in Table 1. Norway is the country that shows the highest average redistributive effect for both metrics of income inequality. Sweden is one of the four countries with the highest concentration of income among top income holders. Iceland also shows differences between the figures for the share of income accruing to the top income percentile and the ratio between the top 10% and the bottom 50%, showing being the lowest in the former, and the highest in the later.

Fig. 1

Pre-tax income inequality and redistribution – Top percentile income holders (1980-2021)

Share of top income percentile in total pre-tax income

Market income inequality | Redistribution

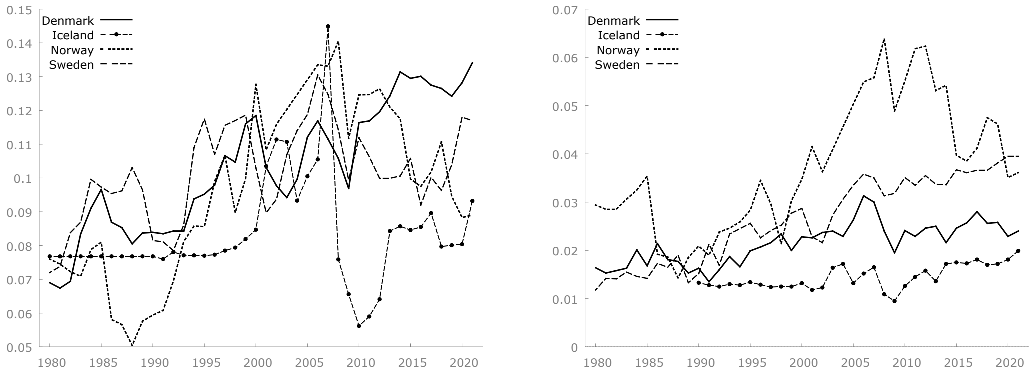


Table 1

Summary statistics

	Share of top income percentile				Ratio top 10/bottom 50			
	Mean	Min.	Max.	SD	Mean	Min.	Max.	SD
Inequality								
Denmark	0.103	0.067	0.134	0.019	1.263	1.040	1.620	0.176
Iceland	0.083	0.056	0.145	0.015	1.313	1.089	1.661	0.131
Norway	0.097	0.050	0.141	0.025	1.156	0.800	1.446	0.196
Sweden	0.102	0.072	0.131	0.014	1.205	0.950	1.418	0.134
Redistribution								
Denmark	0.021	0.014	0.031	0.004	0.467	0.354	0.611	0.083
Iceland	0.014	0.010	0.020	0.003	0.432	0.294	0.533	0.050
Norway	0.037	0.014	0.064	0.013	0.513	0.285	0.741	0.135
Sweden	0.026	0.012	0.040	0.009	0.452	0.302	0.599	0.091

Notes: Min. stands for Minimum, Max. for Maximum and SD for standard deviation.

Overall, the graphs highlight the persistence of governments in mitigating the effects of income inequality, albeit not enough to prevent the prevalence of income inequality and its continuous growth. In order determine whether these trends are deterministic or stochastic, we run the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test (Kwiatkowski et al. 1992), which tests the null hypothesis that the time series is stationary around a deterministic trend against the alternative of a unit root. In Table 2 we present the results of the test. While in most cases the null hypothesis is rejected at the 5% significance level in the specification without trend, especially for income inequality, we obtained mixed evidence, which justifies the choice of modelling approach presented in the next section. Our results are in line with a recent study by Makhlouf (2023), who found that inequality has either been either increasing or stable in 15 developed countries.

Table 2
Test for stationarity – KPSS test statistics

	Share of income among top 1% holders				Ratio top 10/bottom 50			
	Inequality		Redistribution		Inequality		Redistribution	
	with trend	no trend	with trend	no trend	with trend	no trend	with trend	no trend
Denmark	0.040 (>0.10)	1.068 (<0.01)	0.112 (>0.10)	0.888 (<0.01)	0.189 (0.02)	1.042 (<0.01)	0.162 (0.04)	1.112 (<0.01)
Iceland	0.097 (>0.10)	0.164 (>0.10)	0.119 (>0.10)	0.612 (0.03)	0.193 (0.02)	0.487 (0.04)	0.096 (>0.10)	0.352 (>0.10)
Norway	0.199 (0.02)	0.690 (0.02)	0.138 (0.070)	0.733 (<0.01)	0.152 (0.04)	0.789 (<0.01)	0.146 (0.06)	0.808 (<0.01)
Sweden	0.128 (0.09)	0.500 (0.04)	0.078 (>0.10)	1.128 (<0.01)	0.156 (0.04)	0.880 (<0.01)	0.125 (0.09)	1.109 (<0.01)

Notes: Estimation period 1980–2021. Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test for stationarity (Kwiatkowski, Phillips, Schmidt and Shin, 1992). Critical values i) with trend: 0.122 (10%), 0.149 (5%), 0.212 (1%); ii) with no trend: 0.352 (10%), 0.462 (5%), 0.720 (1%). Null hypothesis: time series is stationary around a deterministic trend (i.e. the process is trend-stationary), against the alternative of a unit root. Interpolated p-values between brackets.

4. Methodology

In this study, following a similar approach to Claveria and Sorić (2023), we combine two different modelling strategies in order to obtain a granular perspective on the relationship between income inequality and redistribution: a regression model with time-varying parameters (TVP) and the Nonlinear Autoregressive Distributed Lag (NARDL) model. These procedures are advantageous for several reasons. First, they consider the potential time-variability and asymmetric effects in the data generating process of income inequality (Huang et al., 2015; Balcilar et al., 2021). Second, they allow for a mixture of I(0) and I(1) variables (Pesaran et al., 2001), which is what we observed in the previous section. Besides, the NARDL model is robust to bi-directional feedback effects between dependent variable and regressors, conditioned to a correct specification of the lag order so that regressors become weakly exogenous (Chudik et al., 2016). Finally, NARDL is specifically designed for limited data sizes, such as our dataset (Narayan, 2005).

To examine the stability of the relationship between income inequality and redistribution over time, we used the TVP model proposed by Durbin and Koopman (2012). The model comprises an observation equation and a state equation:

$$Y_t = z_t{}'\beta_t + \varepsilon_t, \quad \varepsilon_t \sim \mathrm{N}\left(0, \sigma_{t,\varepsilon}^2\right) \tag{1}$$

$$\beta_{t+1} = \beta_t + \eta_t, \quad \eta_t \sim \mathrm{N}(0, \mathrm{Q}), t = 1, \ldots, T, \tag{2}$$

where T denotes sample size and Y_t is the observation vector containing the corresponding measure of redistribution. The unobserved state vector, $\beta_t{}'$, is defined as $\beta_t{}' = \left(\beta_{t,0} \;\; \beta_{t,1} \ldots \beta_{t,m}\right)$, $Q = diag\left(\sigma_{t,1}{}^2, \sigma_{t,2}{}^2, \ldots, \sigma_{t,m}{}^2\right)$ is a diagonal covariance matrix, $z_t' = \left(1 \;\; x_{t,1} \;\; x_{t,2} \ldots x_{t,m}\right)$ is the regressor vector, and $\eta_t{}' = \left(\omega_{t,1}, \omega_{t,2} \ldots \omega_{t,m}\right)$ the error term. In all cases, m denotes the number of state variables, and $\beta_{t,0}$ is a potentially time-varying parameter often referred to as the local level.

We used the Broyden–Fletcher–Goldfarb–Shanno (BFGS) algorithm to estimate the unknown variances in the covariance matrix Q (Durbin and Koopman, 2012:177). We obtained the unobserved state values of β_t using the diffuse Kalman filter (De Jong, 1991).

It is worth noting that we did not impose time-variability of the estimated parameters, but rather allowed for it. Each variance in Q could be either deterministic or stochastic, yielding either a fixed or a time-varying parameter for each assessed regressor. We only allowed for time-variability, i.e. stochastic variance, of the income inequality parameter. We selected the optimal model specification for each country using the Akaike information criterion (Commandeur and Koopman, 2007). Following Koopman et al. (1999), after identifying the optimal model specification for each country, we applied standard diagnostic tests: the Doornik and Hansen (1994) version of the Bowman-Shenton normality test, a nonparametric heteroskedasticity test (Koopman et al., 1999), and a standard Ljung-Box autocorrelation test of 4th order. If the null hypothesis was not rejected in all three procedures, it meant that the model passed all diagnostic tests.

In addition to analysing how the relationship between pre-tax income inequality and redistribution changes over time, we also examined whether there are differences in the effects of positive and negative changes in inequality. To investigate this asymmetry, we used the NARDL methodology proposed by Greenwood-Nimmo and Shin (2013):

$$\Delta Y_t = a_0 + \theta_1^+ INEQ_t^+ + \theta_1^- INEQ_t^- + \rho Y_t + \delta GDP_t + \sum_{j=1}^{p-1} a_j \Delta Y_{t-j} + \sum_{j=0}^{q_1^+-1} \pi_{1,j}^+ \Delta INEQ_{t-j}^+ + \sum_{j=0}^{q_1^--1} \pi_{1,j}^- \Delta INEQ_{t-j}^- + e_t, \quad (3)$$

where $INEQ_t^+ = \sum_{j=1}^{t} max(\Delta INEQ_t, 0)$ and $INEQ_t^- = \sum_{j=1}^{t} min(\Delta INEQ_t, 0)$. The optimal lag structure of the model (p, q_1^+, and q_1^-) was determined using the general-to-specific approach (Shin et al. 2014).

We started by estimating model (3) with p=q_1^+=q_1^-=4, and then excluded all insignificant variables via a 5% significance stopping rule. We tested for cointegration using a standard Wald test ($\boldsymbol{H_0}$: $\rho = \theta_1^+ = \theta_1^- = 0$), and formally tested the significance of any nonlinearities in both the long run (LR), $\boldsymbol{H_0}$: $\theta_1^+ = \theta_1^-$), and the short run (SR), $\boldsymbol{H_0}: \sum_{j=0}^{q_1^+-1} \pi_{1,j}^+ = \sum_{j=0}^{q_1^--1} \pi_{1,j}^-$. Whenever the null hypothesis was rejected, we included the underlying asymmetry to prevent estimation bias. When the null hypothesis of LR symmetry could not be rejected for $INEQ_t$, we re-estimated equation (3) with $\theta_1^+ INEQ_t^+ + \theta_1^- INEQ_t^-$ reduced to $\theta_1 \; INEQ_t$.

Similarly, for the case of SR symmetry, model (3) was estimated with $\sum_{j=0}^{q_1^+-1} \pi_{1,j}^+ \Delta INEQ_{t-j}^+ + \sum_{j=0}^{q_1^--1} \pi_{1,j}^- \Delta INEQ_{t-j}^-$ equaling $\sum_{j=0}^{q_1-1} \pi_{1,j} \Delta INEQ_{t-j}$. If the data did not reveal any asymmetry at all, the model became purely linear (ARDL).

After estimating the final version of the model for each economy, we performed the diagnostic tests: Ljung-Box test for autocorrelation of 4th order, Engle's Autoregressive Conditional Heteroscedasticity (ARCH) test of 4th order, and the Shapiro-Wilks normality test of model residuals. If we found statistically significant asymmetries (SR and/or LR), we illustrated them using dynamic multipliers, which show how inequality responds to positive and negative unit changes in inequality:

$$m_{h,\omega}^+ = \sum_{j=0}^{h} \frac{\partial Y_{t+j}}{\partial EPU_t^+} \text{ and } m_{h,\omega}^- = \sum_{j=0}^{h} \frac{\partial Y_{t+j}}{\partial EPU_t^-},\ h = 0, 1, 2, \dots \quad (4)$$

5. Results

In this section, we evaluate the long-term relationship between income inequality and redistribution for Scandinavian countries. As noted by Anderson et al. (2017), there is no consensus in the literature regarding the nexus between both variables. Results of the state-space model contained in Eq. (1) and Eq. (2) are presented in Table 3, where it is shown that all models firmly pass the diagnostic tests. The analysis reveals that the estimated inequality parameters are positive, with the exception of Norway for which we obtained a negative and statistically significant coefficient. This result is indicative of a mostly positive relationship between income inequality and redistribution and is in keeping with previous research by Berg et al. (2018) and Joumard et al. (2012). Fig. 2 presents the evolution of the parameter that captures the relationship between both variables over time in Iceland, for which we obtained a time-varying parameter. The graph displays a mild upward trend in the intensity of the impact of income inequality on redistribution, particularly near the endpoint of the sample and the COVID-19 crisis.

Table 3
TVP model – Share of income among top 1% holders and redistribution

	Local level	*H*	*BS*	*Q*
Denmark	0.010	0.111*	1.178	0.775
Iceland	0.015**	Time-varying	1.617	0.811
Norway	-0.006**	0.480**	2.848	1.657
Sweden	0.022**	0.151**	0.334	0.102

Notes. * (**) denotes significance at 5% (1%) level. *H, BS*, and *Q* entries are test values of the Koopman et al. (1999) heteroskedasticity test, Doornik and Hansen (1994, 2008) normality test, and the Ljung-Box autocorrelation test respectively.

Fig. 2.
Time-varying impact of inequality (top percentile) on redistribution

Note: dotted lines represent the 95% confidence interval.

We conducted a supplementary analysis in order to account for potential asymmetries in the relationship and to test for cointegration between both variables. Table 4 summarizes the NARDL cointegration test results. The preferred model specifications were chosen via a general to specific modelling strategy, and they either do not incorporate any lags of income inequality, or the chosen lags are jointly significant (see the Granger causality row). All model assumptions were clearly met and the underlying error terms can be described as a white noise process.

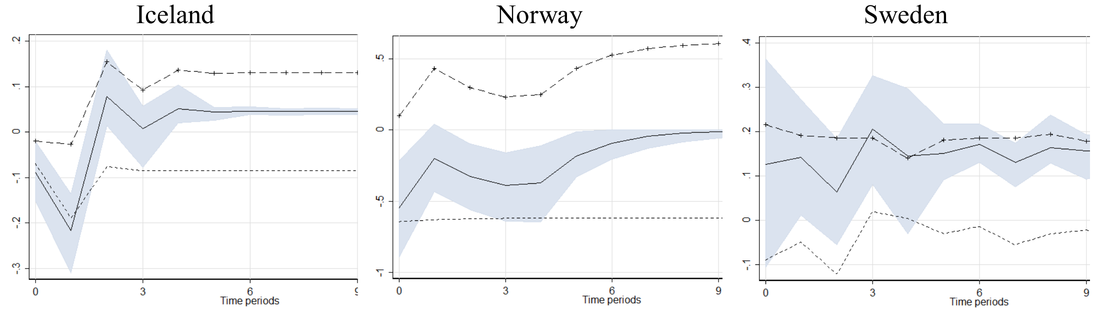
Table 4
NARDL cointegration tests – Income inequality (top percentile) and redistribution

Top percentile	Denmark	Iceland	Norway	Sweden
Asymmetry	–	SR/LR	SR	LR
$INEQ_t^+$	0.097**	0.125**	0.226**	0.093
$INEQ_t^-$	–	0.082**	–	-0.023
Causality	–	14.630**	–	–
Cointegration	7.540*	21.220**	9.200*	5.070
SW	0.975	0.260	-0.969	0.215
ARC	3.339	2.046	7.160	1.297
Q	0.918	2.938	1.057	1.226

Notes. * (**) denotes significance at 5% (1%) level. Entries in the "causality" row refer to Granger causality and are the corresponding F test statistics for the null hypothesis of all lags of economic inequality being insignificant. Entries in the "Cointegration" row are the corresponding F test statistics of the NARDL cointegration test. Narayan (2005) small sample critical values were used. SW, ARCH, and Q row entries are test values of the Shapiro-Wilks normality test, Engle's ARCH test, and the Ljung-Box autocorrelation test (respectively). Specifications with significant ARCH effects were estimated with HAC standard errors.

For all countries with the exception of Denmark, we found that the specifications exhibit some kind of asymmetry. A growth of inequality seems to impact redistribution more intensively than negative changes of inequality. This pattern is presented in a more intuitive manner in Fig. 3 by computing and displaying the evolution of the dynamic multipliers, where we can see that most specifications exhibit a somewhat stronger effect of positive shocks of inequality than negative ones.

Fig. 3.
Time-varying impact of income inequality (top percentile) on redistribution



Notes. Dashed lines represent the impact of negative changes in income inequality. Lines marked with plus signs capture the impact of positive changes in inequality. Full lines are differences between the two (asymmetry). Shaded areas correspond to 95% confidence intervals.

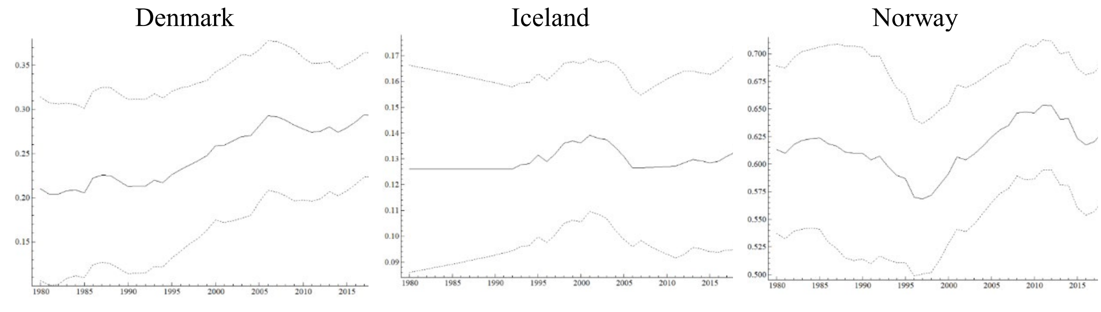
Finally, we subject our evaluation to an additional robustness check, replicating both analyses for a different measure of income inequality that considers the bottom half of the income distribution, thus making it possible to take into account to what extent redistributive policies have a concentrated impact on the middle classes (as suggested, *inter alia*, by Joumard et al., 2012), or on the contrary, they end up having a more uniform impact by being distributed more evenly among the different ranges of rent. Results of the TVP model are presented in Table 5 and Fig. 4, while the results of the NARDL analysis are presented in Table 6 and Fig. 5.

Table 5
TVP model – Income inequality (ratio top10/bottom50) and redistribution

	Local level	*H*	*BS*	*Q*
Denmark	0.146*	Time-varying	0.591	1.296
Iceland	0.058	Time-varying	0.880	1.199
Norway	-0.201	Time-varying	1.808	1.626
Sweden	0.051*	1.740**	0.454	0.992

Notes. * (**) denotes significance at 5% (1%) level. *H, BS*, and *Q* entries are test values of the Koopman et al. (1999) heteroskedasticity test, Doornik and Hansen (1994, 2008) normality test, and the Ljung-Box autocorrelation test respectively.

Fig. 4
Time-varying impact of income inequality (ratio top10/bottom50) on redistribution



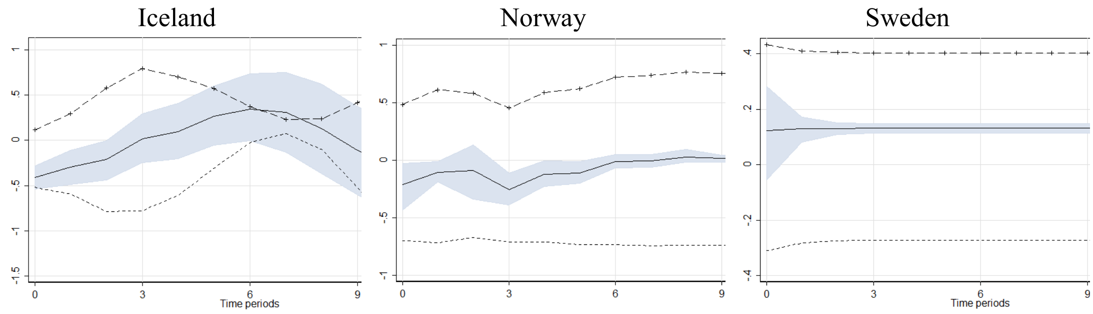
Note: dotted lines represent the 95% confidence interval.

Table 6
Income inequality (ratio top10/bottom50) and redistribution – NARDL cointegration tests

Ratio top10/bottom50	Denmark	Iceland	Norway	Sweden
Asymmetry	–	LR	SR	LR
$INEQ_t^+$	0.080	0.072	0.376**	0.274**
$INEQ_t^-$	–	0.084	–	0.182**
Causality	–	15.800**	63.170**	-
Cointegration	0.830	1.610	12.600**	6.440*
SW	0.911	1292	0.108	-0.480
ARC	9.580	3.571	6.168	6.636
Q	2.472	3.957	1.110	6.079

Notes. See Notes of Table 4.

Fig. 5
Time-varying impact of income inequality (ratio top10/bottom50) on redistribution



Notes. Dashed lines represent the impact of negative changes in income inequality. Lines marked with plus signs capture the impact of positive changes in inequality. Full lines are differences between the two (asymmetry). Shaded areas correspond to 95% confidence intervals.

The obtained results for this more aggregate measure of income inequality are similar to those obtained for top incomes. However, in the state-space analysis some differences are observed (Table 5). The first is that in this case, the coefficient obtained for Denmark is significant, indicating that the relationship between income inequality and redistribution is statistically significant at the aggregate level, but not in the case of top incomes. As it happened before in Iceland for the share of total income accruing to top percentile income holders, the estimate value of the parameter increases over time, especially towards the end of the sample period, which coincides with the pandemic. Additionally, it is also observed how the relationship between both variables in this case is time-varying for all the economies except Sweden.

In the case of the NARDL analysis, results are also very similar (Table 6). We also obtained significant evidence that redistributive measures in the form of taxes and government transfers adjust more rapidly in an upward than in a downward direction. A major exception is Norway, where the outcome of negative changes of inequality dominates. We also found a significant long-run relationship between both variables in Iceland and Sweden, while in Norway it just holds for the short run.

This cointegrating relationship between income inequality and redistribution implies that bi-directional causality between both variables. While there are previous studies where a positive association is found between higher levels of inequality in income distribution and greater redistributive efforts (Granger et al., 2022; Jestl and List, 2023; Ostry et al., 2014), the reverse causality may seem less intuitive. However, this result may be indicating that the segments of the population that benefit the most from the transfers are necessarily those with a lower level of income, but rather the middle classes. Some previous studies point to the existence of this phenomenon (Anderson et al., 2017), which highlights that in order to achieve a more equitable distribution of income, it is not enough just to increase the tax level and the magnitude of the transfers, but it is also necessary to put special emphasis on the progressivity of taxes and on the type and ultimate recipient of the transfers (Joumard et al., 2012).

Overall the results point to a mostly significant and positive impact of income inequality on redistribution. This result is in line with previous research by Berg et al. (2018), Joumard et al. (2012) and Milanovic (2000), who found that redistributive efforts tend to be greater in countries with higher income inequality. Additionally, we obtained evidence that when this nexus is time-varying, it largely exhibits a slight upward trend through time, and that there is a predominance of positive over negative shocks of income inequality on redistribution.

6. Conclusions

To this day, and since the 1980s, income inequality is continuously rising in most developed countries, especially in countries with higher per capita income. Scandinavian countries are no exception, in spite of being considered the least unequal countries in terms of income.

This paper has analysed the adjustment of government redistributive policies in Scandinavian countries following changes in income inequality over the period 1980-2021. We have used two complementary measures of inequality, in order to account for both the share of total income accruing to top percentile income holders and a more general measure computed as the ratio of the share of total income accruing to top decile income holders divided by that accumulated by the bottom 50%.

First, we have observed that, despite a growing implementation of redistributive policies, with the exception of Norway, inequality in income distribution shows a growing trajectory since the 1980s. Second, we obtained a mostly positive and time-varying relationship between income inequality and redistributive measures, save in Sweden where the relationship was found to be positive but with no temporal variation.

Finally, we have used a non-linear framework to test for the existence of asymmetries and cointegration between both income inequality and redistribution. This approach allowed us to account for the potential existence of reverse causality. We found significant evidence that redistributive measures in the form of taxes and government transfers adjust more rapidly in an upward than a downward direction, with the exception of Norway. We additionally obtained a significant long-run relationship between both variables in Iceland and Sweden, while in Norway it was only found to be significant in the short run.

This last result, which indicates the existence in some cases of bidirectional causality between income concentration and redistribution, shows that for taxes and transfers to end up having an effective role in reducing inequality in distribution of income, an adequate design of fiscal policy is fundamental, guaranteeing the progressivity of taxes and the optimal type of transfers.

The present study is not without limitations. The findings might have been influenced by several biases derived from the measurement of income inequality and redistribution. In connection with this, the aggregate nature of the data did not allow us to analyse potential discrepancies between different socioeconomic groups. In addition, given the complex interplay between the very diverse factors that affect redistribution additional potential biases may have arisen. Finally, future researchers might consider applying dynamic models and employing alternative techniques to account for the potential non-linear relationships between variables.

References

Alvaredo, F., Atkinson, A., Piketty, T., Saez, E. (2013). The top 1% in international and historical perspective. *Journal of Economic Perspectives*, 27(3), 3–20. https://doi.org/10.1257/jep.27.3.3

Anderson, E., D'Orey, M. A. J., Duvendack, M., Esposito, L. (2017). Does government spending affect income inequality? A meta-regression analysis. *Journal of Economic Surveys*, 31(4), 961–987. https://doi.org/10.1111/joes.12173

Atkinson, A. B., Leigh, A. (2013). The distribution of top incomes in five Anglo-Saxon countries over the long run. *Economic Record*, 89(S1), 31–47. https://doi.org/10.1111/1475-4932.12004

Atkinson, A., Piketty, T., Saez, E. (2011). The top 1% in international and historical perspective. *Journal of Economic Literature*, 49(1), 3–71. https://doi.org/10.1257/jep.27.3.3

Atkinson, A. B., Søgaard, J. E. (2016). The long-run history of income inequality in Denmark. *The Scandinavian Journal of Economics*, 118(2), 264–291. https://www.jstor.org/stable/45097654

Balcilar, M., Berisha, E., Gupta, R., Pierdzioch, C. (2021). Time-varying evidence of predictability of financial stress in the United States over a century: The role of inequality. *Structural Change and Economic Dynamics*, 57, 87–92. https://doi.org/10.1016/j.strueco.2021.02.002

Benabou, R. (2000). Unequal societies: income distribution and the social contract. *American Economic Review*, 90(1), 96–129. https://doi.org/10.1257/aer.90.1.96

Berg, A., Ostry, J. D., Zettelmeyer, J. (2012). What makes growth sustained? *Journal of Development Economics*, 98(2), 149–166. https://doi.org/10.1016/j.jdeveco.2011.08.002

Berg, A., Ostry, J. D., Tsangarides, C. G., Yakhshilikov, Y. (2018). Redistribution, inequality, and growth: New evidence. *Journal of Economic Growth*, 23, 259–305. https://doi.org/10.1007/s10887-017-9150-2

Björklund, A., Roine, J., Waldenström, D. (2012). Intergenerational top income mobility in Sweden: Capitalist dynasties in the land of equal opportunity? *Journal of Public Economics*, 96(5-6), 474–484. https://doi.org/10.1016/j.jpubeco.2012.02.003

Cevik, S., Correa-Caro, C. (2020). Growing (un) equal: fiscal policy and income inequality in China and BRIC+. *Journal of the Asia Pacific Economy*, 25(4), 634–653. https://doi.org/10.1080/13547860.2019.1699985

Chancel, L., Piketty, T., Saez, E., Zucman, G. (2022). *World Inequality Report 2022*. Harvard University Press. https://wir2022.wid.world/

Chudik, A., Mohaddes, K., Pesaran, M. H., Raissi, M. (2016). Long-run effects in large heterogeneous panel data models with cross-sectionally correlated errors. In: Hill, R. C., González-Rivera, G., Lee, T. H. (Eds.), *Essays in honor of Aman Ullah* (*Advances in Econometrics, Vol. 36*). Emerald Group Publishing Limited, Bingley, pp. 85–135. https://doi.org/10.1108/S0731-905320160000036013

Claveria, O., Sorić, P. (2023). Labour market uncertainty after the irruption of COVID-19. *Empirical Economics*. 64(4), 1897–1945. https://doi.org/10.1007/s00181-022-02304-7

Clementi, F., Gallegati, M., Gianmoena, L., Landini, S., Stiglitz, J. E. (2019). Mis-measurement of inequality: A critical reflection and new insights. *Journal of Economic Interaction and Coordination*, 14, 891–921. https://doi.org/10.1007/s11403-019-00257-2

Commandeur, J. J. F., Koopman, S. J. (2007). *An Introduction to State Space Time Series Analysis*. Oxford University Press, Oxford. https://doi.org/10.1017/CBO9780511617010.002

Dawson, P. J. (1997). On testing Kuznets' economic growth hypothesis. *Applied Economics Letters*, 4(7), 409–410. https://doi.org/10.1080/135048597355159
De Jong, P. (1991). The diffuse Kalman filter. *The Annals of Statistics*, 19(2), 1073–1083. https://doi.org/10.1214/aos/1176348139
De Mello, L., Tiongson, E. (2006). Income inequality and redistributive government spending. *Public Finance Review*, 34(3), 282–305. https://doi.org/10.1177/1091142105284894
Doornik, J. A., Hansen, H. (1994). An omnibus test of univariate and multivariate normality. Discussion Paper: Nuffield College, Oxford.
Doornik, J. A., Hansen, H. (2008). An omnibus test of univariate and multivariate normality. *Oxford Bulletin of Economics and Statistics*, 70(s1), 927–939. https://doi.org/10.1111/j.1468-0084.2008.00537.x
Durbin, J., Koopman, S. J. (2012). *Time Series Analysis by State Space Methods*. Oxford University Press, Oxford. https://doi.org/10.1093/acprof:oso/9780199641178.001.0001
Goulart, P., Ferrittu, G., Ramos, R. (2022). Income inequality and effectiveness in redistribution. In: P. Goulart, R. Ramos, G. Ferrittu (Eds.), *Global Labour in Distress, Volume II: Earnings, (In)decent Work and Institutions.* Springer International Publishing, pp. 13–25. https://doi.org/10.1007/978-3-030-89265-4_2
Granger, H., Abramovsky, L., Pudussery, J. (2022) Fiscal policy and income inequality: The role of taxes and social spending. ODI Report. London: ODI. http://www.odi.org/fiscal-policy-and-income-inequality-the-role-of-taxes-and-social-spending
Greenwood-Nimmo, M., Shin, Y. (2013). Taxation and the asymmetric adjustment of selected retail energy prices in the UK. *Economics Letters*, 121(3), 411–416. https://doi.org/10.1016/j.econlet.2013.09.020
Huang, H. C., Fang, W., Miller, S. M., Yeh, C. C. (2015). The effect of growth volatility on income inequality. *Economic Modelling*, 45, 212–222. https://doi.org/10.1016/j.econmod.2014.11.020
Jestl, S., List, E. (2023). Inequality, redistribution, and the financial crisis: Evidence from distributional national accounts for Austria. *The Review of Income and Wealth*, 69(1), 195–227. https://doi.org/10.1111/roiw.12589
Joumard, I., Pisu, M., Bloch, D. (2012). Tackling income inequality: The role of taxes and transfers. *OECD Journal: Economic Studies*, 2012(1), 37–70. https://doi.org/10.1787/eco_studies-2012-5k95xd6l65lt
Kwiatkowski, D., Phillips, P. C., Schmidt, P., Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root?. *Journal of Econometrics*, 54(1-3), 159–178. https://doi.org/10.1016/0304-4076(92)90104-Y
Kohlscheen, E., Lombardi, M., Zakrajšek, E. (2021). Income inequality and the depth of economic downturns. *Economics Letters*, 205, 109934. https://doi.org/10.1016/j.econlet.2021.109934Get rights and content
Koopman, S. J., Harvey, A., Doornik, J. A., Shephard, N. (1999). Structural time series analysis. Modelling, and prediction using STAMP. Timberlake Consultants Press, London.
Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, 45(1), 1–28. https://www.jstor.org/stable/1811581
Makhlouf, Y. (2023). Trends in income inequality: Evidence from developing and developed countries. *Social Indicators Research*, 165, 213–243. https://doi.org/10.1007/s11205-022-03010-8
Milanovic, B. (2000) The median-voter hypothesis, income inequality, and income redistribution: An empirical test with the required data. *European Journal of Political Economy*, 16(39, 367–410. https://doi.org/10.1016/S0176-2680(00)00014-8

Munielo-Gallo, L., Roca-Sagalés, O. (2013). Joint determinants of fiscal policy, income inequality and economic growth. *Economic Modelling*, 30, 814–824. http://dx.doi.org/10.1016/j.econmod.2012.11.009
Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics*, 37(17), 1979–1990. https://doi.org/10.1080/00036840500278103
Nolan, B., Richiardi, M. G., Valenzuela, L. (2019). The drivers of income inequality in rich countries. *Journal of Economic Surveys*, 33(4), 1285–1324. https://doi.org/10.1111/joes.12328
Ostry, J., Berg, A., Tsangarides, C. (2014). *Redistribution, inequality, and growth*. IMF Staff Discussion Note, No. 14/02. Washington: International Monetary Fund.
Pesaran, M. H., Shin, Y., Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289–326. https://doi.org/10.1002/jae.616
Piketty, T., Saez, E. (2014). Income inequality in the long run. *Science*, 344(6186), 838–843. https://doi.org/10.1126/science.1251936
Ravallion, M. (2014). Inequality in the developing world. *Science*, 344(6186), 851–855. https://doi.org/10.1126/science.1251875
Roine, J., Vlachos, J., Waldenström, D. (2009). The long-run determinants of inequality: What can we learn from top income data? *Journal of Public Economics*, 93(7-8), 974–978. https://doi.org/10.1016/j.jpubeco.2009.04.003
Roine, J., Waldenström, D. (2008). The evolution of top incomes in an egalitarian society: Sweden, 1903-2004. *Journal of Public Economics*, 92(1-2), 366–387. https://doi.org/10.1016/j.jpubeco.2007.06.012
Roine, J., Waldenström, D. (2009). Wealth concentration over the path of development: Sweden, 1873-2006. *The Scandinavian Journal of Economics*, 111(1), 151–187. https://doi.org/10.1111/j.1467-9442.2008.01558.x
Shin, Y., Yu, B., Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In: W. C. Horrace, R. C., Sickles (Eds.), *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications*. Springer Science and Business Media, New York, pp. 281–314. https://doi.org/10.1007/978-1-4899-8008-3_9
Stiglitz, J. E. (2012). *The price of inequality: How today's divided society endangers our future*. New York: W.W. Norton & Company. https://wwnorton.com/books/the-price-of-inequality/
Stiglitz, J. E. (2015). *The great divide: Unequal societies and what can we do about them*. New York: W.W. Norton. https://wwnorton.com/books/9780393352184
Tanninen, H. (1999). Income inequality, government expenditures and growth. *Applied Economics*, 31(9), 1109–1117. https://doi.org/10.1080/000368499323599
Woo, J. (2020). Inequality, redistribution and growth: New evidence on the trade-off between equality and efficiency. *Empirical Economics*, 58, 2667–2707. https://doi.org/10.1007/s00181-019-01815-0

Appendix 1. Descriptive and graphical analysis of redistribution and income in Scandinavian and Mediterranean countries

In this first appendix, we complement the graphical analysis of the data and extend it to the four main Mediterranean countries (Greece, Italy, Portugal, and Spain). In the present study, we computed two alternative measures of income inequality in order to capture different dimensions of the phenomenon. We used the pre-tax share of income accruing to top 1% income holders (INEQ_1) and the ratio between the pre-tax income accumulated by the top 10% divided by that of the bottom 50% (INEQ_2). By computing both metrics for the post-tax shares, we were able to estimate redistribution (REDI) as the proportion subtracted via taxes and transfers. Therefore, the redistributive effect of taxes and transfers was calculated as the difference between inequality in primary income and in disposable income for both measures of inequality, which are, respectively, denoted as REDI_1 and REDI_2.

In this appendix, we present the distribution of all four variables (Fig. A1.1), as well as the evolution of INEQ_1 and REDI_1 during the sample period (Fig. A1.2 and Fig. A1.3, respectively).

Fig. A1.1 shows the distribution of all four variables, both for Scandinavian and for Mediterranean countries. In the case of the former, all economies with the exception of Iceland show a quite homogeneous distribution in terms of inequality. When it comes to redistribution, and regardless of the metric used to proxy it, Norway always shows the highest average values, as opposed to Iceland. While Mediterranean countries show on average similar values of INEQ_1, average values of INEQ_2 are much higher. In the case of Spain, it shows the highest average INEQ_1 value and the lowest mean INEQ_2, indicating once again the importance of the metric used to analyse income inequality and redistribution. In redistributive terms, it is worth noting the differences between Portugal—which shows the highest average levels for the two metrics—, and Italy—which is the economy with the lowest average values in both cases.

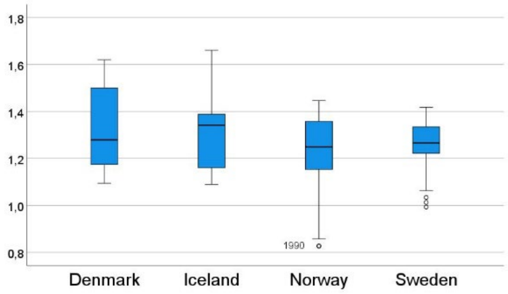
The evolution of variables INEQ_1 and REDI_1, which measure income inequality and redistribution with regards to the share of income accruing to top 1% income holders, are presented in Fig. A1.2 and Fig. A1.3, respectively. Both indicators are compared to the average INEQ_1 and the average REDI_1 in Scandinavian and in Mediterranean countries.

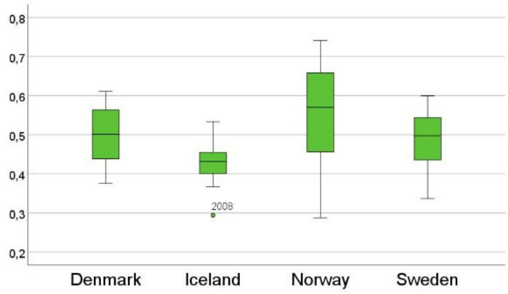
Fig. A1.1. Distribution of pre-tax income inequality and redistribution

Ratio top 10/bottom 50

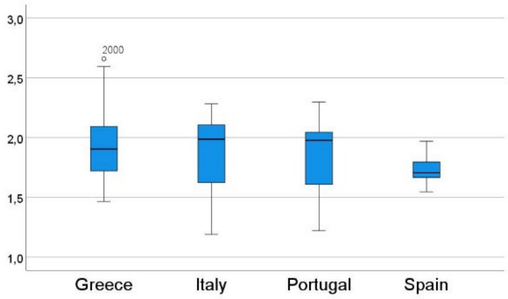
Market income inequality | Redistribution

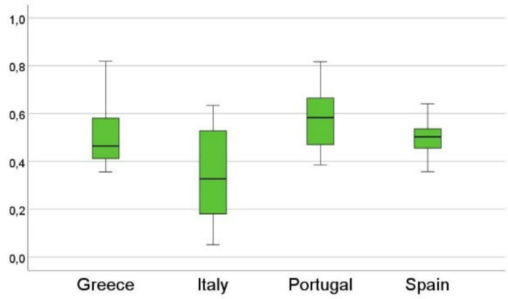
Scandinavian countries





Mediterranean countries

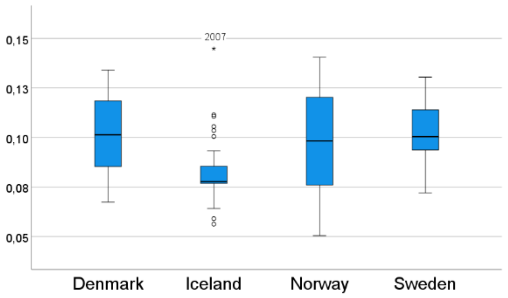


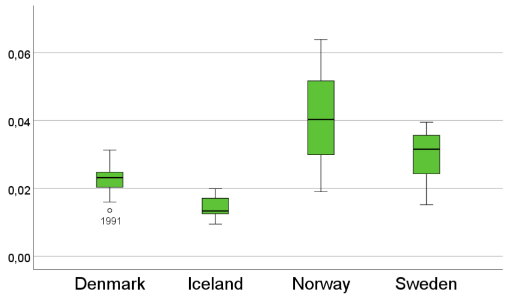


Share of income among top 1% holders

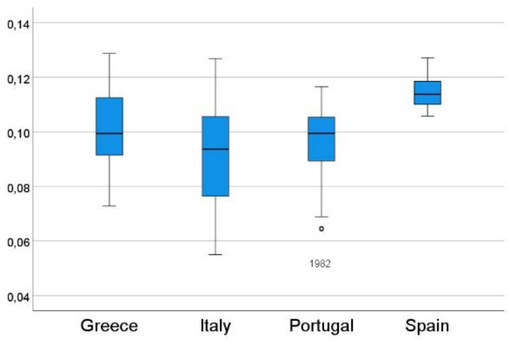
Market income inequality | Redistribution

Scandinavian countries





Mediterranean countries



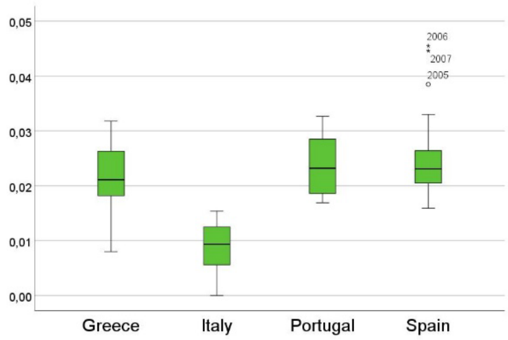
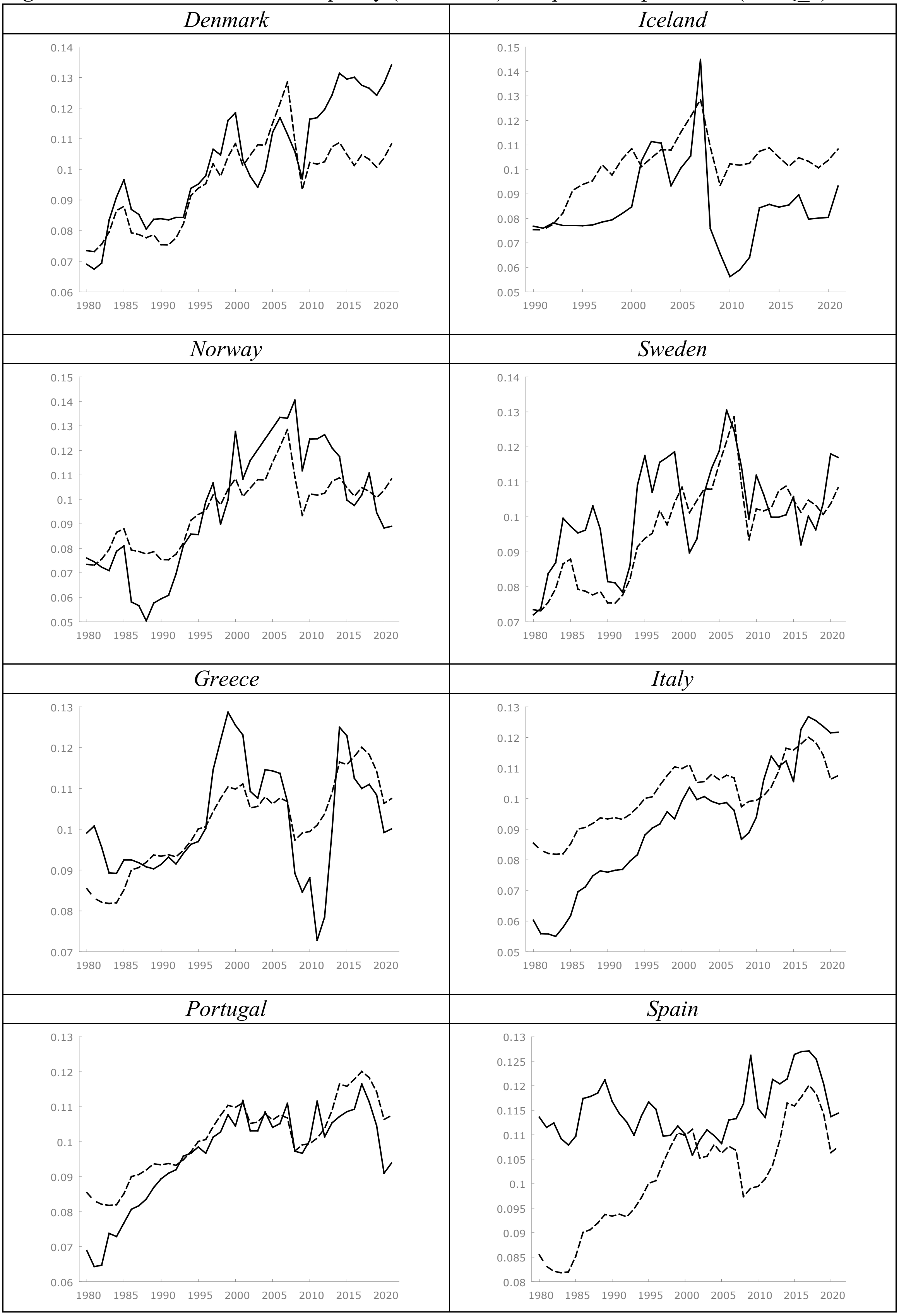
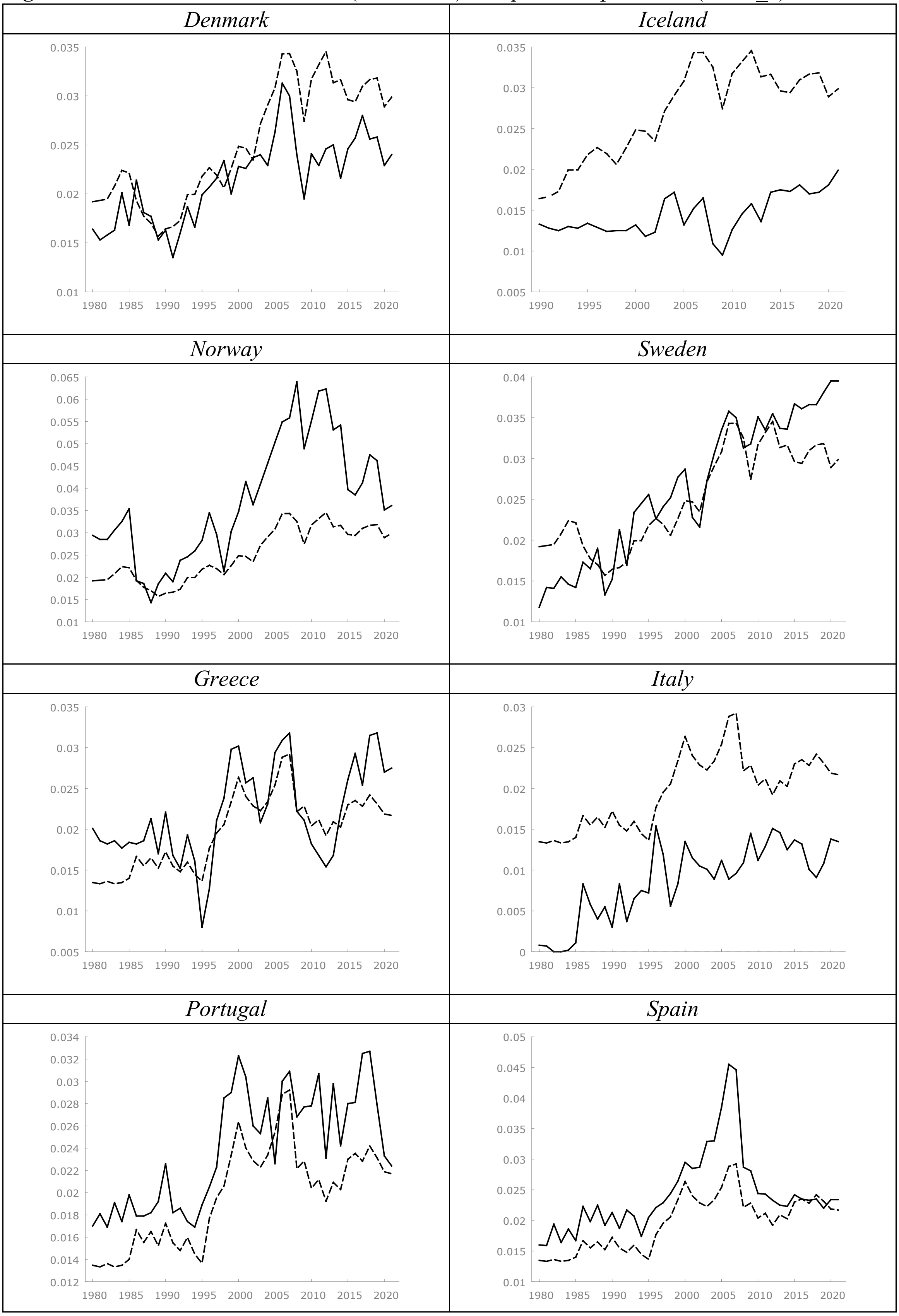


Fig. A1.2. Evolution of income inequality (1980-2021) – Top income percentile (INEQ_1)



Notes: The black line represents the evolution of INEQ_1 in each country, which refers to pre-tax share of income accruing to top 1% income holders, and the dashed black line the evolution of average INEQ_1 in Scandinavian and Mediterranean countries, respectively.

Fig. A1.3. Evolution of redistribution (1980-2021) – Top income percentile (REDI_1)



Notes: REDI_1 is calculated as the difference between inequality in primary income (INEQ_1) and in disposable income (i.e., after taxes and transfers). The black line represents the evolution of REDI_1 in each country and the dashed black line that of average REDI_1 in Scandinavian and Mediterranean countries, respectively.

Overall, we observe an abrupt change in the evolution of income inequality (INEQ_1) after the 2008 financial crisis. Fig. A1.3 presents the evolution of redistribution computed as the proportion of the pre-tax share of income accruing to top 1% income holders subtracted via taxes and transfers. Although in most of the economies analysed a fundamentally increasing trend is observed until one or two years before the 2008 financial crisis, from then on, the trend either reverses (Norway, Spain) or stabilises (Denmark, Italy, Portugal). Finally, it is worth mentioning that Norway is the country that shows the highest average redistributive effect for both metrics of income inequality.

Appendix 2. Relationship between income inequality and redistribution for the top income percentile in Mediterranean countries

As a robustness check, in this second appendix, we evaluate the time-varying dynamics and the long-term relationship between income inequality and redistribution for the share of income among top 1% holders in the main four Mediterranean countries (Greece, Italy, Portugal and Spain). Results of the state-space model contained in Eq. (1) and Eq. (2) are presented in Table A2.1, where it is shown that all models firmly pass the diagnostic tests.

The analysis for the top share of income among top 1% holders reveals that the estimated inequality parameters are positive, with the exception of Spain, for which we obtained a negative although insignificant coefficient. This result is indicative of a mostly positive relationship between income inequality and redistribution, and is in keeping with previous research by Berg et al. (2018) and Joumard et al. (2012).

Table A2.1
TVP model – Income inequality and redistribution – Top income percentile

	Local level	*Inequality coefficient*	*H*	*BS*	*Q*
Greece	0.004	0.234**	1.605	0.795	0.487
Italy	0.000	0.098	0.985	4.330	3.321
Portugal	-0.009	0.343**	1.518	1.115	5.601
Spain	0.024	-0.006	0.778	1.057	4.049

Notes: * (**) Indicates significance at 5% (1%) level. *H, BS*, and *Q* entries are test values of the Koopman et al. (1999) heteroskedasticity test, Doornik and Hansen (1994, 2008) normality test, and the Ljung-Box autocorrelation test, respectively.

We conducted a supplementary analysis in order to account for potential asymmetries in the relationship and to test for cointegration between both variables. Table A2.2 summarises the NARDL cointegration test results. Again, the optimal model specifications were chosen via a general to specific modelling strategy, and they either do not incorporate any lags of income inequality, or the chosen lags are jointly significant (see the Granger causality row). All model assumptions were clearly met and the underlying error terms can be described as a white noise process.

Table A2.2
NARDL cointegration tests – Income inequality and redistribution – Top income percentile

Mediterranean countries	Greece	Italy	Portugal	Spain
Asymmetry	-	-	SR/LR	SR/LR
$INEQ_t^+$	0.193**	0.086*	0.180**	-0.237*
$INEQ_t^-$	-	-	0.132**	-0.294*
Causality	-	-	8.310**	-
Cointegration	10.620**	6.310*	5.250	3.020
SW	0.713	1.168	0.174	2.296*
ARCH	0.630	3.936	1.504	4.927
Q	2.601	0.912	5.498	2.196

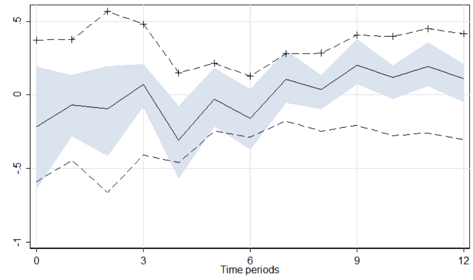
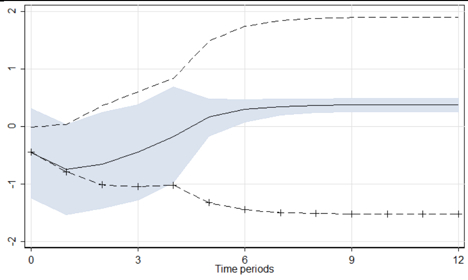
Notes: * (**) Indicates significance at 5% (1%) level. Entries in the "causality" row refer to Granger causality and are the corresponding F test statistics for the null hypothesis of all lags of inequality being insignificant. Entries in the "Cointegration" row are the corresponding F test statistics of the NARDL cointegration test. Narayan (2005) small sample critical values were used. SW, ARCH, and Q row entries are test values of the Shapiro-Wilks normality test, Engle's ARCH test, and the Ljung-Box autocorrelation test (respectively). Specifications with significant ARCH effects were estimated with HAC standard errors.

For all countries, except Spain, we obtained either short-run causality or a significant long-run relationship between income inequality and redistributive policies. Overall, we found that the specifications exhibited some kind of asymmetry, indicating that increases in inequality seem to impact redistribution more intensively than reduction in inequality.

This pattern is presented in a more intuitive manner in Fig. A2.1 by computing and displaying the evolution of the dynamic multipliers, where we can see that in most cases, shocks of inequality have a greater impact on redistribution than negative ones. The obtained results for top income percentiles are similar to the ones presented in Section 5 for the aggregate measure of income inequality (INEQ_2). Overall, we find evidence that redistributive measures in the form of taxes and government transfers adjust more rapidly in an upward than in a downward direction. However, we observe that in Italy, the outcome of negative changes of inequality dominates over the positive ones.

Fig. A2.1.

Impact of income inequality on redistribution (NARDL) – Top income percentile

Portugal	*Spain*
	

Notes: Dashed lines represent the impact of negative changes in income inequality. Lines marked with plus signs capture the impact of positive changes in inequality. Full lines are differences between the two (asymmetry). Shaded areas correspond to 95% confidence intervals.

UBIREA

Institut de Recerca en Economia Aplicada Regional i Pública
Research Institute of Applied Economics

WEBSITE: www.ub.edu/irea • **CONTACT:** irea@ub.edu

AQR

Grup de Recerca Anàlisi Quantitativa Regional
Regional Quantitative Analysis Research Group

WEBSITE: www.ub.edu/aqr/ • **CONTACT:** aqr@ub.edu

Universitat de Barcelona
Av. Diagonal, 690 • 08034 Barcelona