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ORIGINAL PAPER

Eco-welfare States and Just Transitions: A Multi-method Analysis and Research Agenda

Matt Wilder[1] · **Ruth Rosalle**[1] · **Alyssa Bishop**[1]

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Abstract

This paper critically examines the literature on eco-welfare states and just transitions, laying the groundwork for a comprehensive multi-method research agenda. Whereas previous research has found mixed evidence on the relationship between welfare states and environmental performance, this study finds synergy between welfare and environmental variables. It also offers explanations for residual variance, both between countries and within countries over time, by considering how structural and institutional features of the political economy influence policy interventions and behaviour. The main finding is that a country's level of welfare state robustness matters more for environmental performance than its trend toward welfare state entrenchment or retrenchment over time. Using a novel time-variant measure of welfare state robustness and hierarchical mixed-effects modelling, it is shown that countries with robust welfare states emit significantly less CO_2 on average than countries with weak welfare states. However, change in welfare state robustness within countries over time is not a significant predictor of emissions reductions. High level comparative case analysis of Denmark and the United Kingdom sheds explanatory light on causal mechanisms, as both jurisdictions have achieved significant CO_2 reductions despite different welfare policy profiles, structural circumstances, and institutional arrangements. Two main causal drivers are identified: compensation and executive action that imposes transition costs. Implications for governance of just transitions are discussed in the context of an empirically-oriented research agenda dedicated to assessing relationships between elements in causal chains and measuring discrete effects of policy interventions.

Keywords Climate Change · Eco-welfare States · Just Transitions · Mixed Methods · Sustainability · Welfare State Retrenchment

JEL Classification D63 · H23 · I38 · J48 · N5 · P51 · Q5

✉ Matt Wilder
matt.wilder@utoronto.ca

[1] Munk School of Global Affairs and Public Policy, University of Toronto, Toronto, Canada

Introduction

The path to net zero emissions is fraught with challenges, many of which stem from the interplay between technology and politics [1–3]. In response, analysts have urged states to absorb or otherwise manage costs associated with sustainable transitions [4–6]. Theory on eco-welfare states is arguably poised to inform just transitions policies, the unifying premise being that social insurance and redistribution complement environmental sustainability [7–9]. Disagreement exists, however, regarding the efficacy of existing welfare policies in achieving meaningful emissions reductions. Much contemporary literature on eco-welfare states argues that pro-growth consumption-oriented redistribution does little to curb emissions, and may in fact increase carbon output [10–12]. Yet, the relationship between welfare state robustness and environmental performance has not been rigorously established [13, 14].

This paper contributes to the scholarship on eco-welfare states and just transitions by employing a step-by-step mixed-method analysis that links a micro-level behavioral theory to macro-level aggregate indicators of environmental performance. We begin by reviewing the literature on eco-welfare states and just transitions. Next, we articulate an insurance-based behavioural model of preference aggregation, which we situate within an institutionalist theory of policy change. We then use factor analysis to distill indicators of welfare state generosity, union centralization, and active labour market policy into a single time-variant, country-level measure of welfare state robustness. Next, we employ hierarchical mixed-effects modelling to regress annual national CO_2 emissions on welfare state robustness in 21 countries over a thirty-year period (1990–2019). Finally, to identify and assess causal mechanisms, we examine case-level processes to explain CO_2 reductions in Denmark and the United Kingdom: two countries that have witnessed considerable ecological improvement despite differing levels and trends on our welfare state robustness variable.

The overall findings are as follows. First, countries with strong welfare regimes emit significantly less CO_2 than countries with weak welfare regimes. Second, within-country changes to welfare state robustness over time (welfare state entrenchment and retrenchment) are not significant predictors of emissions trends. These findings are sustained across models that predict consumption-based CO_2 output and environmental policy stringency, albeit with weaker effects and some notable outliers. Third, case analysis suggests that emissions reductions stem from two main causal pathways: compensation and executive action, the former of which compensates affected interests for transition costs, while the latter simply imposes transition costs. Lastly, whereas progress via compensation appears to be durable, progress via executive action may be fragile due to electoral incentives to capture votes of ‘policy losers’ by reversing course on prior commitments.

The findings have implications for just transitions policies which seek to manage technological change and related social dislocations fairly and equitably [5, 7, 14]. Although uncompensated transition costs may be justified on the basis that the right to emit is not a recognized positive freedom, the fact that some high-emitting activities are permitted (e.g., air transportation) while others are phased out raises concerns about fairness. Moreover, blue-collar workers in high-emitting industries tend to have comparatively modest incomes and therefore lower average individual emissions from consumption than white-collar professionals [15]. For the sake of both durability and fairness, policies that emphasize compensation over regulation may be preferable. However, the two pathways are not mutually exclusive. Regulatory institutions may also be designed with political insulation in mind, thus mitigating potential pathologies of executive action.

The concluding section outlines an empirically-oriented research agenda that is sensitive to multi-causality and equifinality [16]. Two general suggestions are made. One suggestion is that future research focus on empirical verification of hypothesized relationships between elements in causal sequences. The other suggestion calls for the use of quasi-experimental methods to evaluate social and environmental impacts of specific policy interventions.

Prior Theory and Evidence

Although the literature on eco-welfare states is variegated, it is united by a common thread that associates welfare state robustness with sustainable outcomes. However, debate surrounds whether eco-welfare states currently exist or whether social and institutional innovations are required to bring eco-welfare states to fruition. Whereas the 'synergy hypothesis' maintains that environmental and social welfare policies are mutually-reinforcing, critics argue that trade-offs exist between social and environmental objectives because redistribution increases consumption [14, 17, 18]. From the latter perspective, 'layering' of discrete social and environmental policies is insufficient; rather, policymakers must cultivate 'linkages' between social and environmental policies for eco-welfare states to emerge [19]. Although many commentators acknowledge that the process will be gradual, aligning social and environmental objectives is highly involved, tantamount to a 'paradigm change' [20, 21].

Empirically, the debate is far from settled. In one of the first explicit tests of the synergy hypothesis, correspondence analysis by Fritz and Koch revealed that welfare and ecological performance were not systematically correlated, as suggested by the synergy hypothesis, nor did they find environmental performance to differ significantly across different types of welfare states [18]. Yet, in a subsequent hierarchical cluster analysis, Duit found a cluster of 'established environmental states' consisting of Austria, the United Kingdom, Sweden, France, Germany, Finland, the Netherlands, and Denmark [22]. Further hierarchical cluster analysis by Zimmerman and Graziano found a narrower cluster the authors dubbed 'eco-welfare states' comprised of the Nordic European countries [23]. These findings were challenged by García-García et al., however, who instead found two Nordic clusters, both of which performed poorly on their material footprint indicator [14]. Meanwhile, Cahen-Fourot found evidence consistent with both studies, observing that the cluster representative of 'Northern-continental European Capitalism' simultaneously exhibited the highest environmental performance and the greatest tendency to relocate environmental impacts to other countries [24].

Other research has investigated the relationship between welfare state robustness and intermediate steps in the causal sequence toward sustainability. Looking at the determinants of environmental policy, Lim and Duit found that left-wing governments are more likely to expand environmental policies in countries with robust welfare states, while right-wing governments are more likely to expand environmental policy in countries with weak welfare states [25]. However, the thesis that environmental and social policies are complementary is controversial. Whereas Gough found that conventional carbon mitigation policies on their own tend to be regressive and therefore work against social welfare goals, Nelson et al. found that social policy is an effective buffer against environmental tax burdens for lower income households [14, 26]. Still, the question of whether compensation truly affects attitudes toward environmental policy is not settled. Some studies have found preferences for social and environmental policy to be substitutive, while others have found evidence of complementarity in some Continental European countries [27–29].

Structural variables also affect policy preferences, particularly economic exposure to asset stranding. Recent research has found that even knowledge-based economies may be at risk of cascading effects of capital stranding depending on how they are integrated into global value chains [30, 31]. Consequently, the economic costs of supporting environmental initiatives may be much higher than superficial appearances suggest. Although schemes have been devised to de-risk investment required for sustainable transitions, critics argue that financial concerns remain insufficiently linked with social and environmental policy, and may even contribute to social and environmental harm [32, 33].

Despite many areas of contention in the literature, there is consensus that preference formation and aggregation are mediated by political institutions [2]. In two separate studies, Jahn and Scruggs found that countries with neo-corporatist arrangements and strong social democratic parties fare better on environmental indicators than liberal pluralist countries [34, 35]. Dryzek et al. added nuance to this argument by observing that liberal pluralist systems can achieve environmental progress, despite political dissensus, if governments adopt an activist stance on environmental issues [36]. Along these lines, recent work by Jahn has found that former laggards on environmental performance (including the United Kingdom) have since joined high performing countries in Continental Europe [1]. However, progress on environmental policy is particularly vulnerable to reversal in liberal pluralist systems due to electoral swings associated with plurality rule [37].

Notably, Jahn's perspective is part of a larger body of scholarship on agenda-setting institutions which associates representative political institutions with political negotiation and positive social and environmental outcomes [38–40]. Similarly, recent case study research has identified a causal role for institutionally-embedded and professionalized environmental advocates (termed 'climate translators' by Doerr and Porsild Hansen) [9, 41, 42].

In summary, although there is debate between proponents of the synergy hypothesis and its critics, the perspectives are not necessarily mutually-exclusive [43]. For instance, Millward-Hopkins and Oswald appeal to both perspectives with their finding that conventional redistribution reduces emissions up to a point, after which additional progress requires redistribution away from household consumption toward public services [44]. An evolutionary perspective based on incremental policy change explains the emergence of a just transitions discourse within a growth-oriented paradigm, the purpose of which is to deliberately link social and environmental objectives [5, 7]. In practice, just transitions policies tend toward de-risking and compensation for asset stranding and other frictions on factor mobility created by decarbonization initiatives [45]. The following section therefore articulates an insurance-based behavioural model that features compensatory mechanisms, which we then situate within an institutional theory of collective action.

Behavioural Model and Institutional Theory

As discussed above, many studies posit that social policy can be used as insurance against risk of dislocations caused by environmental regulation [46]. The implication, long appreciated by economists in the context of moral hazard, is that insured individuals behave differently than their uninsured counterparts because the former expect to be compensated for negative consequences arising from risky behaviour [47]. Seen in a positive light, it has been argued that diffusion of risk may alter behaviour so profoundly that it makes possible societal feats that would otherwise be impossible [48]. Indeed, public absorption of transition costs may render progressive policy change politically palatable to constituents who might otherwise resist it [6,

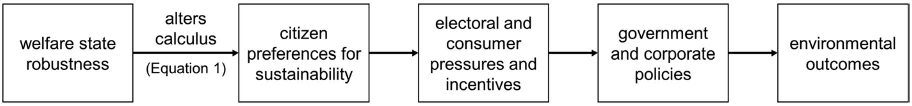

Fig. 1 Hypothesized causal pathway

14, 49]. Along these lines, it has been argued that 'socialization of risk' in the form of corporate welfare is responsible for observed incidence of innovation, even in liberal market economies, owing to its effect on the risk calculus of corporate executives [4].

From the perspective outlined above, individual preferences for sustainability may be modelled as a function of the utility an actor expects to receive from environmental protection minus uncompensated losses incurred from policy change. Consistent with the literature on expected utility from collective action, we invoke probability terms to account for risk [50]. Formally,

$$u_i(s) = \left[u_i(e)p_i(e)\right]\delta_i + u_i(c)p_i(c) - u_i(a) \tag{1}$$

where $u_i(e)p_i(e)$ is the i^{th} individual's expected utility from environmental protection (read: the individual's utility from environmental improvement multiplied by the probability assigned by the individual to environmental improvement being forthcoming), δ_i is a discount rate necessary to capture delayed utility from environmental benefits, $u_i(c)p_i(c)$ is expected utility from compensation, and $u_i(a)$ is the reservation utility from current activities (e.g., wages, profit) that will be displaced by policy change. Preferences for sustainability are assumed to obtain when expected utility from policy change is positive, i.e., when $u_i(s) > 0$.

Welfare state generosity is assumed to alter utility functions in favour of sustainability by increasing the value of $u_i(c)p_i(c)$, which is interpreted as a complement to 'post-material' incentives e and a substitute for 'material' incentives a. We hasten to note, however, that we consider the conventional material/post-material terminology to be misleading in this context, as the distinction lies in the fact that environmental incentives are time-discounted and uncertain whereas productive incentives yield immediate and certain returns.[1] With the behavioural assumptions of Eq. 1 specified, we may trace the hypothesized linkages between welfare state robustness and environmental outcomes according to the causal process outlined in Fig. 1.

At the collective level, robust welfare states are hypothesized to create constituencies in support of environmental policy. Citizen preferences do not translate directly to policy, however, but rather aggregate in different ways as determined by political institutions [36, 37, 40]. Other variables (e.g., value chain vulnerability to asset stranding) also affect switching costs at the individual and organizational level, which in turn affect the size of environmental constituencies at the collective level. Countries with sufficiently large and influential environmental constituencies are hypothesized to successfully exert political pressure to achieve lower emissions. Whether environmental constituencies are influential depends largely on political institutions, with proportional representation being generally more sensitive to environmental constituencies than plurality rule [34, 35, 40]. Other important institutions include neo-corporatist arrangements and policy networks set up by entrepreneurial 'climate translators' or entrepreneurial 'active states' who support them [36, 41, 49].

[1] Whether environmental concerns constitute materialist or post-materialist (altruistic) values depends on individual tastes. Although unimportant for our purposes, it is typically inappropriate to assume environmental values are non-material. Rather, environmental concerns are often best described as material but time discounted, hence the inclusion of the discount term in Eq. 1.

Alternative explanations floated in the literature include international agreements, EU membership, environmental threats, government ideology, political feasibility, social movements, regulatory competition, industrial composition, value chain integration, and economic contraction [20, 25, 30, 31, 34, 35, 51–53]. Insofar as behavioral hypotheses differ, it is with respect to whether transitions are negotiated or imposed by authoritative actors [36]. Of course, there may be several routes to a singular outcome (equifinality); both mechanisms may be at work in a single case [16, 54]. Moreover, because authoritative actors are typically beholden to voters, they have incentive to respond to constituent preferences [55]. Accordingly, we expect policy durability to be a function of welfare state robustness, as disaffected interests may mobilize against sustainability in the absence of compensation [3].

Although previous cluster analysis has found that citizen preferences for sustainability may be strongest in countries with the most robust welfare states, it has also been observed that environmental sustainability does not map neatly to conventional welfare state typologies [18]. These findings may stem from the fact that conventional measures of welfare state robustness do not capture the full suite of compensatory instruments available to policymakers. As a corrective, the following section uses factor analysis to devise a new measure of welfare state robustness that accounts for a broad slate of compensatory policies.

Aggregate Indicators

For our dependent variable, we collected OECD data on CO_2 emissions per capita for 21 countries from 1990–2019 [56]. To check the robustness of our findings, we also collected data on consumption-based CO_2 emissions per capita from the Global Carbon Project [57]. We chose CO_2 emissions per capita over more general measures of environmental protection since the former is non-ambiguous and less affected by local idiosyncrasies (e.g., vulnerability of biodiversity).

For our independent variable, we operationalized a measure of welfare state robustness according to the following procedure. We began by running exploratory factor analysis on variables contained in the Comparative Welfare States Dataset to confirm a positive relationship between the many manifest variables contained therein and a limited set of latent variables representative of welfare state robustness [58].[2] We then conducted confirmatory factor analysis and found excellent model fit and strong loadings for a four-factor model with a single latent variable. As depicted in Fig. 2, manifest variables include unemployment benefits, sickness benefits, union centralization, and active labour market policy. Per the intuition

[2] Although the Comparative Welfare States dataset includes a variable for welfare state generosity (*gen*), it is an additive function of pension, sickness and unemployment benefits that do not load on a single latent dimension, which raises doubts about empirical validity [58]. Our initial (exploratory) factor analysis included the following variables, all of which are positively correlated: public and mandatory private expenditure on active labour market policy (*almp_pmp*), sickness benefits (*sickgen*), unemployment benefits (*uegen*), pension benefits (*pengen*), works council status (*wc*), works council structure (*wc_struct*), works council rights (*wc_rights*), works council involvement in wage negotiations (*wc_negot*), union density (*ud*), union centralization (*unioncent*) and wage coordination (*wcoord*), with series updated to 2019 using OECD ICTWSS data [58, 59]. As shown in the online replication code, we omitted variables pertaining to work councils because they are highly correlated with one another other and union centralization, resulting in overfitting. Pension generosity and union density did not load well, and the latter had many missing values. To test for whether non-stationarity and parameter instability results in biased loadings, we fit discrete models at ten-year intervals over the time period and found consistent loadings. We therefore leave the question of whether loadings are robust to more complex dynamic factor models to future research.

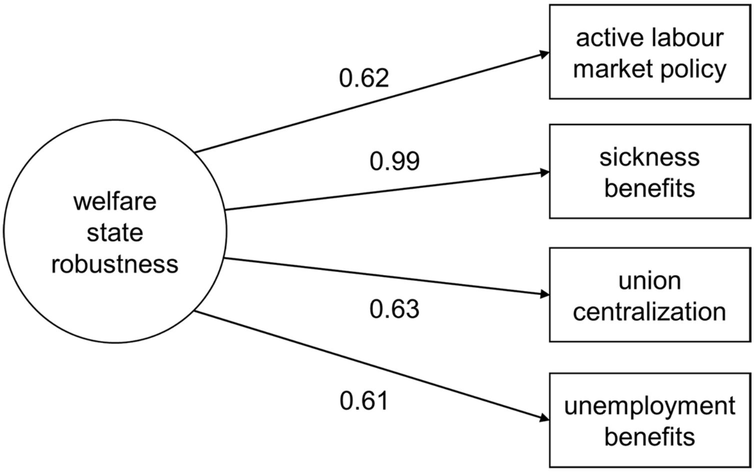

Fig. 2 Factor loadings on latent measure of welfare state robustness. Source: Comparative Welfare States Dataset variables *almp_pmp* (i.e., public and mandatory private expenditure on active labour market policy as a percentage of GDP), *sickgen*, *uegen*, *unioncent* updated to 2019 based on OECD ICTWSS data [58, 59]. Standardized loadings reported. Tucker-Lewis Index (TLI) goodness of fit statistic: 1. Root mean squared error of approximation (RMSEA) badness of fit statistic: 0

of factor analysis, these manifest variables are assumed to be caused by the latent variable, which we interpret as a measure of a country's level of welfare state robustness.

Substantively, sickness benefits compensate workers to the extent that benefits are universal (i.e., not tied to employment). In countries where sickness benefits are disproportionately tied to employment (as has historically been the case in the United States), workers are expected to be more reluctant to support sustainability initiatives that are occupationally threatening than workers in countries where benefits are universal and generous. Similar logic applies to unemployment benefits: workers are expected to put up less resistance to job losses where benefits are generous and universal [48]. Union centralization facilitates labour-government negotiations, fosters solidarity, and increases the ability of unions to anticipate the future [60]. Finally, active labour market policy compensates displaced workers through retraining and job placement programs.

Figure 3 reports descriptive statistics for CO_2 emissions and welfare state robustness from 1990 to 2019 for twenty-one OECD countries. Notably, some countries have witnessed increases in welfare state robustness over time (welfare state entrenchment) while others have experienced decreases (welfare state retrenchment) [61]. Regarding CO_2 output, although some countries saw increased emissions per capita in the 1990s, all countries have since witnessed reductions, albeit to different degrees.

Although illuminating, the trends reported in Fig. 3 provide few clues about whether welfare state robustness significantly affects emissions. The next section assesses the statistical relationship between welfare state robustness and CO_2 emissions, both between countries and within countries over time, controlling for environmental regulation, post-materialist values, EU membership, international agreements, economic growth, political institutions, value chain integration, and government expenditure on research and development.

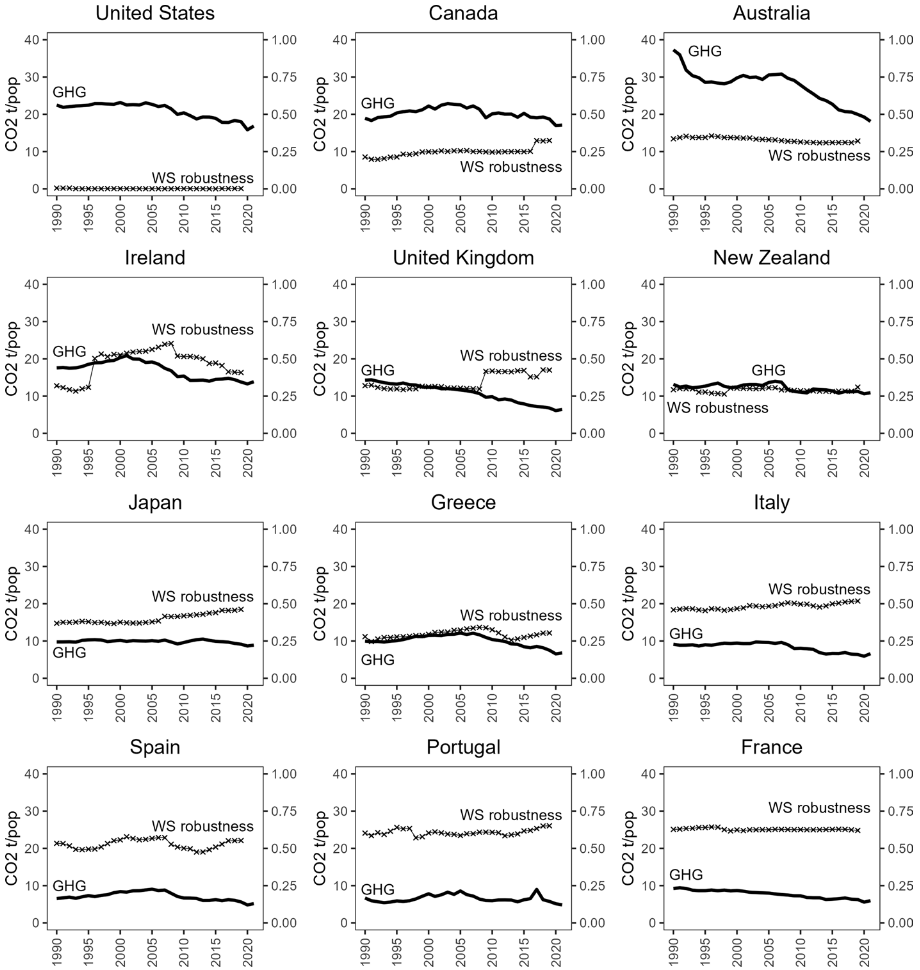

Fig. 3 CO_2 emissions and welfare state robustness by country, 1990–2019. GHG series refers to annual CO_2 tons per capita, including land use, land use change and forestry (LULUCF) [56]. The WS robustness series was generated via factor analysis from Comparative Welfare States Dataset variables *almp_pmp, unioncent, uegen, sickgen* updated to 2019 based on OECD ICTWSS data [58, 59]

Hierarchical Mixed-effects

For our quantitative analysis, we opt for regression over alternative methods because regression is relatively straightforward and, when combined with graphical representation, more easily scrutinized via mixed-method analysis of predicted and outlying cases [62]. To mitigate against implicit biases of the model, we include robustness checks in the appendix that regress consumption-based emissions and environmental policy stringency on welfare state robustness and control variables, the results of which are discussed below [57, 63].

Hierarchical mixed-effects modelling is appropriate for our purposes given that we are interested in the determinants of CO_2 emissions both between and within countries. At the first level, between-effects estimation permits comparisons across countries based on group

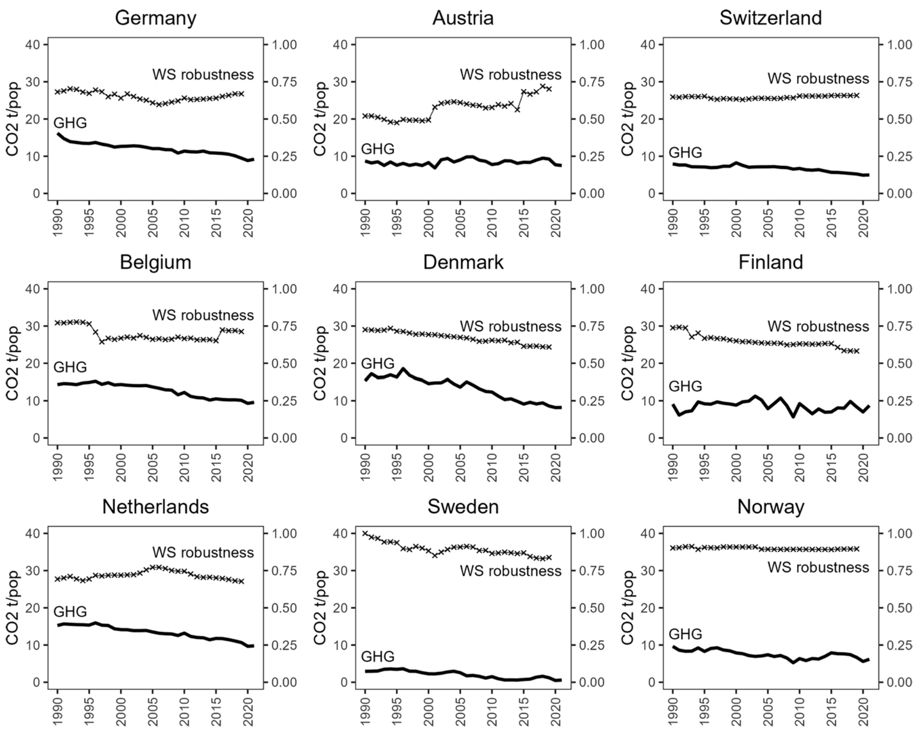

Fig. 3 (continued)

averages (i.e., country means). At the second level, random-effects estimation permits within-country comparisons based on unique intercepts and slopes for each country. Random effects estimation is useful for evaluating whether welfare state entrenchment leads to more substantial CO_2 reductions than retrenchment [61, 64].

Figure 4 conveys the logic of hierarchical mixed-effects in the context of the bivariate relationship between welfare state robustness and CO_2 emissions per capita. The between-effects estimator is represented by the long grey regression line, while the random effects estimator is generated from the manifold colored, country-specific regression lines. The bivariate relationship suggests a strong negative between-country effect that is consistent with our hypothesis, while the varying slopes at the within-country level cast doubt over whether welfare state entrenchment systematically affects CO_2 output.

The intercept values reported in Table 1 represent estimated annual CO_2 tons per capita when variables are at their zero values. Coefficients represent estimated change in annual CO_2 tons per capita for each one unit increase on the respective variable. Because welfare state robustness ranges from 0 to 1, its coefficient represents the estimated difference in emissions between the lowest and highest values for welfare state robustness in the sample. Model 1 reports the bivariate relationship between welfare robustness and CO_2 emissions represented by the grey line in Fig. 4. Model 1 estimates a difference of 16.71 CO_2 tons per capita between the least and most robust welfare state.

Model 2 reports the bivariate between-effects relationship between environmental policy stringency (abbreviated 'regulation') and CO_2 emissions per capita [63]. Model 3 reports the bivariate relationship between post-materialist values and CO_2 emissions [65]. Model 4 reports

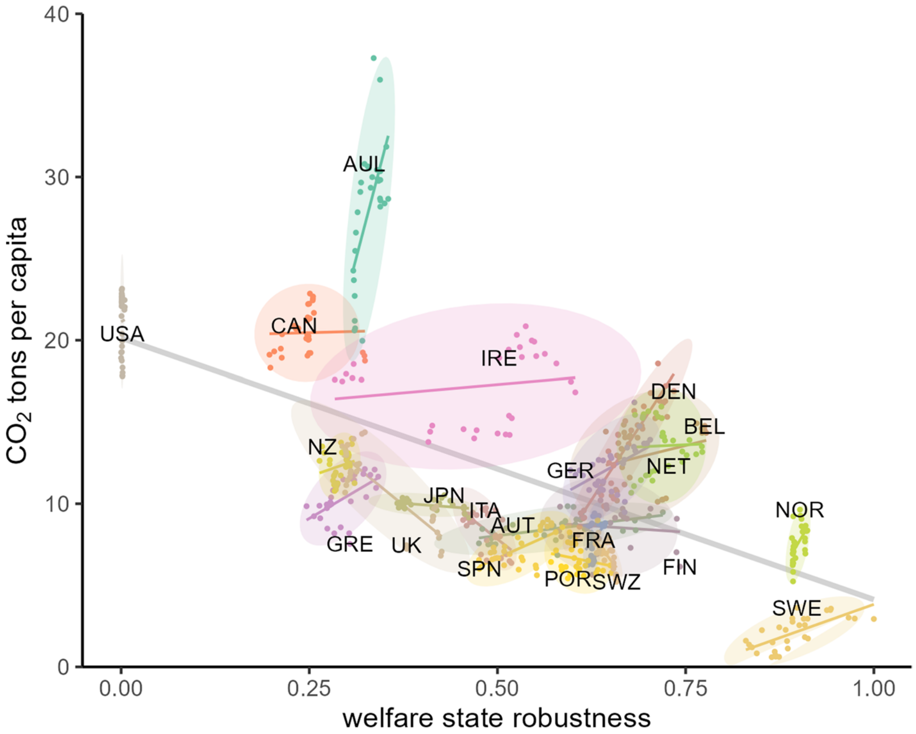

Fig. 4 Relationship between welfare state robustness and CO_2 emissions. CO_2 tons per capita including land use, land use change and forestry (LULUCF) [56]. Welfare state robustness variable generated by factor analysis from Comparative Welfare States Dataset variables *almp_pmp, unioncent, uegen, sickgen* updated to 2019 based on OECD ICTWSS data [58, 59]. AUL = Australia; AUT = Austria; BEL = Belgium; CAN = Canada; DEN = Denmark; FIN = Finland; FRA = France; GER = Germany; GRE = Greece; ITA = Italy; IRE = Ireland; JPN = Japan; NET = Netherlands; NOR = Norway; NZ = New Zealand; POR = Portugal; SPN = Spain; SWE = Sweden; SWZ = Switzerland; UK = United Kingdom; USA = United States

a full between-effects model with all controls. Because the between effects models are estimated from a relatively low number of group means ($n = 21$), we include an alternative, non-heteroskedastic 'pooled' model generated from $N = 50$ random draws from the full $N = 630$ panel, which was necessary to avoid bias due to autocorrelation.[3] The baseline random effects column reports the panel average CO_2 output (11.15 tons per capita). Model 5 reports the bivariate random-effects relationship between welfare state robustness and CO_2 emissions per capita. Model 6 reports the same for environmental policy stringency (regulation). Model 7 reports the bivariate random-effects relationship between CO_2 emissions and post materialist values. Model 8 reports the full random effects model with all controls.

The output for between effects in Table 1 indicates that welfare state robustness has a significant negative impact on emissions when comparing across countries. As reported in the appendix, this finding is robust to consumption-based CO_2 emissions, albeit with weaker effects. Although model 2 reports a significant bivariate effect for regulation, this

[3] To assess the robustness of our pooled coefficient, we generated 10,000 random samples of $N = 50$ from the full panel and calculated an average coefficient of –15.88 for welfare state robustness.

Table 1 Hierarchical mixed-effects results, CO_2 emissions per capita

	Between-effects					Random-effects				
	Model 1	Model 2	Model 3	Model 4	Pooled	Baseline	Model 5	Model 6	Model 7	Model 8
(intercept)	20.50*** (2.72)	21.77*** (4.53)	7.66 (4.92)	6.80 (5.71)	14.66*** (3.08)	11.15*** (1.13)	7.85** (3.49)	13.16*** (1.37)	12.12*** (1.63)	11.84*** (2.12)
Welfare state robustness	–16.71*** (4.80)	-	-	–26.55*** (6.36)	–16.68*** (3.04)	-	3.26 (6.04)	-	-	3.77 (3.23)
Regulation	-	–23.50** (10.25)	-	–1.53 (10.36)	–4.52 (6.49)	-	-	–5.18*** (0.94)	-	–2.25*** (0.37)
Post-materialist values	-	-	7.27 (8.46)	3.18 (5.48)	5.46* (2.74)	-	-	-	–1.09 (2.46)	–0.20 (1.52)
Kyoto	-	-	-	15.31* (7.42)	1.35 (3.20)	-	-	-	-	–0.18 (0.12)
EU membership	-	-	-	–5.10 (2.63)	–3.39* (1.94)	-	-	-	-	0.20 (0.27)
Growth	-	-	-	1.98* (0.95)	0.59** (0.23)	-	-	-	-	0.03** (0.01)
Veto players	-	-	-	16.91** (7.10)	8.62** (3.60)	-	-	-	-	–3.25* (1.77)
Global value chain participation	-	-	-	7.86 (7.10)	–1.91 (4.38)	-	-	-	-	–2.91*** (0.61)
Government R&D	-	-	-	0.46 (1.63)	0.69 (1.32)	-	-	-	-	–0.01 (0.12)
Adjusted R^2	0.36	0.18	0	0.63	0.68	ICC 0.92				
N	630	630	630	630	50	ΔR^2	0.34	0.57	0.29	0.74
Periods t	30	30	30	30	1–6	N 630	630	630	630	630
Groups n	21	21	21	21	21	n 21	21	21	21	21

ICC = intra-class correlation coefficient. Standard errors in parentheses (heteroskedasticity and autocorrelation corrected standard errors in pooled and random effects models). Approximate p-values reported for random effects based on Wald statistic (z-values). Pooled model Lagrange multiplier test for autocorrelation insignificant at p=0.38. Kyoto, EU membership, growth, regulation, global value chain participation, and government R&D included only as fixed effects in model 8; all other variables computed as random and fixed effects. CO_2 tons per capita including land use, land use change and forestry (LULUCF) [56]. Welfare state robustness variable generated by factor analysis from Comparative Welfare States Dataset variables *almp_pmp, unioncent, uegen, sickgen* updated to 2019 based on OECD ICTWSS data [58, 59]. Regulation = rescaled index based on OECD Environmental Policy Stringency scores [63]. Kyoto = 1 for parties to the Doha Amendment after 2015, 0 otherwise. EU membership = 1 for EU countries, 0 otherwise. Post-materialist values = index generated from average weighted country-wave responses to 3-point question in Integrated Values Surveys with interpolated values between survey years [65]. Growth = growth rate (output approach in percent) [66]. Veto players = Political Constraints Dataset variable *polconiii* with imputed values for 2017–2019 [67]. Global value chain participation = index that combines foreign and domestic value added embodied in exports [68]. Government R&D = government expenditure on research and development related to environment, energy and industrial processes as percentage of GDP [69].

$*p<0.10$, $**p<0.05$, $***p<0.01$

effect is entirely confounded by the correlation between welfare state robustness and regulation, as evidenced by the output for model 4 and the pooled model. Separate analysis reported in the appendix of the relationship between welfare state robustness and regulation supports the conclusion that welfare state robustness is associated with more stringent environmental policy at the between-country level. As indicated by models 3 and 7, post-materialist values explain virtually none of the variance on the dependent variable.[4]

As shown by the random-effects output in Table 1, increased welfare state robustness within countries (welfare state entrenchment) is not a significant predictor of per capita CO_2 emissions, while regulation is. Model 6 estimates a decrease of 2.25 CO_2 tons per capita for each one unit increase in regulation, which we have converted to an index that ranges from 0 to 1. However, the intra-class correlation coefficient (ICC) indicates that 92% of the variance is attributable to group differences (i.e., between-effects).

Regarding the effect of control variables, significant between-effects include EU membership, growth, and veto players. The coefficient on growth estimates change in CO_2 output per one percentage point increase in GDP. Veto players measure 'political constraints' that capture institutional features related to both 'cooperative veto points' (e.g., neo-corporatism) and 'competitive veto points' that make policy change more difficult to achieve [36, 38, 49, 67]. The veto players variable is indexed to a range between 0 and 1. Veto players have a strong positive effect on emissions at the between-country level, but a weak negative effect at the within-country level (as well as a null within-country effect on consumption-based emissions reported in the appendix).[5]

Regulation and global value chain participation are the only variables with significant within-country coefficients in both Table 1 and the consumption-based CO_2 model reported in the appendix. Global value chain participation controls for the structure of the economy by combining foreign and domestic value added embodied in exports, which we have converted to an index that ranges from 0 to 1 [68]. Model 8 estimates that, within a country, a one unit increase in value chain participation is associated with a reduction of 2.91 tons in CO_2 emissions per capita. The finding indicates that countries emit less as they become more integrated into global value chains, which suggests trends toward specialization in less carbon intensive stages of production.

The quantitative results support the hypothesis that welfare state robustness is the most significant predictor of differences in CO_2 emissions between countries. However, welfare state entrenchment within countries does not lead to significantly lower emissions, whereas more stringent environmental regulation does. Notably, the quantitative analyses reported in Table 1 and the appendix suggest that welfare state robustness is the primary cause of both environmental policy stringency and reduced emissions, insofar as between-country comparisons are concerned. This finding is consistent with our theory, but is only evident at the between-country level. At the within-country level, emissions reductions are attributable to increased regulation and global value chain participation. Moreover, post-materialist values do not account for emission output at either the between-country or within-country level. A possible explanation is that high emissions (and perhaps the material benefits therefrom) inspire post-materialist values among some survey respondents, leading to a null relationship between post-materialist values and emissions when the former are aggregated to country scores.

[4] The post-materialist values variable is based on country averages to survey responses on a three-point scale, whereby 1 represents 'materialist' and 3 represents 'post-materialist.' Germany 2017–20 scores highest at 2.32, while Australia 2010–14 scores lowest at 1.63 [65].

[5] Although not reported, bivariate analysis of the relationship between veto players and CO_2 emissions at the between-country level also returns a null result.

Another notable between-country finding is that political veto players are associated with higher emissions when controlling for welfare state robustness. One possible explanation is that union centralization and active labour market policy (as factors underlying welfare state robustness) control for neo-corporatist arrangements, leaving the variance associated with protectionist institutions to be explained by the veto players variable. In other words, welfare state robustness captures negotiated compensation associated with 'cooperative veto points' but not protectionist tendencies associated with 'competitive veto points' [38, 49]. The effect is present only at the between-country level, however.

EU membership is also found to be significant predictor of reduced emissions between countries according to the pooled model, corresponding with a reduction of 3.4 tons of total CO_2 per capita. Being a signatory to the Kyoto protocol does not appear to influence emissions, nor does government R&D related to environment, energy, and industrial processes.

Comparison with consumption-based CO_2 emissions reported in the appendix reveals similar results to Table 1, but with weaker effects. Switzerland and Belgium are notable outliers given their high consumption-based emissions. These findings lend support to the argument that robust welfare states are not immune from relocating environmental impacts from consumption to other countries [14, 24].

Although statistical results are informative, case analysis is needed to shed explanatory light on variance unexplained by our models. Conventional practice in mixed-methods research is to investigate cases both 'on' and 'off' the regression line to assess the operation of hypothesized causal mechanisms [62]. It is also best practice to 'cast the net broadly for alternative explanations' when conducting case research [54]. As discussed in Section 2, structural and institutional factors may influence the causal process outlined in Fig. 1 by determining the size and political influence of environmental constituencies. It is appropriate to study cases that differ on these variables to glean how structural and institutional variables interact with welfare state robustness to influence environmental outcomes. To avoid selecting on the dependent variable, we chose two countries that have achieved significant emissions reductions despite differing welfare state profiles: Denmark and the United Kingdom.

Case Studies

This section provides high level summaries of the causal processes that led to emissions reductions in Demark and the United Kingdom. A more fulsome mixed-method research agenda is outlined in the final section of the paper. Per the logic of mixed-method analysis, the objective is to confirm the operation of the hypothesized causal mechanism articulated in Fig. 1: that welfare state policies foster constituencies in favour of sustainability whose preferences interact with political institutions to influence environmental policy and environmental outcomes.

According to the quantitative data, Denmark had unusually high CO_2 emissions for its level of welfare state robustness at the beginning of the period, but drastically reduced its emissions over time. With reference to the scatterplot in Fig. 4, Denmark moved from a position 'off the line' to a position 'on the line.' The inverse occurred in the United Kingdom. The UK started off with relatively high CO_2 emissions, as predicted based on its relatively meager welfare state, then proceeded to reduce emissions to an extent not predicted by the statistical model. The UK moved from a position 'on the line' to a position 'off the line.' Notably, as shown in Fig. 3, Denmark underwent welfare state retrenchment over the study period, while the UK experienced welfare state entrenchment.

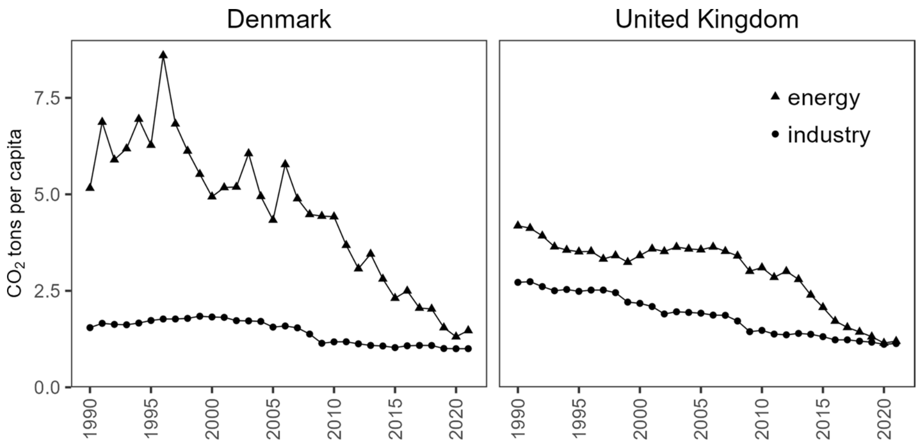

Fig. 5 CO_2 emissions by source in Denmark and the United Kingdom, 1990–2021. Source: OECD Stat [56]. Energy series based on '1A1 energy industries'; industry series based on '1A2 manufacturing industries and construction' and '2 industrial production and product use'

More granular quantitative data may assist in discerning the source of emissions reductions. Figure 5 displays CO_2 emissions for each country by source. These statistics indicate that both countries made substantial progress in the energy sector, while the UK also reduced emissions from industry. For its part, industrial emissions in Denmark were always comparatively low. Of course, the quantitative data do not provide any information about *how* these countries reduced emissions. For that, case study analysis of causal mechanisms is required.

Denmark

Compared to many other industrialized countries, Denmark was historically poor in terms of accessible fossil fuel deposits. In the wake of the 1973 oil crisis, Denmark's apparent energy insecurity became the impetus for both offshore oil drilling in the North Sea and aggressive investment in wind power. Yet, Denmark remained dependent on imported fossil fuels for heat, electricity, and transport until the late 1990s, and imported coal continues to be part of Denmark's energy mix. Given that investment in wind power would take decades to pay dividends, political institutions that facilitate multi-partisan agreements were crucial for sustaining political commitment to creating comparative advantage in renewables [70]. To that end, Denmark's proportional representation system has produced a durable multi-party coalition committed to renewable energy.

Although unions were active supporters of green growth in the 1990s, Danish corporatism has since been criticized for excluding unions in the policymaking process [71, 72]. Instead, Danish energy policy is based predominantly on feed-in tariff subsidies and carbon taxes negotiated with considerable input from industry, revenues from which are channeled into incentives for further sustainable development and retraining in low-emitting occupations [73]. Although lamented in some quarters for promoting 'workfare' over welfare (and therefore welfare state retrenchment), the Danish 'flexicurity model' boasts an impressive record of labour market activation, a low Gini coefficient and high average income [74].

As shown in Fig. 5, Danish industry has few significant emitters. Rather, it is dominated by major wind energy manufacturers, such as Vestas and its suppliers. Notably, industry associations were not always supportive of carbon taxes, as evidenced by opposition on the part of Dansk Industri to the 1995 carbon tax. Arguably, a tipping point was reached at which most influential Danish companies stood to benefit from the country's green growth trajectory. Moreover, although carbon taxes and above-average electricity rates have been found to be regressive for both households and small businesses in Denmark, public opinion data indicate that Denmark's environmental constituency is the largest of any EU country [75, 76].

On the previous point, politically-influential agricultural interests have benefitted from investment in wind energy, as many farmers own turbines and are organized into wind cooperatives. Moreover, Danish agricultural interests have hitherto faced few policies targeting agricultural emissions, which now outrank emissions from energy and industry [56]. Yet, for the time being, emphasis appears to be on limiting emissions from transportation and residential heating via gasoline taxes, electrification, bicycle infrastructure, and district heating.

The case evidence adds nuance to our understanding of the processes by which CO_2 reductions may be achieved. Specifically, neo-corporatist systems of interest intermediation may take many forms that differentially privilege labour and business. While it is true that Denmark's flexicurity regime has been instrumental for redeploying labour across sectors of the economy, corporate welfare has arguably played an even larger role in Denmark's green energy revolution. Political institutions have also facilitated the energy transition, namely the system of proportional representation and coalition government, which necessitates cooperation across partisan lines. Although regressive carbon taxes and high electricity prices impose costs on households and businesses, policy losers stand little chance of reversing policy given the size of the environmental constituency and the political foothold enjoyed by the green growth coalition. While Denmark is vulnerable to environmental risks associated with sea rise, and although Danes report higher than average concern for the environment, the explanation appears to be primarily strategic. It made economic sense for the Denmark to promote itself as a model of sustainable growth—not least because it has helped position Vestas as a major exporter of wind turbines for the world market.

United Kingdom

The UK is the mirror image of Denmark in the sense that the UK is a modest but entrenching welfare state that has historically benefited from ample deposits of fossil fuels. As shown in Fig. 5, progress is largely attributable to industrial restructuring. Specifically, emissions reductions have followed from restructuring in five high-emitting industries: coal, petroleum refining, chemicals, steel, and cement.

The decline of the domestic coal industry and concomitant phase-out of coal-fired electricity generation has been particularly significant, as other high-emitting industries historically depended on coal as a low-cost input to remain competitive. According to Glyn and Machin, the UK coal industry experienced 'a rate of decline that is probably unparalleled in any major industry in any advanced capitalist country' [77]. While industrial adjustment in the UK can be attributed to lack of competitiveness, political and policy-related questions remain as to how closures occurred at the rate they did. Indeed, other jurisdictions sustained domestic coal output, even in the face of low-productivity, through the use of government subsidies [78]. How did the UK manage the transition?

Our theory on eco-welfare states posits that restructuring towards a low-carbon economy follows from policies that mitigate the sting of adjustment. Several such policies can be identified in the UK, which correspond to increases on the welfare state robustness measure in Fig. 3. However, as to whether compensatory policies were responsible for emissions reductions, it must be emphasized that industrial decline was catalyzed foremost by policies that created painful dislocations: the privatization of state-owned enterprises following election of the Thatcher Conservatives in 1979 [79].

Nevertheless, government did implement active labour market policy during the Conservative long reign (1979–1997). Examples include the Job and Career Change Scheme (1985–1995) and green jobs training through the Energy Action Grants Agency (1990–2011). Following the 1997 election of the Blair Labour government, 'new deal' policies promoted human capital development for purposes of transitioning to a low-carbon 'knowledge-driven economy' [80, 81]. Incidentally, high-emitting industries were concentrated in poorer regions with comparatively few alternative options for employment. Labour's 'welfare to work' policy therefore gave unemployment insurance recipients the option of free full-time education or working for an environmental task force when no other suitable opportunities could be found [82]. In 1999, the Department of Communities and Local Government also established the Coalfields Regeneration Trust, which continues to fund social and economic development in former coal communities.

Active labour market policy notwithstanding, Labour's 'green levy' on business is widely regarded as the primary policy instrument responsible for curbing industrial emissions at the turn of the millennium [83]. Premised on the 'polluter pays' principle, the levy combined environmental impact audits with an emissions tax, whereby revenues were used to finance reductions to employers' national insurance contributions so that major employers were less affected than high-emitting capital-intensive firms [80]. Although concerns over urban air quality induced widespread public support for the green levy, it is noteworthy that steel and chemical lobbies successfully mobilized to scale back the levy on the basis that it would move jobs overseas [84].

Regarding effects of policy on employment by industry, Fig. 6 indicates that the coal and cement industries in the UK have been almost entirely wiped out, while the chemical, steel and petroleum refining industries consolidated around 2010 and have remained stable since. The rightmost panel in Fig. 6 also shows that diminished employment in conventional industry has been somewhat offset by increased employment in knowledge-based services. Yet, to the extent that policy succeeded in accommodating displaced workers, evaluations are mixed. Although retraining funneled many displaced workers into new career paths, the fact that many ultimately found themselves in minimum wage occupations or on permanent disability has led commentators to conclude that a gulf exists between the rhetoric and reality of 'life-long learning' in the UK [81].

In terms of explanation, on one hand, emissions reductions in the UK are attributable to political institutions that permit the executive to impose costly policies with minimal interference from affected interests [37, 40]. Specifically, executive dominance in the British political system allowed government to impose the green levy on business, privatize industries, and acquiesce to closures which displaced workers. On the other hand, because the executive is beholden to electoral pluralities at the district level, it has incentive to enact moderate policies to maximize vote share [55]. Political incentives may therefore explain why Conservative and Labour governments offered (counter-intuitive) concessions to workers and businesses in the form of retraining schemes and revisions to the green levy. By the same token, the moderate effect of eco-welfare policy observed at the aggregate level in the UK can be attributed to the declining share of blue-collar voters vis-à-vis white-collar voters in 'knowledge-based' sectors [60].

Although the transition to a low-emission economy in the UK may have been facilitated by compensatory policies (including corporate welfare), it was also motivated by environmental risks (i.e., air quality) and accomplished via the imposition of costs that were not fully compensated. However, political alienation that stoked the Brexit movement has not yet prompted

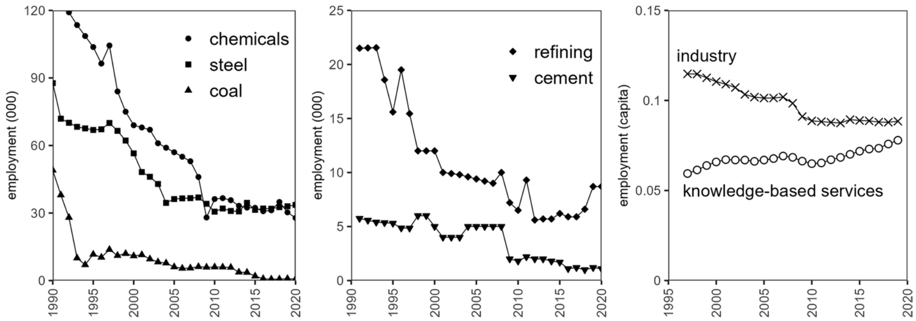

Fig. 6 Employment in the United Kingdom over time. Source: UK and OECD statistics [85–87].'Knowledge-based services' is an aggregate of three service sub-sectors: information and communication; financial and insurance activities; and professional, scientific, and technical activities

major policy reversal on climate change mitigation in the UK. The story contrasts with developments in other jurisdictions, where carbon taxes and support for renewable energy have been resisted and reversed by conservative governments that have galvanized political support of alienated constituents [27]. Rather, public opinion data from the UK indicate that the domestic environmental constituency has grown substantially in recent years [88]. Yet, the environmental constituency in the UK remains smaller and more fragile than its Danish counterpart, with most Britons surveyed prioritizing economic concerns over environmental ones [75]. While public opinion data are consistent with the theory that imposition of transition costs on the part of 'active states' may substitute for the compensatory mechanism outlined in Fig. 1, the two mechanisms may also be complementary [36, 49]. As suggested in the final section of the paper, future research should endeavour to tease apart causal effects of discrete policy interventions.

Discussion

To recap, our quantitative analysis produced two main findings. First, welfare state robustness is the strongest predictor of differences in CO_2 emissions between countries. Second, welfare state entrenchment and retrenchment within countries over time is not systematically associated with emissions reductions.

Case-level analysis confirmed that compensation via active labour market policy was a factor in how Denmark and the UK achieved emissions reductions. The case evidence also suggested that political institutions matter in terms of the constituencies on to which transition costs may be imposed. Consistent with the thesis that negotiated compromise in neo-corporatist systems facilitates the achievement of positive-sum transitions, case analysis found evidence of a durable, cross-class coalition in favour of green growth in Denmark [34–36, 49]. However, the green bargain in Denmark was apparently not negotiated in the traditional image of corporatist interest intermediation, as labour interests were marginal relative to business. Moreover, costs associated with carbon taxes and corporate welfare in the form of feed-in tariff subsidies for renewable energy producers have disproportionately been borne by low-income households and small businesses. Although outcomes were similar in the United Kingdom, the political calculus was different, as institutions do not encourage coalition building but rather moderate policies that appeal to the median voter on issues [55].

Case analysis also revealed that many of the other causes identified in the literature were at play. Specifically, environmental risks and corporate welfare in the form of tax concessions and feed-in tariff subsidies loomed large in Denmark and the UK, as have carbon taxes. Emissions reductions have thus not followed exclusively from voluntary preference change envisioned by the behavioural model depicted in Fig. 1. Rather, emissions reductions have also followed as a consequence of executive imposition of transition costs.

Although effective in the short run, the executive action route is potentially unstable since it creates political incentives for policy losers to counter-mobilize [3, 38]. Experiences elsewhere have been consistent with the prediction, as high-emitting incumbents have exploited competitive political institutions to resist and reverse progress on environmental policy [27]. The implication is that compensation for technological dislocations may be required to ensure durable commitment to sustainability [6].

As discussed in Section 2, we see insurance and compensation as the crux of a behavioural theory of eco-welfare states. Although compensation is not necessarily fair or equitable (especially when granted as ransom), there are obvious parallels between eco-welfare states and just transitions [8, 14]. The case evidence suggests that the transition toward a low-carbon economy has so far not been particularly fair or equitable [89]. For reasons of both fairness and efficacy, there may be grounds for further investment in the compensatory instruments of eco-welfare states. Skeptics may counter that positive inducements are insufficient, and that strong regulations are required to meaningfully confront the climate crisis [51]. Let it be stressed that any conclusions drawn herein are tentative. Our vision for a research agenda is outlined below.

Conclusion and Research Agenda

Despite much discussion of eco-welfare states and just transitions, theory underlying these concepts remains underdeveloped. Consequently, there has been relatively little systematic analysis linking welfare state institutions to ecological performance via testable causal mechanisms. Responding to recent calls for an empirically-oriented research agenda, this paper has undertaken a simple, high-level, and transparent multi-method analysis of the linkages between welfare state robustness and CO_2 emissions [8, 14].

Our quantitative analysis found that welfare state robustness better accounts for differences in CO_2 emissions between countries than other explanations advanced in the literature. Yet, we also found that welfare state entrenchment does not systematically account for CO_2 reductions within countries over time. Case study analysis of CO_2 reductions in Denmark and the United Kingdom revealed two main (but intertwined) causal pathways: compensation and executive action that imposes transition costs.

Although it is arguable that regulation is more effective than compensation in the short-run, the executive action pathway risks prompting counter-mobilization on the part of 'policy losers' intent on reversing course on prior commitments [6]. Questions also arise regarding the fairness of uncompensated transition costs. A tentative argument can therefore be made that compensation is a preferable means of accomplishing sustainability goals. In that sense, theory and evidence on eco-welfare states is closely related to current discussions about just transitions [5, 7]. At the time of writing, official just transitions policies are foremostly designed to compensate for asset stranding and to facilitate redeployment of human capital from declining to emerging sectors [45]. From our insurance-based behavioural perspective, welfare state robustness is a decisive complement to just transitions policies.

Studying just transitions policies contextually is no simple task. Despite being rather cursory, our case analyses revealed complex processes and 'equifinality'—that is, multiple different pathways to an outcome [16, 54]. Further research will therefore require methods that can effectively trace behavioural processes and disentangle discrete causes. In a preliminary step, we assessed correlations between welfare state robustness, environmental policy stringency, and post-materialist values. We also made initial assessments of the positive role played by neo-corporatist arrangements as 'cooperative veto points,' which we juxtaposed against potential pathologies associated with 'competitive veto points' [38]. However, more systematic empirical work is needed on the determinants of environmental constituencies and how they exert political influence within different institutional milieux [1, 36, 41].

Potential next steps include the use of quasi-experimental methods to evaluate environmental and social impacts of specific policy interventions (e.g., regression discontinuity, difference-in-difference) [89]. Substantively, although our findings suggest that modern social welfare policy has played a positive role in carbon mitigation, a central policy challenge going forward involves finding ways to internalize externalities associated with offshored emissions [24, 43]. Major questions arise regarding how eco-welfare policy might be aligned with international regulation, finance, and trade policy [30, 33]. Although compensation and other concessions may be necessary to get partners on-side, international agreements can mitigate destructive tendencies of political swings by binding actors to operate within established rules [6].

Devolution of policymaking authority to independent entities may also neutralize drawbacks of executive action at the domestic level [90]. Political autonomy of environmental agencies varies across jurisdictions and over time, making the phenomenon well suited to quasi-experimental design. Institutionalization of 'climate translators' at the state-society nexus also varies across countries and over time, research on which has already produced some interesting results [41]. Further research is needed, however, to unravel the intricate dynamics that underpin eco-welfare states and just transitions policies, as understanding these complex interactions is necessary for appropriate policy design in the face of evolving environmental and social challenges.

Appendix

Data and replication code can be found at: https://github.com/matt-wilder/eco-welfare-states.

This appendix includes two additional tests: (1) a robustness test of the findings reported in Table 1 using consumption-based CO_2 emissions per capita as the dependent variable; and (2) a test of the causal relationship between welfare state robustness and environmental policy stringency ('regulation' in the regression output tables).

The relationship between welfare state robustness and consumption-based CO_2 emissions per capita is summarized in Table 2. These data are not as complete as the national CO_2 emissions per capita reported in Table 1 in the main manuscript ($N=617$ compared to $N=630$ panel years) and do not consider land use, land use change and forestry (LULUCF). The environmental policy stringency variable (regulation) is scaled from 0 to 1 in Table 2 but is unscaled when used as the dependent variable in Table 3. The coefficient for 'regulation' in Table 2 therefore represents estimated change in consumption-based CO_2 per capita from least to most stringent environmental policy. All coefficients in Table 3 represent the estimated change in environmental stringency per one-unit increase on the independent variables. The range of the unscaled environmental policy stringency variable for the countries in the sample is 0.16 to 4.89.

Table 2 Hierarchical mixed-effects results, consumption-based CO_2 per capita

	Between-effects					Random-effects				
	Model A1	Model A2	Model A3	Model A4	Pooled	Baseline	Model A5	Model A6	Model A7	Model A8
(intercept)	14.81*** (2.01)	12.91*** (2.94)	7.08** (2.82)	2.01 (4.41)	12.36*** (1.88)	11.99*** (0.79)	9.45** (3.32)	13.11*** (0.88)	12.09*** (1.63)	8.66*** (2.88)
Welfare state robustness	–5.38 (3.55)	-	-	–12.90** (5.47)	–9.75*** (1.98)	-	1.52 (5.46)	-	-	4.94 (4.89)
Regulation	-	–2.10 (6.49)	-	9.16 (8.07)	6.05 (4.05)	-	-	–2.44** (1.00)	-	–1.14* (0.61)
Post-materialist values	-	-	8.70* (4.81)	5.25 (4.25)	–1.91 (1.93)	-	-	-	–0.64 (1.55)	–0.27 (1.72)
Kyoto	-	-	-	1.86 (4.71)	–2.31 (1.44)	-	-	-	-	0.10 (0.21)
EU membership	-	-	-	–1.80 (1.75)	–1.39* (0.80)	-	-	-	-	0.28 (0.44)
Growth	-	-	-	1.11 (0.73)	0.33* (0.17)	-	-	-	-	0.02 (0.02)
Veto players	-	-	-	13.23** (5.52)	7.21* (3.63)	-	-	-	-	–0.87 (1.02)
Global value chain participation	-	-	-	5.42 (5.46)	1.55 (2.42)	-	-	-	-	–2.45*** (0.91)
Government R&D	-	-	-	0.02 (1.25)	0.77 (0.56)	-	-	-	-	0.62*** (0.19)
Adjusted R^2	0.06	0	0.10	0.42	0.44	ICC 0.83				
N	617	617	617	617	50	ΔR^2	0.25	0.29	0.15	0.50
periods *t*	17–30	17–30	17–30	17–30	1–6	*N* 617	617	617	617	617
groups *n*	21	21	21	21	20	*n* 21	21	21	21	21

ICC = intra-class correlation coefficient. Standard errors in parentheses (heteroskedasticity and autocorrelation corrected standard errors in pooled model). Pooled model Lagrange multiplier test for autocorrelation insignificant at p=0.34. Kyoto, EU membership, growth, regulation, and government R&D included only as fixed effects in model A8; all other variables computed as random and fixed-effects. Welfare state robustness variable generated by factor analysis from Comparative Welfare States Dataset variables *almp_pmp, unioncent, uegen, sickgen* updated to 2019 based on OECD ICTWSS data [58, 59]. Kyoto = 1 for parties to the Doha Amendment after 2015, 0 otherwise. EU membership = 1 for EU countries, 0 otherwise. Post-materialist values = index generated from average weighted country-wave responses to 3-point question in Integrated Values Surveys with interpolated values between survey years [65]. Growth = growth rate (output approach in percent) [66]. Regulation = rescaled index based on OECD Environmental Policy Stringency scores [63]. Veto players = Political Constraints Dataset variable *polconiii* with imputed values for 2017–2019 [67]. Global value chain participation = index that combines foreign and domestic value added embodied in exports [68]. Government R&D = government expenditure on research and development related to environment, energy and industrial processes as percentage of GDP [69]. Data not available for Norway prior to 2003.

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Table 3 Hierarchical mixed-effects results, environmental policy stringency (regulation)

	Between-effects			Random-effects		
	Model A9	Model A10	Pooled	Baseline	Model A11	Model A12
(intercept)	1.41*** (0.26)	1.77** (0.59)	1.05*** (0.35)	2.18*** (0.12)	5.82 (3.91)	0.60 (0.46)
Welfare state robustness	1.47*** (0.47)	1.25 (0.76)	1.28*** (0.41)	-	–3.68 (6.58)	1.19 (1.37)
Kyoto	-	0.61 (0.96)	1.51*** (0.16)	-	-	0.72*** (0.05)
EU membership	-	–0.20 (0.34)	–0.40* (0.21)	-	-	0.22* (0.12)
Post-materialist values	-	–0.12 (0.72)	–0.05 (0.44)	-	-	0.09 (0.52)
Growth	-	–0.20 (0.11)	–0.02 (0.03)	-	-	–0.02** (0.01)
Veto players	-	–0.15 (0.93)	–0.78* (0.40)	-	-	–0.05 (0.65)
Global value chain participation	-	1.11 (0.88)	2.76*** (0.65)	-	-	4.78*** (0.26)
Government R&D	-	0.04 (0.21)	0.28 (0.19)	-	-	–0.01 (0.)
Adjusted R^2	0.31	0.27	0.76	ICC 0.25		
N	630	630	50	ΔR^2	0.43	0.86
periods t	30	30	1–6	n 21	21	21
groups n	21	21	21	N 630	630	630

ICC = intra-class correlation coefficient. Standard errors in parentheses. Pooled model Lagrange multiplier test for autocorrelation insignificant at $p=0.24$. Kyoto, EU membership, growth, regulation, and government R&D included only as fixed effects in random-effects models; all other variables computed as random and fixed-effects. Environmental policy stringency = OECD Environmental Policy Stringency scores not scaled; range = 0.16 to 4.89 [63]. Welfare state robustness variable generated by factor analysis from Comparative Welfare States Dataset variables *almp_pmp, unioncent, uegen, sickgen* updated to 2019 based on OECD ICTWSS data [58, 59]. Kyoto = 1 for parties to the Doha Amendment after 2015, 0 otherwise. EU membership = 1 for EU countries, 0 otherwise. Post-materialist values = index generated from average weighted country-wave responses to 3-point question in Integrated Values Surveys with interpolated values between survey years [65]. Growth = growth rate (output approach in percent) [66]. Veto players = Political Constraints Dataset variable *polconiii* with imputed values for 2017–2019 [67]. Global value chain participation = index that combines foreign and domestic value added embodied in exports [68]. Government R&D = government expenditure on research and development related to environment, energy and industrial processes as percentage of GDP [69].

$*p<0.10$, $**p<0.05$, $***p<0.01$

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s43615-024-00359-5.

Data Availability Data and replication code can be found at https://github.com/matt-wilder/eco-welfare-states.

Declarations

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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