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The Economics of a Just Transition

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Abstract

Addressing climate change requires policies that are ethically defensible, politically acceptable, and implementable. The concept of a 'just transition'—a decarbonization process that avoids leaving workers and communities behind and mitigates burdens on vulnerable and historically marginalized groups—has gained prominence in academic and policy debates. This paper bridges these debates with insights from environmental economics. We identify and examine four key dimensions of a just transition—distributional, restorative, procedural, and recognition justice—and use them to map existing economic research. We highlight the contributions and limitations of environmental economics in addressing justice concerns and discuss gaps that future research should address to better inform the design of equitable climate policies.

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1. Introduction

Climate change mitigation requires ethically defensible, politically acceptable, and implementable interventions. There is a growing emphasis by stakeholders and policymakers on promoting a 'just transition' — decarbonizing the economy fairly and inclusively, creating decent work opportunities, and leaving no one behind. Climate policy also faces issues regarding responsibility for climate hazards and their unequal distribution across and within countries. Importantly, the local and global net benefits of climate and environmental action are heterogeneously distributed across space and time, and often compound injustices from past emissions and those associated with other arguably mismanaged transitions – e.g., automation, globalization, and digitalization (Creutzig et al., 2022; Hanson, 2023; Weber, 2020).

The term 'just transition' lacks a universal definition and is employed by several actors in diverse contexts, with growing debates about its meaning and interpretation (Galgóczi 2020; X. Wang and Lo 2021). There is a rich and growing literature outside of environmental economics (sociology, energy policy, and political science) on issues of just transition and energy justice. There is also a growing interest by environmental economists to contribute to this burgeoning debate, with most of the focus on the distributive aspects of the transition (Fullerton and Muehlegger 2019; Ohlendorf et al. 2021; Shang 2023; Vona 2023).

This paper seeks to bridge the debate surrounding the 'just transition' with recent insights from the environmental economics literature. We aim to highlight how economists have contributed — and can continue to contribute — to the debate, while also going beyond environmental and climate damages to focus on the broader socioeconomic justice implications resulting from government policies supporting the transition to climate neutrality. To this end, we build on the growing body of scholarship on environmental justice, which analyses inequitable exposure to environmental burdens, and climate justice, which focuses on the uneven impacts of climate change, as well as key lessons from other disciplines (Banzhaf, Ma, and Timmins 2019; Bou-Habib 2019; Cain et al. 2024; Carleton and Hsiang 2016). Ultimately, we highlight future research avenues for environmental economists seeking to move beyond efficiency and effectiveness.

The paper is organized as follows: in Section 2, we illustrate the history of the term 'just transition' and distil four key elements emerging from the academic and policy literature:

distributional, restorative, procedural and recognition justice. Sections 3 through 6 discuss the extent to which economists have engaged with these dimensions to shape climate change policies. In Section 7 we discuss open just transition questions with which environmental economics can meaningfully engage.

2. Historical roots and conceptual framing of the just transition

The concept of a 'just transition' has evolved over time, shaped by labour movements, environmental policies, and international agreements (Verdolini 2023). Initially used in the 1970s to support workers displaced by environmental regulation, the term has since expanded in scope. Labour unions have used it to seek institutional recognition and participation to influence the process and outcomes of climate change policies. Over time, this led to its formal incorporation into major international agreements, notably the 2015 Paris Agreement.

What began as a response to job losses has since evolved into a broader, more deliberate effort to plan for and invest in a transition that engages communities and stakeholders while addressing environmental, social and economic concerns. To date, 'just transition' remains a fluid concept with three core aspects: the creation of decent[‡], new jobs; minimizing negative impacts on workers and communities, particularly those that have been historically marginalized; and ensuring fairness of procedures and inclusive engagement of stakeholders (Verdolini 2023). Increasingly, scholarly work on just transitions also acknowledges the importance of managing adverse impacts on households and energy-intensive industries (Jakob et al. 2020).

Importantly, the just transition has been conceptualized and organized around four key dimensions — distributional, restorative, procedural and recognition justice (Abram et al. 2022; McCauley and Heffron 2018; Zimm et al. 2024). These dimensions, which were developed in the policy arena and by civil society and are well-established in other disciplines — including in the energy and climate justice literature (e.g., Jenkins et al. 2016; Spurlock, Elmallah, and Reames 2022; Van Uffelen, Taebi, and Pesch 2024) — provide a structured framework for evaluating the fairness of climate policies. We argue that it is beneficial to apply the same framework to review the contributions from environmental economists, as has been done in

[‡] ILO defines decent work as involving 'productive employment that offers fair income, workplace security, social protection, opportunities for personal growth, social integration, freedom of expression, participation in decision-making, and equal treatment for all.

related environmental justice reviews (Banzhaf, Ma, and Timmins 2019; Cain et al. 2024), providing key insights from other disciplines to advance existing research beyond distributive and restorative dimensions.

Distributive justice concerns the just allocation of resources, benefits, opportunities, and burdens across social groups. *Restorative justice* seeks to avoid and repair distributional injustices through compensation. *Procedural justice* regards the fairness of processes determining outcomes (Rawls 1971), including transparency, impartiality, and fair treatment, with participatory justice ensuring meaningful inclusion, local preference elicitation, and information disclosure in decision-making (Jenkins et al. 2016). Lastly, *recognition justice* acknowledges the dignity, values, and lifestyles of all human groups. These four justice dimensions are key in the 'just transition', which intersects with broader socioeconomic challenges, including rising income inequality, globalization, and automation (Hanson 2023; Verdolini 2023; J. Weber 2020).

3. Distributive justice

3.1 Distribution of Costs

Costs on workers and regions are at the core of the traditional just transition discourse. Environmental economists have investigated potential labour market costs evaluating ex-post the impact of environmental and energy policies on labour demand (e.g., Greenstone 2002; Kahn and Mansur 2013) and earnings (e.g., Walker 2013; Yip 2018). Results vary depending on the policy analysed. The U.S. Clean Air Act (CAA) reduced employment in most affected counties (Curtis 2018; Greenstone 2002; Walker 2011), the effect being concentrated in pollution-intensive industries. Evaluations of energy price shocks – used to proxy for stringent climate policy – find similar, if not larger, effects (Kahn and Mansur 2013; 2013; Marin and Vona 2019; 2021). Conversely, research on the EU Emission Trading Scheme shows no negative effects in terms of job losses (Colmer et al. 2024; Dechezleprêtre, Nachtigall, and Venmans 2023; Marin, Marino, and Pellegrin 2018). These uncertain labour market impacts are significantly smaller—by an order of magnitude—than the health benefits generated by the CAA (Walker 2011), as well as the benefits associated with the emission reductions implied by increased energy prices (Marin and Vona 2021). A possible explanation for these unclear results likely lies in the limited stringency of the policies assessed. A large-scale transition to renewable energy might impose larger costs on workers in fossil-fuel and carbon-intensive

industries, similarly to the case of mass layoffs in heavy industries (Barreto, Grundke, and Krill 2023) or structural decline of coal production. Another channel limiting job losses is labour reallocation from pollution-intensive to other sectors as illustrated in a few ex-ante evaluations using general equilibrium models (e.g., Hafstead and Williams 2018) and empirically for the British Columbia carbon tax (Yamazaki 2017).

Small estimates of aggregate labour market costs mask high heterogeneity across regions, sectors and workers; importantly, other structural transformations may result in compounding effects. For instance, energy price shocks trigger a reallocation of labour away from blue-collar workers towards mid-skilled technical workers (Marin and Vona 2019). The shift in skill demand induced by the Clean Air Act reinforces the secular increase in the demand for more qualified workers, particularly those possessing technical and engineering skills (Vona et al. 2018). The CAA resulted in substantial earning losses and non-employment spells - especially for workers switching sectors - and larger earning losses for older workers with longer job tenure in pre-regulatory jobs (Walker 2013). Similarly, the British Columbia carbon tax did not affect aggregate employment, but reduced the employment of unskilled workers (Yip 2018). This is consistent with studies finding earning losses deriving from labour reallocation from heavy manufacturing industries to services. Displaced workers in high carbon-intensity sectors face higher earnings losses, difficulties in finding new jobs, and challenges recovering their earnings; women, older workers, and those with vocational degrees experience particularly high costs of displacement (Barreto, Grundke, and Krill 2023).

At the regional level, the size of indirect job multiplier effects from declining, spatially concentrated carbon-intensive sectors to other, non-tradable, sectors are unclear. Recent analyses point to larger effects of the decline in coal production on total employment and earnings than earlier studies (Black, McKinnish, and Sanders 2005; Hanson 2023; J. Weber 2020). Notably, since coal-intensive regions in the US and Europe are poorer, the phase-out of coal or carbon-intensive sectors exacerbated pre-existing regional income inequality (McDowall et al. 2023; Vrontisi et al. 2024). Furthermore, communities reliant on fossil fuel revenues may suffer large transition losses, amplifying distributive concerns (Krause 2023; Raimi et al. 2023). Consistent with other studies on the EU-ETS, Hernandez Carballo et al. (2025) find mild impacts concentrated in highly regulated sectors, but no impacts on total regional employment. Overall, results point to costs that are concentrated on workers and regions which are historically already vulnerable along other dimensions.

Building on public economics, environmental economists have extensively studied the distributional effects on spending using the theory of the incidence of taxation (Fullerton and Heutel 2007; Hassett, Mathur, and Metcalf 2009; Pizer and Sexton 2019). The regressivity of carbon pricing, without revenue recycling, has been widely debated. On the one hand, in industrialized countries carbon pricing is generally regressive, disproportionately burdening lower-income households - which contribute less to emissions - by raising the costs of essential goods like energy and energy-intensive products (e.g., Levinson and O'Brien 2019; Sager 2019). However, its impact varies based on household expenditure patterns, population characteristics, methodological choices, and policy design (e.g., Cronin, Fullerton, and Sexton 2019; Pizer and Sexton 2019). Conversely, differing energy consumption patterns in low- and middle-income countries can make it progressive (Dorband et al. 2019; Ohlendorf et al. 2021; Sager 2019). Accounting for indirect price changes of other goods, consumer adjustments, and lifetime income often results in more progressive outcomes (Ohlendorf et al. 2021).

Beyond income disparities, horizontal (within-income group) inequality can be larger and harder to address (Fischer and Pizer 2019; Hänsel et al. 2022; Steckel et al. 2021). Factors such as commuting needs, public transport access, and housing efficiency drive energy cost disparities (Rausch, Metcalf, and Reilly 2011), while in lower-income countries, car ownership and cooking fuel choices further widen these gaps (Missbach, Steckel, and Vogt-Schilb 2024).

Despite the widespread use of regulatory instruments, their distributive impacts remain understudied (IPCC 2022). Some evidence suggests that efficiency standards and other regulatory tools are often regressive – more so than carbon taxes, particularly with recycling (e.g., Levinson 2019). This is generally the case for fuel economy standards in the US (Davis and Knittel 2019; M. R. Jacobsen 2013). Subsidies and tax credits for green capital equipment are also regressive as they imply upfront costs that are often too high for poorer households, and they disproportionately benefit high-income households (Borenstein and Davis 2016; G. D. Jacobsen 2019). Policies supporting the deployment of renewable energy point to regressivity in terms of income (e.g., Dauwalter and Harris 2023 who however also find greater per capita benefits for minority households) while the distributive impacts of other regulatory instruments such as white certificates, R&D funding, and government procurements remain understudied (see Peñasco, Anadón, and Verdolini 2021 for a review).

Modelling studies have quantified the broader general equilibrium effects of environmental policies (Hafstead, Williams, and Chen 2022; Metcalf and Stock 2023), and their distributional

consequences, highlighting the key role of compensatory measures for promoting a just transition.

Besides workers, environmental policies also strongly affect firms, particularly medium size enterprises (SMEs), which account for 60-70 percent of jobs and over half of GDP in most OECD countries (ILO 2019). These firms face barriers to adopting new technologies, adjusting to structural changes, including limited credit access, a lack of specialized labour force, and path dependency. But evidence on the impact of climate policies on heterogeneous firms is very scant, with most literature being aggregate, or non-representative, focused on developed countries, and limited by data availability, especially across different geographies (e.g., Rubashkina, Galeotti, and Verdolini 2015). Environmental regulations have modest negative short-term effects on trade, plant location, and productivity, particularly within pollution- and energy-intensive sectors (Dechezleprêtre and Sato 2017). Some recent efforts focus on installation-level analyses of the European Union Emission Trading System across countries (Dechezleprêtre, Nachtigall, and Venmans 2023) and energy price impacts on French establishment-level data accounting for firm size, multi- vs. single-establishment, trade-exposure and energy intensity (Marin and Vona 2021). Another important yet understudied distributional impact of climate policies relates to firm-level carbon leakage (Jakob 2023) and its implications for the just transition.

3.2 Distribution of Benefits

The transition to a low-carbon economy also creates benefits, including to the most vulnerable individuals. Poorer households, usually located near polluting plants, can disproportionately benefit from improved air quality, a co-benefit of decarbonization (see Banzhaf, Ma, and Timmins 2019; Cain et al. 2024 for recent reviews). Research on market-based environmental policies points to this direction: multiple recent analyses indicate that California's cap-and-trade program reduced disparities in pollution exposure or did not worsen pollution outcomes in vulnerable communities (Hernandez-Cortes and Meng 2023; P. Weber 2021). For Southern California’s emissions trading program (RECLAIM), Fowlie et al., (2012) find minimal or no demographic disparities in pollution exposure, while Grainger and Ruangmas (2018) find uneven benefits, potentially due to modelling choices (Cain et al. 2024). Additionally, non-market environmental regulations, notably the CAA amendments, have substantially improved air quality and health outcomes, narrowing Urban-Rural and Black-White disparities in pollution exposure (Currie, Voorheis, and Walker 2023; Sager and Singer 2025).

The historical decline in coal production lowered direct mortality and morbidity risks in poorer and more polluted communities in the U.S. (Mueller 2022), but increased mortality and morbidity risks due to mental distress and drug use (Boslett and Hill 2022). Anecdotal evidence suggests that workers in polluting industries prefer "work" over "health", even if health risks are extreme; unions can amplify these preferences (Vona 2019).

The evidence is mixed when focusing on labour market benefits. Overall, job destruction is (more than) offset by job creation in green jobs - i.e., jobs that help reduce harmful environmental impacts – and green sectors (e.g., Popp et al. 2021). However, large investments in renewable energy projects will lead to job gains distributed heterogeneously across workers. On the one hand, the energy transition is found to be skill-biased, favouring the workers with better outside options in the labour market: for instance, green jobs require more on-the-job training, STEM education and technical skills (Consoli et al. 2016; Popp et al. 2024; Saussay et al. 2022; Vona et al. 2018) than similar occupations, but no additional years of formal education (Curtis and Marinescu 2023; Popp et al. 2021). On the other hand, job creation resulting from the American Recovery and Reinvestment Act is concentrated among manual workers in the construction sector, who are more vulnerable to other structural transformations (Popp et al. 2021). Additionally, decreasing global warming benefits workers in occupations with larger heat stress exposure - generally from poorer households (Park, Pankratz, and Behrer 2021).

In addition, there is a limited overlap between areas creating low-carbon jobs and those with job losses (Lim, Aklin, and Frank 2023; Saussay et al. 2022), suggesting that spatial barriers can be a significant constraint and increase relocation costs for low-skilled workers from more vulnerable communities seeking jobs. Yet, the same literature shows consolidated evidence that green and brown jobs, i.e. jobs concentrated in pollution intensive sectors, share a similar set of skills, which facilitates the transition to new jobs for more vulnerable workers (e.g., Brunetti et al. 2025). Suggestive evidence indicates that each dollar spent in training programs for green jobs can have a significant impact on local labour markets (Popp et al., 2021), but to date, a full welfare assessment of all costs and benefits has not been undertaken.

The benefits of green jobs depend also on the wage scale they offer. Descriptive evidence points to a modest but positive wage premium for low-carbon occupations in Germany (Antoni, Janser, and Lehmer 2015), the US (Vona et al. 2018), the UK (Whittard et al. 2025) and cross-country (Bluedorn et al. 2023). Saussay et al. (2022) confirm these findings; they also show

that the low-carbon wage premium is smaller than the wage premium earned in fossil-fuel occupations - and decreasing over time, especially for high-skilled occupations. This lowers the attractiveness of the green transition for traditional energy workers. Yet, the green wage premium is larger than that for workers in polluting industries broadly defined (Bluedorn et al. 2023). Importantly, no evidence exists of green subsidies or the historical increase in green production leading to higher wages (Frattini, Vona, and Bontadini 2024; Popp et al. 2021).

4. Restorative Justice

The redistribution of carbon pricing revenues is a widely studied topic in economics (e.g., Metcalf 2009), with relevant, yet limited, insights for restorative justice. Revenue recycling can take various forms, including earmarking revenues for welfare spending, lump-sum transfers, and tax reductions (Fullerton, Heutel, and Metcalf 2012; Rausch, Metcalf, and Reilly 2011) and can be compared along efficiency, equity, and political feasibility (Klenert and Mattauch 2016; Mohammadzadeh-Valencia et al. 2024).

Lump-sum transfers can generate distributional benefits and increase political acceptability (Klenert et al. 2018; Williams et al. 2015) but cannot address labour market inequalities. Alternatively, environmental tax reforms reducing labour taxation provide a revenue-neutral way to remove pre-existing distortionary labour taxes, creating the double dividend of reducing pollution and increasing employment (Goulder 1995). Yet, targeted labour tax cuts face low political acceptability, cannot tackle inequality dimensions beyond earnings, and do not help workers reskill for green jobs (Vona 2023).

Coordinated green economy investments can incentivize decarbonization technologies and create jobs for low-skilled workers (Popp et al. 2021). Industrial strategies can be designed to address demand, knowledge and network externalities, research and development, and job training (Vona 2023). However, empirical evidence on labour market effects remains limited. The literature on place-based policies shows that investments in training are among the most effective to help distressed communities (Bartik 2020), as positive local employment effects of are larger in areas with a greater prevalence of green skills (Popp et al. 2021). Along similar lines, targeted green subsidies – as opposed to untargeted subsidies – could support low-income households facing financial and behavioural constraints, though research on such programs is sparse (Fowlie, Greenstone, and Wolfram 2018; Muehlegger and Rapson 2022).

Beyond policy design, institutional capacity is critical for equitable redistribution. Existing programs suffer from low coverage (World Bank 2017) and targeting errors (Bah et al. 2019), reaching the poorest households rather than the most impacted by carbon pricing (Missbach, Steckel, and Vogt-Schilb 2024). Furthermore, addressing horizontal inequity requires targeting on characteristics beyond income, considering energy use and geographic vulnerability (Fischer and Pizer 2019).

5. Procedural Justice

Environmental economics has given less attention to *procedural justice*, which affects the rules and methods by which policies are developed, decided upon, implemented and enforced. This includes the fairness of procedures determining outcomes (e.g., Deutsch 1975), economic fairness in resource allocation, dispute resolution, and law enforcement (Rawls 1971), and aspects of participatory justice - e.g., "process control" (Thibaut and Walker 1978), "representation" (Leventhal 1976), and the elicitation of local preferences and needs, information disclosure, and meaningful inclusion of stakeholders (Jenkins et al. 2016).

Insights from environmental justice research highlight factors that impact procedural justice (see Cain et al. 2024 for a review). These include asymmetric information, race, income, language proficiency, and collective action capacity, all of which can influence policy procedures and bargaining outcomes (Campa and Muehlenbachs 2024; Fowlie, Reed, and Wooley 2020; Shadbegian and Gray 2012; Timmins and Vissing 2022). Other research argues that economic decision-making approaches relying on utilitarian approaches and focusing on aggregate outcomes often ignore procedural considerations (Ando et al. 2023).

Political economy research points to several factors that can compromise procedural fairness, particularly those related to the interactions between elected officials and organized interest groups. These issues stem from the uneven representation of interests in decision-making processes related to climate policy and reflect underlying power imbalances between groups, with lobbying serving as a key mechanism of influence (Mildenberger 2020). While lobbying can facilitate advocacy, it also threatens procedural justice when it distorts fairness and transparency. For example, lobbying by firms contributed to the failure of the Waxman-Markey bill in the U.S., imposing an estimated social cost of 60 billion USD (Meng and Rode 2019). Similarly, lobbying influenced the design of the EU Emissions Trading System, leading to grandfathering as a permit allocation rule, favouring incumbent firms, historically large

emitters, and sectors that initially avoided inclusion in the program, such as the chemical and aluminium sectors (Markussen and Svendsen 2005). Procedural imbalances are compounded by low representation of historically marginalized groups in energy jobs (Carley and Konisky 2020), while traditional energy jobs are more likely to be unionized (Haywood, Janser, and Koch 2023), increasing resistance to the green transition among the most negatively affected workers (Vona 2019).

Assessing procedural justice requires more systematic accounting of power asymmetries among political and economic actors, which economics often overlooks. The presence of strong interest groups can weaken governments' credibility to enact effective just transition policies (Kalk and Sorger 2023; Kalkuhl, Steckel, and Edenhofer 2020), undermining procedural justice and the speed of the transition.

Procedural justice, compensation, communication, and trust strongly influence policy acceptance (M. Bergquist et al. 2022; Dechezleprêtre et al. 2025; Maestre-Andrés, Drews, and Van Den Bergh 2019). Revenue recycling and targeted green spending generally enhance acceptability, though high inequality or mistrust can undermine well-designed schemes (Klenert et al. 2018; Mohammadzadeh-Valencia et al. 2024; Vona 2023). Carbon pricing has greater acceptance in contexts characterized by low corruption and high governmental trust (Ewald, Sterner, and Sterner 2022; Klenert et al. 2018). However, more empirical research is needed to understand other factors that affect the success or failure (e.g. passage in California vs increased opposition in Oregon and Washington) of climate policies in other contexts.

Effective and transparent governmental communication is crucial for procedural justice, but can be limited by misinformation. Miscommunication about rebates can create misperceptions, and additional information may not always improve acceptability (Cameron and Shah 2014; Douenne and Fabre 2022; Mildenberger 2020). Conversely, clearly explaining policy benefits typically increases support (Dechezleprêtre et al. 2025). Behavioural economics emphasizes the role of salience in shaping acceptance (Klenert et al. 2018). Highlighting policy costs reduces support (Aklin 2021; P. Bergquist, Konisky, and Kotcher 2020; Stokes and Warshaw 2017), while emphasizing benefits, especially to key political groups, can boost it (Klenert et al. 2018).

6. Recognition Justice

Differently from energy and environmental justice work (Jenkins et al. 2016; McCauley and Heffron 2018; Schlosberg 2004), economists have engaged less with recognition justice — acknowledging all human groups' dignity, values, and ways of life. Fraser (2008) emphasizes that addressing economic disparities alone is insufficient without respecting the diverse cultural and social identities. Similarly, Young (2002) highlights how misrecognition, through degradation and devaluation at the individual and cultural level, harms marginalized communities and undermines their image and status within broader cultural and political contexts. Traditional economic analysis fails to capture cultural factors and identity, with the distinct exception of the recent attempts to introduce them as an object in the utility function (Akerlof and Kranton 2000; Bénabou and Tirole 2011). As a result, issues of recognition justice are poorly and rarely reflected in the approach of environmental economists.

In the climate and energy transition, the misrecognition of marginalized groups – based on ethnicity, age, gender, or disability – exacerbates inequities and undermines just transition efforts (McCauley and Heffron 2018) as is the case when e.g., developing renewable energy projects on Indigenous lands without respecting their cultural rights. The energy transition also has implications for equity and communities' culture and sense of identity (Carley, Evans, and Konisky 2018).

Environmental economists have primarily addressed group identities by documenting demographic heterogeneities, often through the lens of environmental justice, and emphasizing racial disparities in exposure to environmental damages (Banzhaf, Ma, and Timmins 2019; Cain et al. 2024; Colmer et al. 2024). While some environmental policies can be designed to reduce environmental inequalities for racial and ethnic minorities (Currie, Voorheis, and Walker 2023; Hernandez-Cortes and Meng 2023), disparities in access to clean technologies exist. For instance, race, gender and income are key determinants of clean technology adoption in the U.S. (Vaishnav 2023), while White-non-Hispanic households benefit more from energy efficiency incentives due to higher home ownership rates (G. D. Jacobsen 2024).

7. **Open 'just transition' questions for environmental economics**

Contributions from environmental economists to just transition debates largely address distributive and restorative justice, with much focus on carbon pricing and revenue recycling. Taken together, results from this relatively large body of literature demonstrate that the implementation of single environmental policy instruments, be they carbon taxes or

368 regulations, will leave vulnerable communities behind if not appropriately designed or not
369 complemented with appropriate transition support measures (Peñasco, Anadón, and Verdolini
370 2021). At the same time, this literature points to significant distributional benefits of pollution
371 control due to the high exposure of vulnerable households to environmental and climate
372 hazards.

373 Conversely, the contribution of environmental economics to aspects of procedural and
374 recognition justice dimensions is limited. These topics are mainly explored in other disciplines,
375 which offer significant lessons for environmental economists. Behavioural and political
376 economy approaches can inform stakeholder engagement in decision-making processes,
377 improving fairness perceptions.

378 The debate around the just transition offers exciting opportunities to advance the field of
379 environmental economics beyond its traditional focus on efficiency and effectiveness and to
380 make its results and methods more relevant. We identify key areas of future work for
381 environmental economists – namely (i) labour markets, (ii) firms, (iii) the political economy
382 aspects of the energy transition and (iv) insights from and collaborations with other disciplines,
383 and (v) methodological improvements. Focusing on these areas would ensure a continued and
384 long-standing engagement of environmental economists with the crucial debate on how to
385 promote the transition towards climate neutrality while leaving no one behind.

386 A first promising research avenue relates to *labour markets*, which are - and will remain -
387 prominent in the just transition debate. To date, four facts largely remain overlooked: (1) labour
388 markets are segmented by skill types, with substantial increased returns to abstract, social and
389 technical skills over the last five decades; (2) changes in the task content of jobs and the
390 emergence of new jobs are key features of technological change that require rapid supply of
391 training and educational programs; (3) labour markets are highly imperfect, so rents created by
392 monopsony power, labour market institutions and unions are widespread; (4) these impacts
393 are geographically concentrated, have disproportionately harmed low-skilled workers in high-
394 income countries and have created distressed communities through local multiplier effects.

395 Future research should fill these gaps. Heterogeneous impacts on workers - along several
396 dimensions and geographies – and reallocation and job displacement – linked to skill losses in
397 the new job, decreased job security due to lower unionization and lower job rents – need to be
398 more precisely quantified. Methods used to study structural labour market transformations

(e.g., Acemoglu and Autor 2011) can be leveraged to more precisely identify impacted workers based on the skills required, or made obsolete, by energy transitions, focusing on the outcome of job-to-job mobility (e.g., Brunetti et al. 2025; Curtis, O'Kane, and Park 2024). The development of training programs needs to be informed by more systematic evaluations of their effects, including at the worker level. Coal-intensive communities are also a natural case study to distil how contextual factors shape new opportunities beyond employment and earning losses for displaced workers (e.g., Hanson 2023), affecting patterns of government transfers, population dynamics and other measures of well-being - e.g. health outcomes. More research is also needed to identify who are the losers of ambitious climate policies beyond the over-studied case of coal miners, combining data on emissions and job characteristics to construct indicators of the carbon content of regions and jobs (e.g., Graham and Knittel 2024). Newly available data sources - including administrative matched employer-employee, on-line job vacancy and resume data - can be leveraged but are still largely limited to industrialized countries. Finally, more research is needed to understand the extent to which policy-driven effects compound with existing labour market trends and exacerbate the political opposition towards climate policies of carbon-intensive workers.

A second key research area is related to the heterogeneous and geographically concentrated impacts of the energy transition on firms' competitiveness and productivity. Firms are key actors in the energy transition, influencing labour and skills demand; SMEs are strongly understudied. Improving the understanding of the barriers which impede access to the technologies, financing and skills necessary for the transition in firms is crucial both to inform the design of both green industrial policy and, more generally, policies which promote strategic autonomy in the transition towards a carbon neutral economy. Importantly, research should investigate the trade-related impacts of the energy transition, including issues of carbon leakage - relevant also for international equity concerns – and potential border tax adjustment responses. A particularly thorny issue in advancing this research is related to overcoming major data limitations, particularly for less industrialized countries. Lastly, an increasingly important area of research concerns the compounding and contrasting effects from other major societal transformations, such as digitalization, which remain to date largely unexplored (Creutzig et al. 2022; Verdolini 2023).

A third promising future research avenue is the political economy of the just transition. Future work can better characterize how the unequal distribution and visibility of costs and benefits

increases household and worker opposition to climate policies (e.g., Kistinger et al. 2025) and how vested interests in the labour market shape voting for green parties (Cavallotti et al. 2025). Other key areas of future research include obtaining a better understanding of: i) political dynamics, which are essential for enabling just transitions; ii) voter and elite preferences; and iii) of how weak policy commitments may result in suboptimal technological investment decisions (Besley and Persson 2023; Campiglio, Lamperti, and Terranova 2023; Harstad 2020). Insights on elite influence from other social sciences (see Sovacool and Brisbois 2019 for a review) suggest ministries of energy, heads of state, utilities, and mining companies are key actors in the energy transition (Ohlendorf, Jakob, and Steckel 2022) and that state capacity is a necessary condition to support the energy transition (Lamb and Minx 2020; Singh 2023). Environmental economists can contribute by applying rigorous methodologies to causally study these drivers and mechanisms. Along similar lines, environmental economists can contribute to research on intergenerational inequality beyond debating the appropriate social discount factor for cost-benefit analyses: future generations, lack current political representation, and will bear the greatest climate risks (S. Wang et al. 2023). Importantly, traditional approaches might not capture the dynamic and uncertain nature of long-term environmental consequences (Drouet, Bosetti, and Tavoni 2022; Sterner and Persson 2008; Weitzman 2009). More research is needed on how intergenerational aspects shape the political economy dynamics of the just transition, for example by studying how different generations are differentially affected by the benefits and costs of climate action.

A fourth key future research avenue is to advance the understanding of procedural and recognition justice, by integrating insights from political science and interdisciplinary research. For instance, research has started to investigate how proximity to energy projects reduces political support through “Not in My Backyard” effect (Germeshausen, Heim, and Wagner 2023) studied in other disciplines (e.g., Stokes 2016). Economists can further strengthen their collaboration with other disciplines to study political and policy support responses to resource taxation (e.g., Voeten 2024), energy prices (Hernandez Carballo and Sisco 2024), economic losses from other structural shocks such as trade (Bez et al. 2023) or e.g., coal mine closures (Egli, Schmid, and Schmidt 2022). Topics that could benefit from interdisciplinary collaboration include the role that compensation measures play in mitigating political backlash (e.g., Colantone et al. 2023 on polluting vehicle restriction policy); how to design inclusive just transition strategies (e.g., Bolet, Green, and González-Eguino 2023); how to enhance climate policy acceptance in fossil fuel communities (e.g., Gazmararian 2024); and how to build

effective coalitions by assessing workers' knowledge and perceptions surrounding the future distributive impacts of the energy transition (e.g., Gaikwad, Genovese, and Tingley 2022; Silva, Carley, and Konisky 2023). Economists can also contribute to the design of more effective policies, perceived as legitimate and better aligned with local priorities, by researching the impact of different participatory and procedural elements on public acceptability and satisfaction and by applying methods for measuring public and local policy maker preferences around energy transitions (Caggiano et al. 2024; Spiller et al. 2024).

Recognition justice, reflecting community identity, and cultural values surrounding coal jobs, remains a critical area for interdisciplinary collaborations. Promising efforts in this respect include how communities reshape their culture and identity after coal job losses (Carley, Evans, and Konisky 2018), what type of policies can simultaneously address redistribution and recognition — reducing material inequalities while respecting diverse identities and addressing both existing and emerging identity-based inequalities, including historical contexts, root causes, and possible remedies (Ando et al. 2023).

A fifth necessary area of focus for environmental economists are methodological improvements. These relate not only to more sophisticated empirical methods to distil insights based on observable data, but also the improvement of numerical models to explore the equity implications of different transition pathways, as well as their benefits. Currently, models represent heterogeneity mostly in terms of demographics and income disparities, but more work is needed to endogenize additional dimensions such as gender, race and others (e.g., Emmerling and Tavoni 2021). Furthermore, considerations regarding the degree of labour mobility (e.g., Castellanos and Heutel 2024) or about the role of labour market institutions are largely absent from models. Importantly, standard methodological choices in environmental economics can inadvertently create biases (Ando et al. 2023). For instance, willingness-to-pay inherently undervalues improvements for marginalized groups, while aggregate-focused benefit-cost analysis (BCA) prioritizes efficiency over equity. Tools such as equity-weighting, which adjust BCAs to prioritize benefits for disadvantaged communities, ensure that analyses better reflect justice concerns (Adler 2016; Ando et al. 2023). Alternative welfare frameworks with a focus on justice exist and can be proficiently used in ex-ante assessment of environmental policies. For instance, integrating identity and social norms into their analyses — through frameworks such as Akerlof and Kranton's (2000) economics of identity, which accounts for utility derived from identity validation, and by quantifying the costs of

misrecognition, such as discrimination or cultural devaluation —would allow economists to better engage with issues relevant for recognition justice. Importantly, new data sources, including text analysis of social media, job vacancy ads, and political discourses, are increasingly available and challenge environmental economists to use rigorous applied and econometric methods – including new computational methods enhanced by greater computational power and advanced modelling capabilities - to improve the four research directions described above. Surveys and experimental data are particularly valuable in regions with limited evidence but acute justice concerns. Reuniting empirical and numerical methods for both ex-post and ex-ante policy evaluation will increase the societal relevance of environmental economics while also producing methodological advancements which can keep the discipline at the forefront of environmental research.

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