The Economics of a Just Transition

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Introduction

Climate change mitigation requires ethically defensible, politically acceptable, and implementable interventions. There is a growing emphasis by stakeholders and policy makers 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 they often compound injustices from past emissions and those associated with other arguably mismanaged transitions—for example, automation, globalization, and digitalization (Weber 2020; Creutzig et al. 2022; Hanson 2023).

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; 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

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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 article 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 and also go 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 two growing bodies of scholarship: environmental justice, which analyzes inequitable exposure to environmental burdens, and climate justice, which focuses on the uneven impacts of climate change (Carleton and Hsiang 2016; Banzhaf, Ma, and Timmins 2019; Bou-Habib 2019; Cain et al. 2024). We also consider key lessons from other disciplines. Ultimately, we highlight future research avenues for environmental economists seeking to move beyond efficiency and effectiveness.

The article is organized as follows. In the next section, we illustrate the history of the term "just transition" and distill four key elements emerging from the academic and policy literature: distributional, restorative, procedural, and recognition justice. The subsequent sections through "Recognition Justice" discuss the extent to which economists have engaged with these dimensions to shape climate change policies. In the final section, we discuss open questions about a just transition with which environmental economics can meaningfully engage.

Historical Roots and Conceptual Framing of the Just Transition

The concept of a just transition has evolved over time, shaped by labor 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. Labor 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 and addresses 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).[1] Increasingly, scholarly work on just transitions also acknowledges the importance of managing adverse impacts on households and energy-intensive industries (Jakob et al. 2020).

[1]The International Labor Organization 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."

Importantly, the just transition has been conceptualized and organized around four key dimensions: distributional, restorative, procedural, and recognition justice (McCauley and Heffron 2018; Abram et al. 2022; Zimm et al. 2024). These dimensions 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). They 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 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, the elicitation of local preferences, and information disclosure in decision-making (Jenkins et al. 2016). Last, "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 (Weber 2020; Hanson 2023; Verdolini 2023).

Distributive Justice

Distribution of Costs

Costs on workers and regions are at the core of the traditional just transition discourse. Environmental economists have investigated potential labor-market costs, evaluating the postimplementation impact of environmental and energy policies on labor demand (e.g., Greenstone 2002; Kahn and Mansur 2013) and earnings (e.g., Walker 2013; Yip 2018). Results vary depending on the policy analyzed. The US Clean Air Act (CAA) reduced employment in most affected counties (Greenstone 2002; Walker 2011; Curtis 2018), the effect being concentrated in pollution-intensive industries. Studies also have evaluated energy price shocks—the effects of relatively sudden changes in energy prices—as a proxy for stringent climate policy; they find similar, if not larger, effects (Kahn and Mansur 2013; Marin and Vona 2019, 2021). Conversely, research on the European Union Emission Trading System (EU ETS)—in which firms purchase permits to emit carbon—shows no negative effects in terms of job losses (Marin, Marino, and Pellegrin 2018; Dechezleprêtre, Nachtigall, and Venmans 2023; Colmer et al. 2025). These uncertain labor-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 reductions in emissions that are expected when less energy is used in response to higher 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 higher costs on workers in fossil fuel and carbon-intensive industries, similar to the case of mass layoffs in heavy industries (Barreto, Grundke, and Krill 2023) or the structural decline of coal production. Another channel limiting job losses is labor reallocation from pollution-intensive to other sectors, as illustrated in a few evaluations. Examples are found in Hafstead and Williams (2018) using general equilibrium models and empirically for the British Columbia carbon tax (Yamazaki 2017).

Small estimates of aggregate labor-market costs mask great variation across regions, sectors, and workers; importantly, other structural transformations may result in compounding effects. For instance, energy price shocks trigger a reallocation of labor away from blue-collar workers toward midskilled technical workers (Marin and Vona 2019). The shift in skill demand induced by the CAA reinforces a long-term structural 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 unemployment spells—especially for workers switching sectors—and larger earning losses for older workers who had longer job tenure in preregulatory 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 labor 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).

"Job multiplier effects" refer to additional jobs that are created or lost as a result of employment in a specific industry; an example is businesses that provide lunch to local workers. At the regional level, there are unclear results about the size of indirect job multiplier effects from declining, spatially concentrated carbon-intensive sectors to other, nontradable sectors. Compared with earlier studies, recent analyses point to larger effects of the decline in coal production on total employment and earnings (Black, McKinnish, and Sanders 2005; Weber 2020; Hanson 2023). Notably, coal-intensive regions in the United States and Europe tend to be economically disadvantaged, raising concerns that the phaseout of coal or carbon-intensive sectors may exacerbate preexisting regional inequalities (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). However, consistent with other studies on the EU ETS, Hernandez Carballo, Mallarino, and Percoco (2026) find mild impacts concentrated in highly regulated sectors but no impacts on total regional employment or increasing regional inequalities. Overall, existing evidence suggests sector-specific employment impacts and geographically concentrated transition risks, though empirical evidence of systematically regressive regional inequality effects remains limited.

Building on public economics, environmental economists have extensively studied the distributional effects on household spending using the theory of the incidence of taxation (Fullerton and Heutel 2007; Hassett, Mathur, and Metcalf 2009; Pizer and Sexton 2019). Taxation is considered progressive if it disproportionately affects higher-income individuals and households and regressive if it falls harder on those less well-off. A tax on carbon is one way of putting a price on carbon so that it is not "free" to generate emissions; another method is to require industries to purchase permits to emit carbon, such as the EU ETS. One proposal to avoid regressivity is "revenue recycling," where the proceeds from a carbon tax or from the sale of emissions permits are returned to households and individuals in the form of reduced taxes or a tax rebate. 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; Sager 2019; Ohlendorf et al. 2021). 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; Steckel et al. 2021; Hänsel et al. 2022). Factors such as commuting needs, public transportation access, and housing efficiency drive energy–cost disparities (Rausch, Metcalf, and Reilly 2011). In lower-income countries, the drivers of horizontal inequality differ. In these countries, car ownership and cooking fuel choices create distinct patterns of disparities; the lowest-income people in poor countries often fall outside of the formal economy, do not own cars, and are likely to use locally collected fuels, such as wood, that are not covered by taxes or permits (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 if carbon-tax revenue is recycled (e.g., Levinson 2019). This is generally the case for automobile fuel-economy standards in the United States (Jacobsen 2013; Davis and Knittel 2019). Subsidies and tax credits for "green" capital equipment, such as solar panels and electric cars, are also regressive, because they require up-front costs that are often too high for poorer households and disproportionately benefit high-income households (Borenstein and Davis 2016; Jacobsen 2019). Policies supporting the deployment of renewable energy point to regressivity in terms of household income (e.g., Dauwalter and Harris [2023], who, however, also find greater per capita benefits for minority households), whereas the distributive impacts of other regulatory instruments, such as "white certificates" (market-based schemes requiring energy suppliers to achieve certified energy savings), research and development funding, and government procurements, remain understudied (see Peñasco, Anadón, and Verdolini 2021 for a review).

Modeling studies have quantified the broader general equilibrium effects of environmental policies (Hafstead, Williams, and Chen 2022; Metcalf and Stock 2023) and their distributional consequences. These studies highlight the key role of compensatory measures, such as revenue recycling, 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 more than half of GDP in most Organisation for Economic Co-operation and Development countries (ILO

2019). These firms face barriers to adopting new technologies and adjusting to structural changes. The barriers include limited credit access, a lack of specialized labor force, and path dependency (difficulty in making changes from existing practices). However, evidence on the impact of climate policies on different types of firms is very scant. Most studies either aggregate data, so that variations among firms are not revealed; are not representative, in that they focus on developed countries; or are limited by data availability, particularly because of the lack of comparable data across countries. One of the European cross-country analyses is 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 EU ETS across countries (Dechezleprêtre, Nachtigall, and Venmans 2023). Another considers energy price impacts on French establishment-level data, accounting for firm size, multi- versus single-establishment, exposure to international trade, and energy intensity (the quantity of energy per unit of output; Marin and Vona 2021). Another important yet understudied distributional impact of climate policies relates to firm-level carbon leakage (Jakob 2023). "Carbon leakage" refers to the situation where a regulation reduces industrial activity and associated carbon emissions in one place but diverts them to another; because carbon mixes globally in the atmosphere, the overall climate impact is not reduced. Moreover, the relocated industrial activity can produce emissions in addition to carbon that are harmful to human health in the new location. For these reasons, the possibility of leakage has serious implications for the just transition.

Distribution of Benefits

The transition to a low-carbon economy also creates benefits, including for the most vulnerable individuals. Poorer households, usually located near polluting plants, can disproportionately benefit from improved air quality, a cobenefit of decarbonization; for recent reviews, see Banzhaf, Ma, and Timmins (2019) and Cain et al. (2024). Research on market-based environmental policies, such as emissions trading, points in 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 (Weber 2021; Hernández-Cortés and Meng 2023). For Southern California's emissions trading program (RECLAIM), Fowlie, Holland, and Mansur (2012) find minimal or no demographic disparities in pollution exposure, whereas Grainger and Ruangmas (2018) find uneven benefits, potentially because of choices in how their study was modeled (Cain et al. 2024). In addition, nonmarket environmental regulations, such as 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).

Coal production is associated with increased mortality risk, particularly from cardiovascular disease among older populations, and disproportionately affects vulnerable communities in the United States (Mueller 2022). While the decline in coal production has therefore improved some health outcomes, the loss of coal jobs has also increased mortality and morbidity risks because of 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 labor-market benefits. In aggregate, job destruction is more than offset by job creation in green jobs—that is, 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 that are distributed unevenly across workers. On the one hand, the energy transition is found to be skill-biased, favoring workers with better outside options in the labor market. For instance, green jobs require more on-the-job training; education in science, technology, engineering, and math; and technical skills (Consoli et al. 2016; Vona et al. 2018; Saussay et al. 2022; Popp et al. 2024) than similar occupations, but no additional years of formal education (Popp et al. 2021; Curtis and Marinescu 2023). 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 in the economy and labor market (Popp et al. 2021). In addition, if global warming were decreased, that would benefit workers in occupations with larger heat-stress exposure, such as farm workers and construction workers, who are generally from poorer households (Park, Pankratz, and Behrer 2021).

In addition, there is a limited overlap between geographic areas where low-carbon jobs are created and those where jobs are lost (Saussay et al. 2022; Lim, Aklin, and Frank 2023). This suggests that spatial barriers can be a significant constraint and can increase relocation costs for low-skilled workers from more vulnerable communities seeking jobs. Yet the same literature shows consolidated evidence that green jobs and "brown" jobs (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 labor markets (Popp et al. 2021). To date, a full welfare assessment of all costs and benefits has not been undertaken.

The benefits of green jobs also depend on the wage scale they offer. Descriptive evidence points to a modest but positive wage premium (higher wage for these jobs) for low-carbon occupations in Germany (Antoni, Janser, and Lehmer 2015), the United States (Vona et al. 2018), the United Kingdom (Whittard et al. 2025), and cross-country (Bluedorn et al. 2023). Saussay et al. (2022) confirm these findings. However, they also show that the low-carbon wage premium is smaller than the wage premium earned in fossil fuel occupations, and it is decreasing over time, especially for high-skilled occupations. This reduces 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, existing evidence does not find that green subsidies or historical increases in green production raise average wages in affected sectors (Popp et al. 2021; Frattini, Vona, and Bontadini 2024).

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 (i.e., government expenditures on social benefits and income support), lump-sum payments, and tax reductions (Rausch, Metcalf, and Reilly 2011; Fullerton, Heutel, and Metcalf 2012). These recycling approaches can be compared on the basis of efficiency, equity, and political feasibility (Klenert and Mattauch 2016; Mohammadzadeh-Valencia et al. 2024).

Lump-sum transfers can generate distributional benefits (more equitable income distribution) and increase political acceptability (Williams et al. 2015; Klenert et al. 2018) but cannot address labor-market inequalities. Alternatively, environmental tax reforms reducing the taxation of labor provide a revenue-neutral way to remove preexisting labor taxes that distort employment decisions away from efficient allocation of labor, which would create the double dividend of reducing pollution and increasing employment (Goulder 1995). Yet targeted labor tax cuts face low political acceptability, as they are not seen by citizens as the preferred way to use carbon revenues, 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 labor-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 are larger in areas with a greater prevalence of green skills (Popp et al. 2021). Along similar lines, green subsidies for residential energy efficiency and clean technologies targeted to low-income households—as opposed to untargeted subsidies—could help such households address financial and behavioral constraints (such as knowledge gaps and uncertainty about the technologies), 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 those most affected by carbon pricing (Missbach, Steckel, and Vogt-Schilb 2024). Furthermore, addressing horizontal inequity requires targeting characteristics beyond income, considering energy use and geographic vulnerability (Fischer and Pizer 2019).

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, law enforcement (Rawls 1971), and aspects of participatory justice. Participatory justice includes "process control" (Thibaut and Walker 1978), "representation" (Leventhal 1976), 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 affect procedural justice (see Cain et al. 2024 for a review). These include asymmetric information (where some parties have more information than others), race, income, language proficiency, and capacity for collective action, all of which can influence policy procedures and bargaining outcomes (Shadbegian and Gray 2012; Fowlie, Reed, and Wooley 2020; Timmins and Vissing 2022; Campa and Muehlenbachs 2024). Other research argues that economic decision-making approaches relying on utilitarian approaches (seeking to maximize aggregate social welfare) and focusing on aggregate outcomes (with less attention to who benefits and who bears the costs) often ignore procedural considerations (Ando et al. 2024).

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). Although 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, which proposed a broad set of policies to reduce greenhouse gas emissions in the United States, leading to an estimated social cost of $60 billion in forgone social welfare (Meng and Rode 2019). Similarly, lobbying influenced the design of the EU ETS, leading to grandfathering as a permit allocation rule; grandfathering favors incumbent firms, historically large emitters, and sectors that initially avoided inclusion in the program, such as the chemical and aluminum sectors (Markussen and Svendsen 2005). Procedural imbalances are compounded by low representation of historically marginalized groups in energy jobs (Carley and Konisky 2020), and 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 a 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 (Kalkuhl, Steckel, and Edenhofer 2020; Kalk and Sorger 2023), undermining procedural justice and the speed of the transition.

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

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; Mildenberger 2020; Douenne and Fabre 2022). Conversely, clearly explaining policy benefits typically increases support (Dechezleprêtre et al. 2025). Behavioral economics emphasizes the role of salience in shaping acceptance (Klenert et al. 2018). Salience refers to how much attention a consumer pays to information, such as price, when making a decision; a typical example is that consumers see the electric bill only once a month and tend not to think about this information every time they turn on a light. Highlighting the costs of a policy reduces support (Stokes and Warshaw 2017; Bergquist, Konisky, and Kotcher 2020; Aklin 2021), whereas emphasizing benefits, especially to key political groups, can boost it (Klenert et al. 2018).

Recognition Justice

Different from energy and environmental justice (Schlosberg 2004; Jenkins et al. 2016; McCauley and Heffron 2018), 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 diverse cultural and social identities. Similarly, Young (2002) highlights how misrecognition, through degradation and devaluation at the individual and cultural levels, 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: the measurement of individual or social welfare (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). For example, this is the case when developing renewable energy projects on Indigenous lands without respecting their cultural rights. The energy transition also has implications for equity and for communities' culture and sense of identity (Carley, Evans, and Konisky 2018).

Environmental economists have primarily addressed group identities by indirectly, 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. 2025). Although some environmental policies can be designed to reduce environmental inequalities for racial and ethnic minorities (Currie, Voorheis, and Walker 2023; Hernández-Cortés and Meng 2023), disparities in access to clean technologies exist. For instance, race, gender, and income are key determinants of households' decisions to adopt clean technology in the United States (Vaishnav 2023), and White non-Hispanic households benefit more from energy-efficiency incentives because of higher homeownership rates (Jacobsen 2024).

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

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

The debate around the just transition offers exciting opportunities to advance the field of environmental economics beyond its traditional focus on efficiency and effectiveness and to make its results and methods more relevant. We identify key areas of future work for environmental economists, namely (*a*) labor markets, (*b*) firms, (*c*) the political-economy aspects of the energy transition, (*d*) insights from and collaborations with other disciplines, and (*e*) methodological improvements. Focusing on these areas would ensure a continued and long-standing engagement of environmental economists with the crucial debate on how to promote the transition toward climate neutrality and leave no one behind.

A first promising research avenue relates to labor markets, which are—and will remain—prominent in the just transition debate. To date, four facts largely remain overlooked: (1) labor markets are segmented by skill types, with substantial increased returns (in the form of higher wages) to abstract, social, and technical skills over the past 5 decades; (2) changes in the task content of jobs and the emergence of new jobs are key features of technological change that require rapid supply of training and educational programs; (3) labor markets are highly imperfect, because of labor-market institutions, unions, and firms' bargaining power; and (4) these impacts are geographically concentrated, have disproportionately harmed low-skilled workers in high-income countries, and have created distressed communities through local multiplier effects.

Future research should fill these gaps. Heterogeneous impacts on workers (along several dimensions and geographies) and reallocation and job displacement (linked to skill losses in the new job, decreased job security because of lower unionization, and fewer pay and benefit advantages compared with previous jobs) need to be more precisely quantified. Methods used to study structural labor-market transformations (e.g., Acemoglu and Autor 2011) can be leveraged to more precisely identify affected workers based on the skills required, or made obsolete, by energy transitions, focusing on the outcome of job-to-job mobility (e.g., Curtis, O'Kane, and Park 2024; Brunetti et al. 2025). 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 distill how contextual factors shape new opportunities beyond employment and earning losses for displaced workers (e.g., Hanson 2023), affecting patterns of government transfer payments, population dynamics, and other measures of well-being, such as health outcomes. More research is also needed to identify who the losers are in ambitious climate policies beyond the overstudied 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 and online 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 labor-market trends and exacerbate the political opposition to 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 labor and skills demand; SMEs are very much understudied. Improving the understanding of the barriers that impede access to the technologies, financing, and skills necessary for the transition in firms is crucial in the transition toward a carbon-neutral economy. This is necessary to inform the design of green industrial policy and, more generally, policies that promote strategic autonomy. Strategic autonomy means reducing critical dependencies on third countries in key sectors such as technology and energy by fostering domestic industrial capacity and strengthening supply-chain resilience (Damen 2022). 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 (such as tariffs on carbon-intensive imports). A particularly thorny issue in advancing this research is related to overcoming major data limitations, particularly for less industrialized countries. Last, 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 increase household and worker opposition to climate policies (e.g., Kistinger et al. 2025) and how vested interests in the labor market shape voting for green parties (Cavallotti et al. 2025). Other key areas of future research include obtaining a better understanding of (*a*) political dynamics, which are essential for enabling just transitions; (*b*) the preferences of voters and of elites; and (*c*) how weak policy commitments may result in suboptimal technological investment decisions (Harstad 2020; Besley and Persson 2023; Campiglio, Lamperti, and Terranova 2023). Insights on elite influence from other social sciences (see Sovacool and Brisbois 2019 for a review) suggest that 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 (the value placed on consumption now vs. consumption in the future) for benefit–cost analyses. Future generations lack current political representation and will bear the greatest climate risks (Wang et al. 2023). Importantly, traditional approaches might not capture the dynamic and uncertain nature of long-term environmental consequences (Sterner and Persson 2008; Weitzman 2009; Drouet, Bosetti, and Tavoni 2022). 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 the "not in my backyard" effect (Germeshausen, Heim, and Wagner 2023), which has been 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), and economic losses from other structural shocks such as trade (Bez et al. 2023) or, for example, 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. [2024] on policies that restrict polluting vehicles), how to design inclusive just transition strategies (e.g., Bolet, Green, and González-Eguino 2024), 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) and what type of policies can simultaneously address redistribution and recognition—reducing material inequalities, respecting diverse identities, and addressing both existing and emerging identity-based inequalities, including historical contexts, root causes, and possible remedies (Ando et al. 2024).

A fifth necessary area of focus for environmental economists involves methodological improvements. These relate not only to more sophisticated empirical methods to distill insights based on observable data but also to 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 include additional dimensions such as gender, race, and others (e.g., Emmerling and Tavoni 2021). Furthermore, considerations regarding the degree of labor mobility (e.g., Castellanos and Heutel 2024) and the role of labor-market institutions are largely absent from models. Importantly, standard methodological choices in environmental economics can inadvertently create biases (Ando et al. 2024). For instance, willingness to pay—a measure used to evaluate how much individuals would be willing to pay for environmental improvement—may undervalue improvements for marginalized groups, because willingness to pay is constrained by lower income. Similarly, aggregate-focused benefit–cost analysis (BCA) prioritizes efficiency—the maximization of net social benefits—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. 2024). Alternative welfare frameworks with a focus on justice exist and can be proficiently used in ex ante (preimplementation) assessment of environmental policies. For instance, integrating identity and social norms into their analyses would allow economists to better engage with issues relevant to recognition justice. This could be done through frameworks such as Akerlof and Kranton's (2000) economics of identity, which accounts for utility (well-being) derived from identity validation. Similarly, the costs of misrecognition, such as discrimination or cultural devaluation, could be quantified. 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 modeling 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 to anticipate the effects of policies before they are implemented, and to measure their effects after implementation, will increase the societal relevance of environmental economics and also produce methodological advancements that can keep the discipline at the forefront of environmental research.

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