Monday
June 1, 2026

08:30 – 08:45 Welcome address and Monte Verità intro (Auditorium)

08:45 – 10:00 Gernot Wagner: Innovation Uncertainty Shapes Different Patways Toward Decarbonization (Auditorium)

10:00 – 10:45 *Coffee Break*

10:45 – 12:15 Parallel Sessions 1

Measuring climate damages (Auditorium)	Valuation of nature and biodiversity (Sala Balinth)	Electricity markets (Sala Eranos)	Political economy (Sala Pioda)
Benjamin Peeters: Modeling Climate Damage on Capital: Reconstruction Dynamics and Investment Allocation in Growth Models	**Dennis Engist:** The Value of Biodiversity: Evidence from Migratory Birds	**Nandeeta Neerunjun:** Optimal Electricity Consumption and Storage under Short-Term Renewable Supply Variability	**Till Armbruster:** The Role of Political Power and Strategic Lobbying in Climate Policy Implementation
Roman Eric Sieler: The Impact of Coral Bleaching on Fisheries, Nutrition, and Stunting in East Africa	**Rob Hart:** Saving Genetic Information	**Raul Hochuli:** Decisions at the Grid's Edge: An Improved Spatial PV Expansion in Swiss Residences	**Niko Jaakkola:** Environmental Policy in the Presence of Bias and Uncertainty
Jannik Reinbold: Heat and Inequality: A Theory of Vulnerability to Global Warming	**Moritz Drupp:** Heterogeneous Complementarity Preferences and the Value of Nature	**Francesca Diluiso:** Orders of Importance: Gas, Renewables and the Macroeconomy	**Philip Fliegel:** The Political Economy of Asset Ownership: Evidence from the Global Power Sector
Christian Traeger (Chair): Temperature Shocks and Climate Change: A Conceptual Analysis	**Martin Quaas (Chair):** Urban Population and Urban Nature: A Difficult Relationship	**Doina Radulescu (Chair):** Congestion Management for Electric Vehicle Charging Stations	**Snorre Kverndokk (Chair):** Public Acceptance and the Dynamic Evolution of Adopting Carbon Capture and Storage

12:15 – 12:30 *Short Break*

12:30 – 14:00 *Lunch (Ristorante)*

14:00 – 19:00 ***Hike from Verscio to Ponte Brolla***

19:00 – 20:30 *Dinner (Ristorante)*

*Program version 2 (Changes may still occur)

Tuesday
June 2, 2026

08:30 – 10:00 Andreas Löschel: Navigating the Energy Transition: The Role of Economic Policy Advice (Auditorium)

10:00 – 10:45 *Coffee Break*

10:45 – 12:15 Parallel Sessions 2

Resource extraction & energy transition (Auditorium)	Clean innovation (Sala Balinth)	Sustainable transport policy (Sala Eranos)	Dynamic climate risks & tipping points (Sala Pioda)
Jevan Cherniwchan: Energy Transitions in the Long Run: Theory and Evidence from English Coal	**Katinka Holtsmark:** Shock Therapy for Clean Innovation	**Beaumont Schoeman:** Working from Home and Vehicle Electrification as Levers for Transport Decarbonisation: Evidence from Switzerland	**Romain Boris Jean-Luc Fillon:** The Need for Regulation of Climate Subsystems
Gilbert Kollenbach: Resource Extraction and Renewable Capacity: Dynamic Limit Pricing and Climate Policy Effects	**Guillaume Wald:** Wired For Change? Clean Technology Adoption and Labor Market Transitions	**Audrey Thenot:** Income-Targeted Subsidies for Low-Emission Cars	**Marco Thalhammer:** IMPACD: An Integrated Macroeconomic Model of Pandemics, Climate Change, and Deforestation
Matti Liski: Uncertainty Barrier in Energy Transition Dynamics	**Katherine von Graevenitz:** The Environmental Bias of Industrial Policy	**Waldemar Marz:** Distributional Effects of Vehicle Emission Standards between Cities	**Soheil Shayegh:** Early Warning Systems
Lucas Bretschger (Chair): Cold War on a Warming Planet: Climate Policy in a Divided World	**Joelle Noailly (Chair):** Supply Shocks in Rare-Earths and Innovation for the Clean Energy Transition: Firm-level Evidence from France	**Nicolas Koch (Chair):** Levers for Change? The Welfare Effects of a Large-Scale Public Transport Subsidy in Germany	**Florian Wagener (Chair):** On the Optimal Management of Weakly Interacting Natural Resources with Tipping Points

12:15 – 12:30 *Short Break*

12:30 – 13:45 *Lunch (Ristorante)*

13:45 – 15:15 Parallel Sessions 3

Carbon pricing & policy (Auditorium)	International climate policy (Sala Balinth)	Resource management (Sala Eranos)	Advice, beliefs & personal finance (Sala Pioda)
Ulrike Morgalla: Corporate Responses to Carbon Pricing and Policy Rollbacks	**Simon Elgersma:** Leadership and Commitment in Oil Markets: Market Power Meets Climate Policy	**Sarah Meier:** Forest Conservation Policy, Additionality, and Socio-Environmental Implications	**Daniel Heyen:** Inform and Persuade
Luca Taschini: Mind the Emission Gap: Policy Stringency Matters for Emission Reductions in the EU ETS	**Sarah Spycher:** Solar Radiation Management and Trade	**Sreoshi Banerjee:** Jurisdictional Reward Funds for Tropical Forest Conservation and Restoration	**Achim Hagen:** Carbon Pricing and Household Finance: How Banks Price Transition Risk in Auto Loans
Tobias Bergmann: Market Design and Complementary Policies for the EU ETS2: Estimating Price and Welfare Effects	**Marina Glaus:** International Environmental Agreements under Other-Regarding Preferences	**Diana Weinhold (Chair):** Conservation Strategies in Contested Environments: Insights from Dynamic Simulations and a Bolivian Case Study	**Marie-Catherine Riekhof (Chair):** Belief Updating, Narratives, and the Dynamics of Resource Use
Ian Mackenzie (Chair): Stuck In The Middle With You: The Impact of Intermediaries In Credit-Based Environmental Markets	**Geir B. Asheim (Chair):** Comprehensive National Accounting for CO2 Emissions Under the Polluter Pays Principle		

15:15 – 16:00 *Coffee Break*

*Program version 2 (Changes may still occur)

16:00 – 17:30 Parallel Sessions 4

Green growth (Auditorium)	Effects of air pollution (Sala Balinth)	Instrument design & policy mix (Sala Eranos)	Carbon risk & uncertainty (Sala Pioda)
Guillaume Delafosse: Green Growth or Degrowth? Green Transition under Ecological Limits	**Piero Basaglia:** When the Boundary Layer Drops: Air Quality and Healthcare Use in Mexico	**Charlotte Plinke:** The Impacts of Agri-Environmental Policies on Multiple Planetary Boundaries	**Jules Welgryn:** Optimal De-Risking Strategies for Breakthrough Technologies: Risk Allocation in Green Industry Transitions
Wilfried Rickels: Removing the Carbon: Optimal Emission Reductions and Carbon Dioxide Removal in the DICE-2023 Model	**Patrick Bigler:** Hazy Dreams: The Impact of Air Pollution on Sleep	**Jannis Käsler:** Emission Taxes and The Nexus between Technology Improvement and Adoption	**Inès Mourelon:** Transition Risk, Preference Shocks, and Climate Policy
Rik Rozendaal: Carbon Dioxide Removal and Directed Technical Change	**Peiyao Shen:** From Coal to Clean: The Impact of Clean Energy Adoption on Children's Health	**Herman Vollebergh:** Choosing Corrective Pricing in the Presence of Other Distortions	**Stefan Baumgärtner (Chair):** Economic Valuation of Environmental Goods Under Knightian Uncertainty
Till Requate (Chair): The Role of Technologies in Mitigating Climate Change: Resource Extraction in the Presence of a Backstop Technology and Carbon Dioxide Removal	**Benjamin Krebs (Chair):** Household Responses to Personalized Risk Information	**Reyer Gerlagh (Chair):** Source Taxes Versus End-of-Chain Taxes in General Equilibrium	

17:30 – 17:45 *Short Break*

17:45 – 19:00 Valentina Bosetti: Who Shapes Green Legislation? The Political Effects of Lobbying in the European Union (Auditorium)

19:00 – 21:30 ***Conference dinner at Grotto America***

*Program version 2 (Changes may still occur)

Wednesday
June 3, 2026

08:45 – 10:00 Simon Dietz (Auditorium)

10:00 – 10:45 *Coffee Break*

10:45 – 12:15 Parallel Sessions 5 (Policy Sessions)

Green industrial policy (Auditorium)	Trade & carbon leakage (Sala Balinth)
Eric Nowak: Navigating the Dual Challenge: Corporate Climate Strategies under Climate Policy and Energy Market Shocks	**Antonia Kurz:** Resource Shuffling & Scrap Trade
Emilia Garcia-Appendini: Rewiring Supply Chains Through Uncoordinated Climate Policy	**Johannes Gallé:** Welfare-Optimal Policy Response to Border Carbon Adjustments: An Emerging Economy Perspective
Sungwan Hong: Green Industrial Policy in a Globalized Economy	**Philipp M. Richter:** Clean Production, Dirty Sourcing: How Embodied Emissions Alter the Environmental Footprint of Exporters
Francesco Ricci (Chair): Strategic Recycling of Critical Raw Materials	**Helene Ollivier (Chair):** Quantifying Climate Damages When Regions Trade: A Structural Gravity Approach

12:15 – 12:30 *Short Break*

12:30 – 13:45 *Lunch (Ristorante)*

13:45 – 15:15 Parallel Sessions 6

Climate uncertainty and learning (Auditorium)	Climate policy & redistribution (Sala Balinth)	Electrification, discounting & public goods (Sala Eranos)	Waste, recycling & footprint regulation (Sala Pioda)
Hannah Römer: Climate Change Beliefs and Savings Behavior: A Macroeconomic Perspective	**Lutz Sager:** The Distributional Effects of Low Emission Zones: Who Benefits from Cleaner Air?	**Henrik Neumeier:** Market Structure, Directed Innovation, and the Electrification Transition	**Maria Alsina Pujols:** Growing Green: How State-Level Banking Deregulation Helped Reduce US Industrial Emissions
Andrea Titton: The Uncertainty Premium of Climate Tipping Points	**Simon Lang:** Coase Meets Negishi: A Property Rights Rationale for Welfare Weights in Climate Economics	**Simon Disque:** An Experimental Test of Dual Discounting for Consumption and the Environment	**Etienne Lorang:** The Social Cost of Waste
Felix Meier: Uncertain Remedies to Fight Uncertain Consequences: The Case of Solar Geoengineering	**Frikk Nesje:** Intergenerational Discounting and Inequality	**Claudia Kelsall:** Income Sharing for Common Pool Resources with Uncertain Productivity	**Michael Sureth:** The Social Cost of Carbon when Accounting for Biosphere Integrity and Land Use Change: An Extension of the DICE Model
Svenn Jensen (Chair): Structure, Shocks, and Speed: Learning's Impact on Optimal Climate Policy	**Jean-Philippe Nicolaï (Chair):** Regulating the Environmental Footprint of Data Consumption: Efficiency and Distributional Effects of Taxation and Quotas	**Sabrina Eisenbarth (Chair):** The Impact of Temporary Group-Level Conservation Incentives Across Diverse Institutional Landscapes	**Chang Hyun Kim (Chair):** Closing the Waste Haven: Innovation Responses to China's 2018 Waste Import Ban

15:15 – 15:30 *Short Break*

15:30 – 16:45 Catherine Hausman: Disruption: The Policy and Economics of Threats to Energy Producer Profitability (Auditorium)

16:45 – 19:30 *Visit to Ascona*

19:30 – 21:30 *Dinner at Grotto Baldoria in Ascona*

*Program version 2 (Changes may still occur)

Modeling Climate Damage on Capital: Reconstruction Dynamics and Investment Allocation in Growth Models

Benjamin Peeters*† Franziska Piontek‡

2026-01-16

Abstract

This paper develops a framework for modeling climate damage directly on capital stocks in long-term multi-regional, multi-sector growth models. We decompose capital into potential stock and an integrity factor representing the undamaged fraction, with investment split between expansion of new capacity and reconstruction of damaged capital. In the baseline formulation, we show that the allocation between new investment and reconstruction does not affect the equilibrium paths of capital, output, or consumption—the optimizer faces no trade-off between investment types. We then introduce several mechanisms that create distinct roles for reconstruction: direct welfare effects from capital damage, differential gestation lags, higher returns from restoring damaged capital (which earned average rather than marginal productivity), sectoral bottlenecks, location-specific infrastructure, supply chain amplification, and labor displacement from housing destruction. These channels differ in whether they generate reconstruction preferences, capacity constraint effects, or both, and have distinct implications for shock persistence and consumption-investment dynamics.

JEL classification: Q54, E22, O44

Keywords: climate damage, capital dynamics, reconstruction, integrated assessment

*We thank Johannes Koch and Christian Otto for valuable discussions and feedback.

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The Impact of Coral Bleaching on Fisheries, Nutrition, and Stunting in East Africa

January 13, 2026

Abstract

A potential avenue for climate change impacts is damage to ecosystems relevant to human well-being. A prime example for such an ecosystem is the coral reef, which is both vulnerable to coral bleaching driven by climate change and provides resources for fisheries. Based on a novel large-scale coral bleaching dataset created using satellite imagery and relying on long-term sea surface temperatures as instruments, this paper analyzes whether coral bleaching impacts fish catch, household consumption and adaptation as well as child malnutrition in East Africa. Results confirm the hypothesized chain of consequences; coral bleaching significantly reduces fish catch, leads to a reduction in protein consumption and forces households to reduce assets. It furthermore causes exposed children to be too short for their age, which is an indicator for early childhood malnutrition. These results show that climate-induced coral bleaching presents a considerable threat to the economic well-being of coastal communities.

Preliminary Draft

Heat and Inequality: A Theory of Vulnerability to Global Warming *

Jannik Reinbold† Thomas Steger‡

January 15, 2026

Abstract

Global warming reshapes the probability distribution of weather events, increasing exposure to heat along both the extensive and the intensive margin. Understanding the consequences of climate change requires studying the implications of such weather patterns. To advance this understanding, we propose an economic life-cycle model that structures the effect of heat on lifetime utility. Agents face mortality risk linked to stochastic temperature and respond through endogenous adaptation and health investment. These choices generate heterogeneous vulnerabilities to heat. We calibrate the model to U.S. data on health, income, and climate and show that global warming imposes regressive welfare losses that intensify with age, as poorer and older individuals face higher utility losses. In contrast, disbelief in climate change produces a progressive welfare pattern by reducing adaptation among richer agents. The paper highlights how differences in resources, physiological resilience, and beliefs jointly shape the unequal burden of global warming.

Keywords: *Climate Change, Weather Extremes, Heat, Mortality, Inequality, Adaptation, Expectations, Welfare, Life-Cycle Model, Deficit Accumulation Model.*

JEL Classification: *I14; Q54; D63; D15; J17.*

*We thank Martin Quaas and Kenneth Judd for valuable comments and suggestions.

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Temperature Shocks and Climate Change: A Conceptual Analysis*

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Version of December 2025

Abstract: This paper addresses the challenge of accurately modeling and estimating climate change damages. Time series approaches rely on weather shocks, while cross-sectional analyses capture climatic differences but suffer from omitted variable bias. Climate is defined as the statistical pattern of weather that persists over time and allows for adaptation, unlike unpredictable weather realizations. To assess econometric approaches, I (i) integrate forward-looking adaptation into a full-fledged integrated assessment model of climate change permitting an analytic solution and (ii) generalize the insights based on a dynamic stochastic envelope argument. I show how a carefully designed time series (or panel) estimation strategy can comprehensively identify the costs of climate change, including the indirect identification of unobserved adaptation costs. The paper also presents the first explicit formula for the social cost of carbon under forward-looking adaptation. This result is not only insightful in its own right but also valuable for clarifying and refining prevailing envelope-theorem arguments in the literature and for emphasizing that adaptation costs are part of the social cost of carbon.

JEL Codes: Q54, H23, D80, D62

Keywords: adaptation, climate change, climate econometrics, damages, integrated assessment, social cost of carbon, uncertainty, identification

*This paper draft benefited greatly from discussions on adaptation and damage estimation with Max Auffhammer, Lint Barrage, Geoffrey Barrows, Ghassane Benmir, Tamma Carleton, Chris Costello, Meredith Fowlie, Lars Hansen, Sol Hsiang, Niko Jaakkola, Derek Lemoine, Jérémy Lucchetti, Larry Karp, Felix Kübler, Gisle Natvik, Pierre Mérel, Kyle Meng, Espen Moen, Hélène Ollivier, Filippo Pavanello, Rick van der Ploeg, Simon Scheidegger, Guglielmo Zappala and seminars at the University of Zurich, CESifo, Paris School of Economics, Mohammed VI Polytechnic University, University of Freiburg, MCEE 2025, AUROE 2025, EAERE 2025, University of Geneva, BI Norwegian Business School, and the University of Bologna.

The Value of Biodiversity: Evidence from Migratory Birds

Frederik Noack, Dennis Engist & Ashley Larsen

2025-06-23

Abstract

We estimate the economic value of biodiversity by estimating the value of pest control services provided by migratory birds to U.S. agriculture and forestry. Exploiting exogenous variation in migratory bird returns driven by winter habitat conditions in South America, we find that a 10% decline in avian biodiversity reduces crop revenues by 1.1% and increases forest pest outbreaks by up to 1.2%. We find that the elasticity of substitution among bird species is high in agricultural landscapes and lower in forests, implying that ecosystem service provision in agriculture depends more on the total abundance of birds, while in forests it depends more on the number of species. These findings identify biodiversity as a productive input and highlight cross-border externalities from environmental degradation.

1 Introduction

"*That insectivorous birds are of immense value to the farmer and the forester is so well-known that their protection is now believed to be absolutely necessary to the welfare of any country.*"(Henshaw, 1907)[1]

Biodiversity is essential for ecosystem functioning and a wide range of economic activities that it supports. Yet, the economic consequences of its global decline remain largely unmeasured. While economists have long theorized the value of biodiversity (Weitzman, 1992, 2000; Brock and Xepapadeas, 2003; Polasky et al., 2005; Fenichel et al., 2024; Dasgupta, 2021), empirical estimates of its causal impact on economic production remain scarce. A growing literature has begun to document the economic impacts of species' decline or recovery (e.g., Raynor et al., 2021; Frank and Sudarshan, 2024; Frank, 2024), but most studies focus on individual species or groups of similar species in isolation. This misses a central insight from ecology: ecosystem services provided by biodiversity depend

[1] Henry Henshaw was the head of the U.S. Biological Survey and a proponent of the Weeks-McLean Act for protecting migratory birds. The Act was signed by President Woodrow Wilson in 1913. More than 100 years later, empirical evidence supporting the benefits of birds to farmers and foresters remains elusive.

Saving genetic information[☆]

Pedro Naso[a], Rob Hart[a], Björn Lindahl[b]

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[b]*Department of Soil and Environment, Swedish University of Agricultural Sciences, Box 7014, 750 07 Uppsala, Sweden.*

Abstract

We find plot-specific adjustments to cutting ages of Swedish forest plots which maximize—for a given conservation budget—expected fungal diversity according to criteria from conservation biology. The optimal policy is essentially bimodal: the majority of plots belong to one of two subsets, on one of which cutting is delayed by several decades, while on the other cutting is scarcely delayed at all. This shows how inhomogeneity across plots—both with regard to the lost profits from delay, and the benefit in terms of boosting the survival chances of threatened fungal species—should play a crucial role in conservation policy. Our work is one of only a handful of applications of Weitzman's famous 'Noah's ark' approach to conservation of genetic information, and the first to use rigorous econometric methods to tackle a large-scale problem of competition between extraction of market goods from the land, and conservation of genetic information.

1. Introduction

Paraphrasing Weitzman (1998), how do we choose between alternatives for preserving fungal biodiversity in Swedish forests? To answer this question we assemble a dataset from 1812 Swedish forest plots—on both the presence of fungal species based on DNA sampling and sequencing, and characteristics such as tree age and volume, soil quality, and fire risk—and use it to estimate forest owners' profits as a function of cutting age, and the probability of detecting each fungal species on each plot as a function of stand age. Given these functions, we find cost-effective, plot-specific adjustments to cutting ages which maximize expected fungal diversity according to criteria from conservation biology.

Conservation of biodiversity is rising to the top of the global sustainability agenda, but despite Weitzman's seminal work (1992; 1993; 1998) we still lack even an agreed definition of what it is we are trying to conserve.[1] We are frequently concerned about the preservation of one or more specific—often charismatic—species, such as the Bengal tiger or the blue whale. In other cases we may be concerned about the ecosystem services provided by a group of species, such as pollinators. These concerns, while related to the desire for biodiversity preservation, are clearly not equivalent to it. In the former case the concern regards particular species rather than biodiversity per se, and in the latter it regards the ecosystem service; if for instance we develop cheap and effective nano-drones which remove the need for living pollinators, the concern about their preservation disappears if it is purely based on the service they provide. Clearly, an overarching goal to protect biodiversity must either be justified on the basis that it is an imperfect proxy for other goods, or it must be grounded not on the phenotypes of individual species but on their genotypes, it must be about *saving genetic information*.[2]

[☆]Thanks to ...
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[1]See also Solow et al. (1993).
[2]Note that many authors have argued for the opposite conclusion, that to study loss of genetic information in isolation is a mistaken approach. See for instance Fenichel et al. (2024) and Brock and Xepapadeas (2003). Frank and Sudarshan (2024) provide a striking example of how undreamed-of ecosystem services provided by a species are understood once a species disappears and its role in the ecosystem is thus revealed; if such cases are the rule rather than the exception then this would be an argument for using biodiversity as a proxy

Heterogeneous complementarity preferences and the value of nature

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Björn Bos[c], *and* Simon Disque[a]

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January 12, 2026

Abstract: We study the heterogeneity in preferences regarding the limited substitutability of environmental public goods versus private consumption and how it affects the economic value of nature. We show theoretically how mean marginal willingness to pay (WTP) depends on the distribution of complementarity preferences, and that it increases in preference heterogeneity. We provide a sufficient statistic for the contribution of preference heterogeneity to mean WTP and derive heterogeneity-equivalent representative agent preferences. We subsequently introduce an experimental framework to elicit individual-level complementarity preferences directly, applying it to incentivized and hypothetical trade-offs between market goods and forest ecosystem services. Estimating preference parameters for a large general population sample, we document substantial preference heterogeneity. The majority of estimates imply a preference for complementarity, with a median elasticity of complementarity of around 2.5, and a heavy long tail. We illustrate how accounting for the heterogeneity in complementarity preferences may considerably increase the economic value of nature.

JEL-Classification: Q51, Q56, H41, D64, C99

Keywords: Substitutability, complementarity, heterogeneous preferences, non-market valuation, experiment, donations, public goods

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*Correspondence: Department of Management, Technology, and Economics, ETH Zürich, Zürichbergstrasse 18, 8092 Zurich, Switzerland (email: mdrupp@ethz.ch). We are grateful to Sarah Jacobson, Andreas Lange, Marion Leroutier, Daniel Phaneuf, Martin Quaas, Christian Traeger, three anonymous reviewers, and audiences at ASSA 2026, the 2020 World Biodiversity Forum, the 2023 NBER-CRIW Conference on Measuring and Accounting for Environmental Public Goods, NAERE 2024, and at Bremen, Lucerne, Mannheim and Yale for helpful comments, to Mark Lustig for excellent research assistance, Alexandra Herter for language editing, and to the WiSo Research Laboratory for administering the donations. We acknowledge support from the German Federal Ministry of Education and Research (BMBF) under grant number 01UT2103B.

Urban Population and Urban Nature: A Difficult Relationship

Konstantin Reisner[1,2] and Martin Quaas[1,2]

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January 12, 2026

Abstract

Increasing urban population puts urban nature – in particular green space and clean air – under pressure, as competition for space increases and more people emit pollutants. Yet, urban nature has characteristics of a public good. An increasing number of people benefiting from urban nature calls for an increasing supply, ceteris paribus. This paper develops a theoretical framework to formalize this trade-off. We show that in the unregulated market equilibrium, urban nature declines with urban population density. Under efficient supply of urban public goods, the supply of urban nature is higher, and may increase or decrease with population density, depending on the elasticities of marginal utility and marginal costs.

The empirical findings, based on global data, support the theory. For low quality of governments we find a negative effect of urban population density on green space and air quality, an effect that is mitigated by better governmental quality. We find that, from the worst to the best governance in our sample, the population elasticity reduces in absolute value from -0.95 to -0.19 for green space and -0.58 to -0.02 for air quality. That is, in our preferred specification, the sizable negative effect of population growth under bad government almost vanishes for cities with good policies. For the upper quintile of governmental quality, the population elasticity of environmental public good supply is positive.

JEL-codes: H41, H11, R14, Q52, Q58, R11

Keywords: Urban Economics; Government Effectiveness; Environmental Public Goods; Urban Green Space; Air Quality; Population Density; Public Policy

Parts of this analysis were supported by generative AI tools. ResearchRabbit was used for searching and summarizing literature. ChatGPT 4o, 5 and 5.1 was used for coding and style checking. All content was critically reviewed and edited by the authors to ensure scientific accuracy and integrity.

Optimal electricity consumption and storage under short-term renewable supply variability*

Martin DHAUSSY[a,1], Nandeeta NEERUNJUN[b,2,*], Hubert STAHN[c,1]

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Abstract

The expansion of intermittent electricity increases supply variability and requires greater flexibility from consumers. This results in welfare losses for these agents, which can nevertheless be mitigated by energy storage. Our model analyzes these welfare consequences in the context of short-term variability in renewable energy given fixed dispatchable and storage capacities. We explore an optimal control problem that determines a welfare-maximizing electricity consumption path by adjusting dispatchable and stored energy throughout the short-term production cycle of renewables. This optimization problem identifies three regimes (no storage and active storage, with or without capacity constraints) and provides the associated consumer welfare over this cycle. Under all three regimes, a certain degree of consumer flexibility is part of the optimal solution and entails welfare losses. Active storage reduces these losses but cannot eliminate them completely due to the energy conversion losses induced by this activity. However, when storage capacity is constrained, a proactive adjustment of this capacity can offset the losses.

Keywords: intermittent renewable, energy storage, electricity consumption, welfare analysis, optimal control

JEL classification: D61, Q40, Q42

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Decisions at the Grid's Edge: An Improved Spatial PV Expansion in Swiss Residences

Conference Paper - January 2026

Author: (redacted)

Abstract

The rapid expansion of residential photovoltaic (PV) installations is a central pillar of the transition toward a renewable energy production. However, increasing PV penetration is beginning to create congestion in low-voltage distribution grids, risking damage to network components, production losses and constraints on further PV deployment. Using a newly developed spatial expansion model for a Swiss subregion, this paper quantifies the timing and magnitude of grid-related losses in the near future. The results further illustrate how a small adjustment to existing subsidy schemes can delay binding grid constraints by one to two years and reduce congestion-related losses by up to 6.02 percent. While such a subsidy design does not represent a first-best economic solution, it offers a practical and readily implementable approach, addressing the coordination challenges associated with decentralized residential PV adoption.

1 Introduction

The global debate about the energy transition has been accelerated in recent years both due to more political attention to climate change and a surge in fossil fuel prices. Policymakers at all levels are increasing their efforts to decarbonize their energy production. Photovoltaic (PV) electricity production is playing a decisive role in this transition and is predicted to surpass coal in 2027 with 2350 GW or 22 percent of global cumulative power production capacity (IEA, 2022).

Because the decision of adaptation of residential PV is with individual investors, their installations' impacts on low-voltage grid network capacities are not taken into consideration. A coordination mechanism steering decentralized behavior and avoiding negative effects is still absent. Consequently, grid component overloading has already been observed, requiring costly grid updates or the curtailment of production which in turn slows down the further expansion of renewable energy (REN21, 2023).

Orders of importance: gas, renewables and the macroeconomy *

Francesca Diluiso† Natalie Rickard‡

January 2026

PRELIMINARY – DO NOT CITE

Abstract

The 2022/2023 inflationary episode highlighted the importance of natural gas shocks as a driver of inflation. Some countries, notably the UK, experienced even more severe bouts of inflation, due to their heavy reliance on natural gas, and the pivotal role of natural gas in setting electricity prices. The latter is driven by the use of the 'merit order' electricity pricing system, where gas is typically the marginal generator, setting prices. We embed a stylized merit order electricity pricing system into a canonical New Keynesian framework to show the amplification of gas shocks and how monetary policy responses need to be more contractionary under this electricity pricing system. The substantial rise in renewables production has increased the disconnect between the price setting power of gas, relative to its smaller role in producing electricity. We show that during the transition to a greener electricity system, the merit order could substantially amplify renewable intermittency and increase the impact of electricity price shocks. However, in the long term, a green electricity system should deliver greater price stability.

Keywords: energy transition; gas price shocks; monetary policy; renewable intermittency.
JEL codes: E32; E52; Q43.

*The views expressed in this paper are those of the authors and do not necessarily reflect the official policy or position of the Bank of England or its committees. We thank Boris Chafwehé, Lucio D'Aguanno, and Boromeus Wanengkirtyo for insightful discussions and comments.

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Congestion Management for Electric Vehicle Charging Stations [*] [†]

Jing Li[‡] Doina Radulescu[§]

January 12th, 2026

[PRELIMINARY DRAFT. PLEASE DO NOT CIRCULATE PUBLICLY.]

Abstract

Congestion at electric vehicle (EV) charging stations has been a concern for drivers since the early days of the EV industry, and the concerns and issues grow as new EV sales continue to expand rapidly in many countries around the world. Using data from the charging industries in Germany and Switzerland from 2022 and 2023, we document two policy-relevant patterns in the data: (i) Congestion occurs throughout the EV charging networks in Germany and Switzerland. (ii) The distribution of charging session duration has a long right tail (right-skewed). (iii) Demand spills over from a congested charging station to neighboring ones. To evaluate the effectiveness of three congestion-management policies, we specify a model where drivers choose trip departure times, where to charge, and how long to charge: expanding the number of connectors, upgrading the electrical power, improving service quality (i.e reducing outages), and congestion pricing.

Keywords: Electric Vehicles, Congestion, Queueing

JEL Codes: L00, L90, L91, R41,

[*]The authors thank Gabriel Kreindler, participants at the Toulouse School of Economics Environmental Economics Seminar, the Navarra Workshop on the Economics of Climate Change and Environmental Sustainability and the Harvard Kennedy School Workshop on the Economics and Policy of Electric Transportation Charging Infrastructure for helpful discussions and comments.

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The Role of Political Power and Strategic Lobbying in Climate Policy Implementation

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January 16, 2026

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Abstract

Economic transformations such as the green transition are often hindered, or at least slowed down, by the concentration of political power among incumbent industries. This paper develops a political economy model to study how political power, uncertainty, and technological transition shape climate policy outcomes over time. We consider firms with political power, which can influence a carbon tax through lobbying under imperfect information about the economic costs of climate policy. Yet they face credibility losses when claims about these costs prove inaccurate. The model yields two main results. First, lobbying is most effective when policy costs are uncertain and credibility constraints are weak. Second, learning about policy costs endogenously limits strategic lobbying by increasing the expected loss of political capital from misleading claims. Our study provides a first step toward understanding why firms increasingly align themselves with climate goals while continuing to obstruct or delay specific policies, and how political power, uncertainty, and political salience shape this pattern over time.

*Armbruster thanks the German Academic Scholarship Foundation. Mattauch thanks the Robert Bosch Foundation

Environmental policy in the presence of bias and uncertainty

January 2026

WORK IN PROGRESS. PLEASE DO NOT CITE.

Abstract

We develop a theoretical model of the European Union emissions trading scheme (EU ETS) in which participants design collectively optimal policy, understanding that they will face heterogeneous political pressure to conduct more or less ambitious policy *ex post*. Member states can commit to an *ex ante* minimum requirement on complementary emission reduction technologies. If policy on these complementary technologies is designed at the Union level, this minimum requirement will also take into account the redistributive effect through permit allocation and the global externality. However, asymmetric information still distorts the emission cap away from the constrained-efficient outcome.

Keywords: climate change; bias; uncertainty; commitment; flexibility

JEL Classification: Q54; D70; D50

The political economy of asset ownership: Evidence from the global power sector*

Philip Fliegel†, Achim Hagen‡, Alex Stomper§

January 16, 2026

Abstract

In this paper, we investigate how political shocks affect asset ownership in the global power sector. Therefore, we gather a unique dataset on 2 million global power plant-year observations including ownership information over time. In a difference-in-differences setting on the power plant level, we leverage the highly surprising first presidential election of Donald Trump as a quasi-exogenous change of the political orientation in the U.S. We find that foreign investors are more likely to sell brown US power plants to home-investors compared to a control group of global power plants. The effect is sizeable: the likelihood of this asset transaction increases by more than 8 percentage point for a given power plant, relative to the control group. Conversely, home investors buy less green US power plants after the election shock, while foreign investors from liberal countries increase green power plant purchases. We explain our results by the interplay between the political distance of different investor groups to the new US ideology, as well as the transition risk of the power plants.

Keywords: Political risk, climate transition risk, power plants, DiD, NLP

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January 2026

Public acceptance and the dynamic evolution of adopting carbon capture and storage

Abstract

Public acceptance has influenced the evolution of carbon capture and storage (CCS) in Europe. To study the mechanisms behind this, we use evolutionary game theory where the governmental policy towards CCS, such as subsidies to the industry, is dependent on public acceptance. Public acceptance further depends on the perceived benefits and costs for individuals of CCS. We show that in this model, multiple equilibria may exist, and the starting point as well as the heterogeneity of firms will determine the equilibrium that will be reached over time. While the subsidy is tied to public acceptance, the government can affect development by correcting other imperfections in the market. Using such policy instruments, a new equilibrium may develop with a higher share of investments in CCS. The model also suggests an explanation of the different situations in many countries today with respect to CCS investments and investment plans.

Key words: Carbon capture and storage, evolutionary games, public acceptance, climate change.

JEL classification: C73, H23, Q35, Q38, Q54

Corporate Responses to Carbon Pricing and Policy Rollbacks *

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January 2026

Abstract

Climate policies, particularly market-based instruments like carbon pricing, are well-established as effective tools for reducing emissions. However, the growing prevalence of climate policy rollbacks presents a critical, yet underexplored, question: do climate policy rollbacks undo the effects they had on firm-level emissions and economic activities? Using the introduction and subsequent repeal of Australia's carbon pricing mechanism (2012–2014) as a quasi-experiment, this paper provides novel firm-level evidence of how firms respond to climate policy rollbacks. Using a difference-in-differences framework, the analysis shows that the policy's introduction significantly reduces regulated firms' direct (Scope 1) emissions by approximately 15%. Following the rollback, emissions only partially rebound and do not return to pre-policy levels, indicating asymmetric and potentially non-reversible effects. Reductions are achieved primarily through operational downsizing rather than improvements in emissions intensity or new low-carbon investments. Evidence from the firms' annual and sustainability reports suggests heterogeneous post-repeal trajectories are shaped by firms' prior beliefs about policy permanence and their consequent operational adjustments. The findings underscore that while policy-induced decarbonisation can exhibit path dependence, the credibility and durability of climate policy remain crucial for long-term emission reductions.

Keywords: Climate policy, carbon pricing, policy rollback, uncertainty, emissions.
JEL Classification: Q58, Q52, D22.

* *Corresponding author:* Ulrike Morgalla, ulrike.morgalla@ip.mpg.de
Nisa Erarslan and Paul Titus Pietsch provided excellent research assistance.

Mind the Emission Gap: Policy Stringency Matters for Emission Reductions in the EU ETS

Abstract

We document that firm-level emission reductions under the EU ETS program are strongly influenced by climate policy stringency. We define this stringency as the firm-specific expected compliance gap over time, which in turn is defined as the difference between projected allowances and emissions, adjusted by the allowance price and scaled by sales. By capturing both immediate regulatory pressure and firms' expectations about future compliance obligations, our stringency measure emerges as a key determinant of firms' decisions to reduce emissions. Sectoral analyses confirm that policy stringency remains influential across diverse industries, irrespective of financial constraints or technological barriers. We use the sectoral model to assess progress toward the EU's emission goals by 2030. While the phased reduction of free allowances associated with the Carbon Border Adjustment Mechanism (CBAM) drives emissions reductions in covered sectors, it is insufficient to drive the economy-wide reduction required to meet this goal. Meeting the required regulatory pressure across the economy would entail an immediate carbon price of around €125 per tonne.

Keywords: Carbon pricing; Climate policy; Low-carbon transition; Policy-stringency.

JEL Classification: C58, E58, G32, Q51, Q56, Q58

Market Design and Complementary Policies for the EU ETS2: Estimating Price and Welfare Effects*

Tobias Bergmann† Matthias Kalkuhl Maximilian Kellner
Michael Pahle Lennart Stern

January 2026

Abstract

The EU ETS2 is highly contended in the political discourse because of potentially high prices. Complementary policies and market rules might dampen demand for emission permits and reduce future prices. This paper proposes a dynamic calibrated model of the ETS2 that allows to examine these price effects in a transparent way accounting for (i) changing abatement costs over time and (ii) different designs of price stabilization mechanisms in a modular way. We develop a conceptual framework for calculating carbon-price equivalents of complementary policies. We find ETS2 prices for 2027 in the range of 311 to 422 EUR/tCO_2 depending on the assumed equation of motion of the price elasticity over time. Complementary policies consisting of national carbon prices, EU vehicle regulation and international offsets can reduce the ETS2 price by up to 56 EUR/tCO_2 in total. We also study the proposed one-year delay of the ETS2 and show that postponement increases carbon prices in subsequent periods if the cumulative emissions cap remains unchanged.

Keywords: carbon pricing, emissions trading, complementary policies, EU ETS2, welfare analysis
JEL codes: Q52, Q58, D61, H23

*We would like to thank Ottmar Edenhofer, Simon Feindt, Christopher Leisinger and Kai Lessmann for helpful comments and Anja Wächter for excellent research assistance.

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Stuck In The Middle With You: The Impact of Intermediaries In Credit-Based Environmental Markets

Lana Friesen* Ian A. MacKenzie† Peiyao Shen‡

December 1, 2025

Abstract

This article investigates the impact of market intermediaries in credit-based environmental markets, such as carbon or biodiversity credit markets. We develop a model in which firms can participate in the market either directly or via an intermediary. We focus on a market with demand uncertainty and evaluate two common forms of contracts between firms and the intermediary: a fixed-price contract and a share-price contract. Our theory predicts that introducing a dominant intermediary, under either contract type, increases the overall supply of credits but has an ambiguous impact on industry profits. A trade-off exists, where the intermediary enables firms with high entry costs (but low marginal costs) to enter the market but this is at the expense of incumbent firms, who reduce their supply and profits. We design a laboratory experiment to test our theoretical predictions for the case of positive intermediary effects. The results are largely consistent with theory and confirm the benefits of intermediaries over a range of parameter values that reflect varying demand and supply conditions. We additionally find a fixed-price contract is more effective at increasing supply than a share-price contract.

Keywords: Carbon Credits; Biodiversity Credits; Intermediary; Experiment; Transaction Costs
JEL Codes: C92, Q54, Q57

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The Impacts of Agri-Environmental Policies on Multiple Planetary Boundaries

January 2026

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Abstract

Agriculture is a leading driver of global environmental degradation, contributing to the transgression of several planetary boundaries. Governments have implemented diverse agricultural environmental policies, but their effectiveness across multiple environmental dimensions as well as their interactions remain largely unclear. This study provides the first global, multi-dimensional assessment of agricultural policies, combining a comprehensive policy database with panel data on key environmental indicators. Using a generalized difference-in-differences framework and machine-learning–based structural break detection, we identify policies that induce significant changes in environmental damage trajectories and evaluate their trade-offs. Preliminary results reveal heterogeneous policy impacts, with market-based interventions appearing particularly effective in mitigating environmental pressures. Institutional factors are evaluated in their relevance for policy effectiveness. Our findings aim to offer actionable insights for aligning agricultural production systems with environmental sustainability goals.

Emission Taxes and the Nexus between Technology Improvement and Technology Adoption

November 28, 2025

Abstract

We study the impact of a policy mix, consisting of an emissions tax and an R&D subsidy on both abatement technology improvement (R&D) and technology adoption. In an upstream industry with market power (monopoly or duopoly) an improved abatement technology is developed for polluting downstream firms that are subject to the aforementioned policy mix. These firms can adopt the new technology, which has different value for each firm, leading to product differentiation. First, we study the optimal policy, which includes output subsidies. Next, we examine second-best policy mixes, such as emission taxes and R&D expenditure subsidies, for different market forms. We identify novel aspects of these policy mixes. For instance, in a monopoly, the optimal second-best policy must account for the intra-marginal benefits of adopting firms. In a duopoly, the policy mix must also address strategic under- or overinvestment by upstream technology developers.

Keywords: abatement technology, environmental R&D, emission taxes, R&D expenditure subsidy, technology adoption, vertical industry structure

JEL codes: D21, D62, H21, L12, L13, O14, O33, Q55

Choosing Corrective Pricing

in the Presence of Other Distortions

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This version: 15 December 2024

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Abstract

This paper compares the efficiency of different corrective tax instruments in a general equilibrium model with externalities and transaction cost. Our model not only allows for separability between inputs and abatement but also for both upstream and downstream firms. We derive a simple general formula that allows to evaluate social welfare impacts of different corrective tax instruments or combinations of tax instruments on their own tax base as well as other (indirect) tax bases in the presence of administrative costs. This formula guides Pigovian rules for specific taxes in a second best setting as well as cost-effectiveness of marginal tax reform of specific taxes on emissions, inputs or outputs, in the presence of other taxes. The paper contains important lessons for tax design of environmental externalities such as carbon pricing. We find that life cycle consumption taxes nor input taxes are good substitutes for emission taxes if linkage between emission and inputs is relatively weak and administrative cost are not too large. Mixed systems of taxes are also considered. Upstream input taxes are not always a good substitute for emission taxes, in particular if abatement for downstream firms is easier relative to the associated administrative costs.

Key words: Externalities, Corrective Taxation, Transaction Costs, .Carbon Pricing, Multiple Instruments, Instrument Packages

Source taxes versus end-of-chain taxes in General Equilibrium

Reyer Gerlagh, Etienne Lorang, Aude Pommeret, Antonin Pottier

January 15, 2026

Abstract

We propose a general equilibrium model to analyze the taxation of an externality, where only the aggregate amount matters. In this common situation, regulation is traditionally considered at the source of the externality. We rigorously define how efficient regulation can also be implemented at the end-of-chain, through taxation of the embodied externality, that is conserved along the value chain through balance or accounting identities, as in the case of greenhouse gas emissions footprinting. We identify conditions under which source-based and/or end-of-chain taxes can implement the social optimum. We show that implementation via end-of-chain taxes requires the existence of equilibrium price schedules under which goods are traded as bundles of quantities and embedded externalities. Our results characterize the informational and pricing structures required, and provide a unified general equilibrium framework for the analysis of environmental policies.

1 Introduction

Externalities violate the independence axiom, hence invalidating the two welfare theorems. Such a market failure calls for government intervention and since Pigou (1936), economists have long advocated externality pricing as an effective and efficient policy to address unintentional spillover effects of economic transactions. However, the price instrument still requires careful selection. For example, there is a broad literature focusing on differences in

Forest conservation policy, additionality, and socio-environmental implications*

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Abstract

The world has lost one-third of its forests due to agricultural expansion. Tropical forests provide immense ecological and climate benefits but face the most rapid declines. Bolivia epitomises this crisis, currently experiencing the highest deforestation rates in South America. This study evaluates the impact of Bolivia's Protected Areas (PAs) established between 1991 and 2023 on a range of economic and environmental outcomes. We employ a novel staggered differences-in-differences (DID) design, matching units based on predicted deforestation risk in the absence of protection using a Random Survival Forest model. This design allows us to explore the determinants of location bias in PA siting, namely, why protection is typically enacted in areas under the lowest threat of conversion. Our staggered DID estimates indicate that, on average, PAs reduce deforestation rates by approximately 0.19 percentage points (pp), a substantial effect given background annual deforestation rates of 0.28pp, and avoiding approximately 1.88 $MtCO_2$ emissions. PAs in the highest risk quintile – where the potential for additionality is greatest due to intense land conversion pressure – reduce deforestation rates most substantially, by 0.54pp. Finally, we find no evidence of trade-offs between PA designation and economic outcomes, extinction risk, or carbon storage along the continuum of baseline deforestation risk. Thus, the observed location bias of PAs in Bolivia cannot be attributed to multi-objective planning. These findings underscore the importance of prioritising PAs in high-risk areas to maximise additionality.

Keywords: additionality, conservation policy, biodiversity, deforestation, multi-objective policy, protected areas, Random Survival Forest

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Jurisdictional Reward Funds for Tropical Forest Conservation and Restoration

Sreoshi Banerjee[*], Max Franks[*], Matthias Kalkuhl[*†], Lennart Stern[*‡], Xuan Xie[*]

January 16, 2026

The latest version of this paper is available here.

Abstract

Tropical forests are disappearing at an alarming rate, yet large efficiency gains remain untapped in international climate finance. A promising solution is to pay countries directly for forest conservation based on measured deforestation rates. However, existing payment schemes have a critical flaw: they set individual baselines for each country, often adjusted based on past performance. This creates a "ratchet effect"- countries deliberately underperform today to avoid tougher targets tomorrow, undermining effectiveness. We propose an optimized jurisdictional reward fund (JRF) with a universal, formula-based design that avoids this perverse incentive. We explore the optimal design of the Reversing Deforestation Mechanism (RDM) proposed by Assuncao et al. (2025), a jurisdictional reward fund that would pay jurisdictions on the basis of the net deforestation rate, defined as the emissions from deforestation and degradation minus the carbon captured through forest restoration. In this paper, we develop a dynamic model in which countries choose net deforestation rates in response to reward payments linked to a universal reference level. We show that static, contemporaneous incentives dominate dynamic, stock-based incentives, implying that optimal design can be well approximated using a static framework. We derive closed-form formulas for the optimal reference level, reward rate, and emission reductions as functions of budget, calibrated to empirical deforestation data from 76 tropical forest countries (2002–2024). Using a uniform distribution approximation, we show remarkable tractability with less than 10% error compared to discrete-country models. In the funding game, China, EU emerge as a stable coalition that would each year donate USD 9.6 billion out of collective self-interest, avoiding an annual flow of 213 MtCO2 emissions by saving an annual flow of 0.52 million hectares of tropical forests.

Keywords Reward Funds · Tropical Forests · Deforestation · Tropical Forest Forever Facility · Incentives

Declarations of interest: None

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Conservation Strategies in Contested Environments:

Insights from Dynamic Simulations and a Bolivian Case Study*

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December 17, 2025

Draft version – for discussion purposes only

Click here for the latest version of this draft

Abstract

Conservation planning studies typically treat threats as exogenous and evaluate siting rules from a planner's perspective. We argue that conservation is often contested, and develop a sequential land-claim game that models conservation as a dynamic, adversarial contest between conservationists ("Greens") and developers ("Farmers"). We explore the framework in a *Claims World* that isolates the role of rivalry and leakage, and in a *Budget World* that introduces procurement constraints, decomposing outcomes into a Pure Strategy Effect (PSE)—the intrinsic quality of sites a strategy targets—and a Displacement–Leakage Effect (DLE)—the spillover gains from displacing developers' preferred sites when leakage is incomplete. Our results generate several counterintuitive patterns. First, the link between threat-weighting and additionality breaks down once developer adaptation is allowed. Second, reducing leakage can paradoxically increase misallocation. Third, the textbook ratio-greedy rule (maximise efficiency) is systematically *dominated* by the simple value-greedy rule (maximise environment): we explore this 'knapsack reversal' more formally and show how it can produce a 'disappointment gap' between static (Marxan) planning and dynamic implementation. We then transport our dynamic contest to a Bolivia-based planning board constructed from biophysical data and confirm that the qualitative rankings from the simulations carry over, and adversarial outcomes lie well below the static cost-effectiveness upper bound. Tiny-grid equilibria, formal analysis and robustness exercises in the Appendix show that these patterns are consistent with best-response logic rather than artefacts of modelling choices. Together, the results suggest that robust conservation in contested landscapes requires strategies that anticipate adaptation, not just static threats. Replication materials and code are available via GitHub and archived on Zenodo (DOI: 10.5281/zenodo.17114490).

Key words: Conservation strategies, Additionality, Adversarial procurement, Monte Carlo simulation

JEL classifications: Q01, Q57, Q24, C72

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Inform and persuade

January 16, 2026

Abstract

Advice plays a central role in health, personal finance, and energy efficiency investments. How should a benevolent expert give advice to a biased agent, i.e an agent who misses relevant aspects of the decision problem or updates information irrationally? The expert faces two motives: to inform the agent to enable better decision-making, and to persuade the agent away from suboptimal choices that stem from their biases. In a Bayesian persuasion framework, we demonstrate that better information can be detrimental but full information disclosure is still optimal.

Keywords: advice; risky decisions; Bayesian persuasion; information design; bias; behavior; non-Bayesian updating

1 Introduction

We study settings in which a well-intentioned expert aims to improve an agent's decision by choosing what evidence becomes available, for example, whether to commission a diagnostic test of medium or high accuracy. The agent directly observes the test result but may be behaviorally biased in multiple ways, for instance misinterpreting evidence or failing to fully account for relevant consequences of the choice. Therefore, the expert must select evidence that is not only informative from her point of view, but also robust to the agent's bias.

For a concrete illustration, consider the clinical challenge of treating *Plasmodium vivax* ("vivax") malaria. Patients may be offered a *radical cure*—a course of antimalarial drugs that clears dormant parasites in the liver and thereby prevents relapses—but for some patients the same drugs can be dangerous. In particular, patients with an inherited enzyme deficiency (glucose-6-phosphate dehydrogenase, G6PD, deficiency) face a risk of severe hemolysis, i.e. a rapid breakdown of red blood cells, when exposed to these medications. Because a patient's G6PD status is typically unobserved, the clinician (the expert) may commission a diagnostic test that informs the patient's binary choice: to take the radical cure or not.

The clinician often has several diagnostic tests to choose from. In the malaria example, these include an intermediate-accuracy fluorescent spot test that can be implemented with basic laboratory capability and a highly accurate quantitative laboratory assay involving spectrophotometry (Devine et al. 2020).[1] The clinician is rational: she weighs

[1]For more information on this example, see Section 8 and Appendix E.

Carbon Pricing and Household Finance: How Banks Price Transition Risk in Auto Loans*

Philip Fliegel†, Achim Hagen‡, Nicolas Koch§, Nolan Ritter¶

November 24, 2025

Abstract

We study the impact of carbon pricing on household finance using European microdata on loans for internal combustion engine vehicles. Exploiting cross-country variation in the same car models with a difference-in-differences design, we find that banks respond to Germany's carbon price announcement by raising interest rates by 0.5 percentage points, with larger increases for loans on fuel-intensive vehicles and for longer maturities. Banks also shorten loan maturity, reduce amounts, and shift to linear repayments, while households choose more fuel-efficient new cars. Captive banks respond more strongly than commercial banks. Collateral and default risk channels jointly explain these adjustments, highlighting household finance as a key transmission channel of climate policy.

JEL codes: G21, G50, G51, Q54, Q58
Keywords: Credit pricing, climate policies, climate transition risk

* We thank Max Bruche, Alvin Chen, Andreas Hoepner, Beatriz Mariano, Marcus Opp, Loriana Pelizzon, Klaus Schaeck, Suphi Sen, Jan Starmans, Alex Stomper, the participants of the Dutch Sustainable Finance Workshop 2025, the 2025 EEA, the 2025 EAERE, the Stockholm School of Economics PhD Seminar, the 7th JRC Summer School on Sustainable Finance, the Research Symposium on Finance and Economics (RSFE) 2025 and the LAPE Spring Workshop 2025 for their helpful comments and suggestions. We also thank Cosima von Mierlo for excellent research assistance. We acknowledge funding by the Leibniz Competition under grant K462/2022 and the German Federal Ministry of Education and Research (BMBF) under grant 01UU2205A.

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Belief Updating, Narratives, and the Dynamics of Resource Use *

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Preliminary Version, January, 2026

Abstract

Beliefs about the world are shaped by narratives, which in turn influence economic decisions and market outcomes. When narratives fail to align with observed reality - for example of a shock changing underlying dynamics related to the state of the world - agents may persist in suboptimal strategies until discrepancies become untenable. This paper develops a formal model of belief updating and narrative switching where agents follow either an agency narrative (believing their actions affect the state of the world) or a no-agency narrative (believing the world develops exogenously) to examine intertemporal feedback between the state of the world and narrative types. We provide empirical evidence for both types of narratives related to climate change and ocean use. Using empirical evidence on fishery management, we show that agents historically adjust their behavior only when re-estimated (observed) resource stocks deviate from initial estimates (beliefs) by 25%.

Our model demonstrates that prevailing narratives fundamentally alter equilibrium outcomes. For climate change, an agency narrative leads to lower emissions

*We thank participants at the EAERE conference 2025 as well as Martin Quaas and Biao Huang for helpful comments.

and carbon concentrations compared to a no-agency narrative. In fisheries, however, the effects are more nuanced: while fish stocks are larger under agency, harvest levels and profits depend on the interaction between narrative prevalence and belief rigidity. Surprisingly, agents under a no-agency narrative systematically overestimate profits, which may explain its persistence despite worse environmental outcomes.

These findings contribute to the literature on bounded rationality, dynamic decision-making, and belief distortions. They also yield novel policy insights: reducing the threshold for belief updating and encouraging narrative flexibility can improve both economic and environmental outcomes.

Keywords: narratives, beliefs, natural resources, intertemporal development, climate change, fishery, bounded rationality,

JEL Classification: Q3, Q4, D8

Green Growth or Degrowth? Green Transition under Ecological Limits

Abstract

Can economies grow while staying within ecological limits? We revisit the directed technical change framework of Acemoglu et al. (2012) by relaxing two assumptions central to the green-growth versus degrowth debate. First, we assume that the clean sector also relies on an exhaustible resource (e.g., critical minerals), alongside the dirty sector's reliance on fossil fuels. When the clean resource is relatively costly, a carbon tax induces a larger transitional slowdown than in models without clean-resource scarcity. Long-run green growth remains feasible if clean-resource prices rise and clean R&D is permanently subsidized. Second, we impose a no-backstop cap on the clean share of output, capturing thermodynamic limits to substitution. This yields a finite maximum sustainable scale and requires permanent climate policy: if the cap is far away, policy achieves strong decoupling and then stabilizes the economy at a sustainable level (green growth); if close, managed degrowth becomes necessary. Our analysis suggests that even modest strong-sustainability assumptions, when introduced into an otherwise optimistic green-growth framework, reinforce the message that climate policy must be a lasting institution.

Removing the Carbon: Optimal emission reductions and carbon dioxide removal in the DICE-2023 model

Jonathan Steininger* Wilfried Rickels†

January 2026

Abstract

Atmospheric carbon dioxide removal (CDR) is considered essential for ambitious climate policy and to compensate for expensive-to-eliminate industrial CO_2 emissions. Detailed analysis of different nature-based or rather technical CDR methods is mainly provided by large-scale integrated assessment models derived as part of cost-efficient climate policies to meet certain temperature targets. The consideration of CDR in cost-benefit climate policies is still in its infancy and is primarily limited to generic investigations of CDR. Here, we augment the carbon cycle representation in the most recent version of the DICE model, a neoclassical growth model, and introduced different CDR methods with different carbon storage pathways, direct air carbon capture and storage (DACCS), ocean alkalinity enhancement (OAE) and ocean iron fertilization (OIF). We show that emission reduction through abatement still provides the primary source of tackling climate change efficiently. However, CDR provides great economic use after the complete phase out, and hence after emission reduction can not reduce climate change damages anymore. CDR acts as a tool to bring temperatures after phase-out to pre-industrial levels faster and therefore reduce climate change damage significantly in the long run. While efficient CDR employment has only a minor impact on the SCC in the short run, CDR can decrease the SCC in the long run significantly. We show that the main CDR contribution in our model is provided by DACCS and OAE while OIF is too limited in potential to impact global temperatures. Furthermore, we show how different carbon cycle calibrations impact the efficient deployment level of in particular ocean-based CDR methods, indicating that with rather simple box-model representations, important characteristics of different carbon removal pathways can be analyzed.

Keywords: carbon dioxide removal, climate change mitigation, integrated assessment models, carbon cycle calibration
JEL: Q54

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Carbon dioxide removal and directed technical change*

Rik Rozendaal
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January 16, 2026

Abstract

To meet climate goals novel carbon dioxide removal (CDR) technologies are needed, which are currently too expensive to be competitive. This paper proposes an economic model that features directed technical change and CDR, which is modeled as a public good. Climate change can be mitigated by emission reductions and by removals. Climate policies impact researchers' decisions whether to innovate in clean energy, dirty energy or CDR. We show that the socially optimal pathway involves immediate investment in CDR research while postponing deployment until costs converge with emission reduction, typically late in the century. If R&D cannot be subsidized independently, early deployment becomes necessary to trigger cost reductions, even at high initial costs. Our analysis provides policy insights on the timing of CDR deployment, temperature overshoot and the inefficiency of integrating CDR into carbon markets under certain constraints.

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The Role of Technologies in Mitigating Climate Change: Resource Extraction in the Presence of a Backstop Technology and Carbon Dioxide Removal

by

Leonie P. Meissner, London School of Economics & Kiel Institute

Till Requate, Kiel University

Wilfried Rickels, Kiel Institute

Abstract

This paper analyzes the role of carbon dioxide removal (CDR) and backstop technologies in transitioning to net-zero greenhouse gas emissions. We use a dynamic optimization approach with three carbon stocks – the resource stock, the atmospheric carbon stock, and carbon storage – to analyze the effect of temporary CDR in the presence of a backstop technology on resource consumption. Additionally, we consider multiple renewable atmospheric carbon stocks that decay at different rates. We find that when the resource is abundant and the CO_2 stock in the atmosphere is low enough, the resource alone is used. This is followed by a phase of simultaneous use of the resource and the backstop. Meanwhile, the use of CDR increases rapidly during the in the first years and then converges to a pumping equilibrium in the steady state. The calibration reveals that the backstop plays a more important role in decarbonization than CDR. In a steady state, non-renewable resources are no longer extracted, and the backstop technology fully meets demand.

When the Boundary Layer Drops: Air Quality and Healthcare Use in Mexico*

Piero Basaglia[1,2,3] Luis Sarmiento[4,5,6,†]

This version: January 16, 2026

We use the complete set of administrative public healthcare records in Mexico to provide the first nationwide assessment of diagnosed morbidity attributable to $PM_{2.5}$ exposure across various health conditions in a developing country. By leveraging quasi-random air pollution shocks from variations in the planetary boundary layer height across Mexican municipalities, we determine the causal impact of $PM_{2.5}$ on healthcare demand. Our findings indicate that a marginal increase in $PM_{2.5}$ leads to a 2.3% rise in emergency department admission rates. This effect varies significantly by age group and exposure levels. While most of the increase results from respiratory conditions related to air pollution, we also identify significant impacts on several previously unexplored health issues.

JEL codes: Q53, Q58, I31, I18

Keywords: Air pollution, Public health, Development, Environmental policy, Health inequality

*We are grateful to Moritz Drupp, Björn Bos, Felix Schaumann, Jonas Grunau, Lutz Sager, Nicolas Koch, Hannah Klauber, Johannes Brehm, Henri Gruhl, Iivo Vehvilainen and Lassi Ahlvik as well as audiences in Hamburg, Bordeaux, Berlin, Helsinki, and Gothenburg for helpful comments and feedback. Piero Basaglia acknowledges financial support from IdEx Université de Bordeaux / GPR HOPE.

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Hazy Dreams: The Impact of Air Pollution on Sleep*

Patrick Bigler† Benedikt Janzen‡

January 16, 2026

Abstract

Surprisingly little is known about the causal impact of air pollution on human sleep. Using daily district-level data on sleep duration collected by half a million consumer wearables in Germany from 2020 to 2022, we find that even low levels of particulate matter air pollution adversely affect sleep. We document that a 10 unit increase in the average daily PM10 concentration reduces sleep duration on average by about one minute. To strengthen the causal interpretation of our findings, we employ an instrumental variables approach, using local wind direction as a predictor for local air pollution. Our findings offer a potential mechanism linking air pollution to a wide range of human outcomes. Although the estimated effects are modest in magnitude, the critical role of sleep in human well-being highlights the potential social burden of pollution-induced sleep loss.

Keywords: Air Pollution, Sleep

JEL Codes: I12, Q52, Q53

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From Coal to Clean: The Impact of Clean Energy Adoption on Children's Health

Yvonne Jie Chen, Li Li, Shiko Maruyama, Peiyao Shen*

May 27, 2026

Abstract

This study examines the health effects of a clean heating policy in rural areas of a county in northern China. Exploiting the staggered rollout of the policy and linking administrative health insurance claims with village-level policy timing, meteorological data, and meter-level electricity records, we estimate a difference-in-differences model. We find that clean heating significantly reduces respiratory disease incidence among children aged 0–14, with larger effects during cold periods. The benefits are concentrated among younger children and in villages with lower pre-treatment electricity consumption, where households were more likely to rely on coal heating before the policy. Clean heating also reduces hospitalization expenditures and length of stay. Mechanism analyses suggest that the policy increases household electricity use and that reduced indoor coal-combustion exposure is the primary channel.

Keywords: winter heating; clean energy; health; energy consumption; air pollution

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Household Responses to Personalized Risk Information

Benjamin Krebs[1,*], Matthew Neidell[2,3,4]

May 27, 2026

Abstract

We study how personalized information affects household responses to environmental risk. Using data from residential air quality monitors, we exploit the timing of monitor installation and high-frequency fine particulate matter ($PM_{2.5}$) readings to identify responses to new information about indoor pollution risk. We find that indoor $PM_{2.5}$ concentrations decline by 2.5 $\mu g/m^3$ over the 12 weeks following installation, conditional on contemporaneous outdoor pollution, with effects significantly larger among households with high initial indoor pollution. The indoor-outdoor pollution gradient declines over time, indicating that households become increasingly effective at mitigating exposure when marginal health damages are highest. Using machine learning techniques to infer cooking activity and air purifier adoption, we show that households respond primarily through durable defensive investments rather than reductions in pollution-generating behavior, with back-of-the-envelope calculations implying positive net benefits. Our results suggest that personalized monitoring transforms air pollution from an external threat to avoid into an internal risk that households can control.

Keywords: indoor air quality, pollution monitoring, pollution information, avoidance behavior, defensive investments
JEL codes: D81, D83, I12, Q53, Q55

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Leadership and Commitment in Oil Markets: Market Power Meets Climate Policy*

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December 9, 2025

Abstract

We examine how leadership and commitment in oil markets affect climate damages, welfare, and the effectiveness of climate policy. Using a cartel–fringe model with renewables and climate damages, we compare Nash–Cournot, open-loop von Stackelberg, and feedback von Stackelberg equilibria. Our results show that leadership changes extraction patterns: when the cartel acts as a von Stackelberg leader, relatively more polluting extraction by the fringe is postponed, reducing climate damages relative to Nash–Cournot. However, the absence of commitment in feedback equilibria limits these gains and can even increase damages with respect to Nash-Cournot. We quantify these welfare losses and decompose them into a conservation and sequence effect. We show both for carbon taxes and renewable subsidies that small policy changes can trigger abrupt shifts in extraction regimes, causing large jumps in welfare and climate damages. Marginal changes in climate policies can have qualitatively different impacts on climate damages than non-marginal changes. These findings highlight that a von Stackelberg type of leadership can either amplify or reduce climate damages, and that policy design must account for discontinuous responses.

JEL codes: Q01, Q30, Q38, Q42

Keywords: cartel-fringe, climate policy, renewables, dynamic game, von Stackelberg equilibrium

*We would like to thank Florian Wagener and participants of the ISDG Workshop (Paris, 2025), the FAERE annual conference (Nantes, 2025), the Université Laval economics seminar (Québec, 2025) and the CIREQ-CIRANO-RRECQ workshop on environmental and natural resource economics in honour of Bob Cairns (Montréal, 2025) for their valuable comments. Hassan Benchekroun thanks the Fonds de recherche du Québec - Société et culture (FRQSC) and the Canadian Social Sciences and Humanities Research Council (SSHRC) for financial support.

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Solar Radiation Management and Trade

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Alessandro Tavoni[4] Joschka Wanner[2]

January 12, 2026

Abstract

We develop a trade-theoretic model of strategic Solar Radiation Management (SRM) in a dynamic setting with tariff policy. Two blocs of countries interact repeatedly, choosing SRM intensity and import tariffs. Although unilateral SRM is feasible and can generate a free-driver problem, linking trade policy to SRM restraint enables self-enforcing outcomes that sustain free trade and disciplined SRM deployment. We characterize the trigger level of SRM that aligns incentives and show how the enforceable cap depends on preference heterogeneity, trade gains, punishment severity, and patience.

A transparent calibration, mapping blocs to a cooler, richer North and a hotter, poorer South, illustrates the mechanism. For empirically plausible trade stakes and sufficient patience, the threat of trade retaliation can substantially curb overcooling incentives; when punishment is weak or actors are impatient, trade leverage fails. Overall, trade retaliation emerges as a conditional governance mechanism for SRM, distinct from counter-geoengineering, and clarifies when a trade-based "climate club" can discipline SRM deployment.

Keywords: Solar Radiation Management, Geoengineering, International Cooperation, Political Economy, Trade Policy, Issue Linkage

JEL codes: C73, F13, Q54, Q58

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International Environmental Agreements under Other-regarding Preferences*

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Abstract: We study the formation of international environmental agreements in a standard two-stage coalition formation model when countries exhibit other-regarding preferences. We adopt Fehr & Schmidt (1999) inequality aversion, where countries suffer disutility from payoff differences, with potentially different weights on advantageous and disadvantageous inequality. Countries are homogeneous in material payoffs but heterogeneous in their social-preference parameters. We show that equilibrium abatement choices are symmetric within membership groups: coalition members choose a common abatement level and free-riding outsiders also choose a common (generally different) abatement level. Relative to the benchmark without other-regarding preferences, coalition members reduce abatement, while outsiders increase abatement. Turning to membership decisions, other-regarding preferences can increase stable coalition size, but this effect is typically modest. We further obtain systematic self-sorting into membership status depending on countries' degrees of advantageous and disadvantageous inequality aversion. A numerical illustration demonstrates that other-regarding preferences can substantially mitigate the public-good provision problem, mainly because they raise outsiders' abatement rather than because they generate much larger coalitions.

Keywords: international environmental agreements; coalition formation; inequality aversion; other-regarding preferences; public goods; climate cooperation.

JEL-Classification: D62; D63; H41; Q54; Q58.

* We are grateful to seminar participants at the University of Bern for valuable comments on an earlier draft. Declaration of interest: none.

Comprehensive national accounting for CO_2 emissions under the polluter pays principle*

Geir B. Asheim[a] Rintaro Yamaguchi[b]

23 December 2025

Abstract

We examine the polluter pays principle as a rationale for the treatment of CO_2 emissions in the World Development Indicators of the World Bank. Since current emissions increase future damage, the properties of sustainability indicators depend on how emissions are compensated over time. We investigate two different interpretations of the polluter pays principle: compensating for the social cost of carbon of current emissions (PPP1) or for the current damage of historical cumulative emissions (PPP2). We show that PPP1 does not lead to the World Bank expression of genuine saving—despite having been given as its rationale—while PPP2 essentially does if countries mitigate up to the point where the marginal cost of mitigation equals the global social cost of carbon. Our empirical application to recent genuine saving data shows that PPP1 makes developing countries appear less sustainable and current large emitters more sustainable, since decarbonization will reduce the net compensations over time. Moving from PPP1 to PPP2 counteracts this effect, as payments are shifted forward in time to compensate for the future damage that emissions cause. Our empirical results support the theoretical prediction that the World Bank expression makes countries appear less sustainable than under PPP2 when mitigation is less than efficient. Still, one might caution against empirical analyses which assume hypothetical compensations according to some version of the polluter pays principle, since actual compensations would have led to behavioral change.

Keywords: Climate change, comprehensive national accounting, genuine saving, social cost of carbon (SCC), sustainable development

JEL Classification Numbers: C43, D63, O47, Q01, Q54

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Growing green: how state-level banking deregulation helped reduce US industrial emissions

[Preliminary work—please do not circulate]

Maria Alsina-Pujols* Mathias Hoffmann†

January 15, 2026

Abstract

How does access to finance matter for the greening of our economies? This paper addresses this question by exploiting regional (county-level) variation in financial integration and the tightness of environmental regulation created by the interaction of two staggered natural experiments: US state-level banking deregulation and the Clean Air Act (CAA). We document that banking deregulation is strongly linked to the reduction of US industrial emissions after 1990. Tightening environmental standards require firms to adapt, either by cleaning up their production (the intensive margin) or by closing down or reallocating their activities to cleaner products or to more lenient jurisdictions (the extensive margin). At the same time, access to finance may enable new cleaner firms to start up and may also allow households to smooth consumption, thus stabilizing local demand for non-tradable goods, enabling a swifter reallocation from polluting to less polluting industries. We show using emissions and employment data from local economies (at the industry-county level), that financially more open local economies saw a swifter reduction in emissions, mainly along the intensive margin. This happened because financially open places had a more elastic credit supply due to a stronger presence of banks with geographically diversified credit portfolios ("integrated banks"). Our analysis also suggests a potential reallocation of employment to the services sector as a result of tighter environmental policy and better access to finance, as well as an increase in emissions-abating innovation. To address endogeneity, we implement different techniques, including the use of a granular measure of banking diversification, the implementation of a shift-share instrument, as well as matching differences in differences. Finally, a stylized two-sector model with credit expansion shocks, pollution, carbon taxes, and endogenous innovation, rationalizes our empirical findings theroetically and quantitatively.

JEL classification: Q52, Q58, G2

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Optimal de-risking strategies for breakthrough technologies: Risk allocation in green industry transitions

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Abstract

Even with carbon pricing in place, investment in low-carbon technologies have remained below socially optimal levels with additional market failures in place. In this work, we develop a two-period partial equilibrium model to evaluate the welfare effects of de-risking policy instruments when learning externalities occur, future carbon prices are uncertain and risk markets are incomplete. Focusing on the risk transfer away from the producer and into the fiscal budget, we account for the regulator's exposure to carbon price risk and the opportunity cost of earmarked funds associated with long-term, contingent liabilities such as carbon contracts for difference (CCfDs). This framework allows us to characterise optimal risk sharing between the producer and the regulator when fiscal risk is itself socially costly. For this second-best setting, we show analytically that - even in the absence of private hedging markets - a full transfer of carbon price risk into the public budget is generally not optimal. Our numerical results imply that risk-transferring instruments can play an important role in narrowing the welfare gap to first-best, but that excessive public risk absorption may generate large fiscal costs of risk, hence reducing welfare even below a no-policy benchmark.

Keywords: carbon pricing, fiscal cost, incomplete markets, carbon contracts for difference, partial equilibrium model, risk, technology learning, welfare analysis

*Corresponding author at darius.sultani@pik-potsdam.de. The authors would like to thank Marie-Louise Arlt, Mario Liebensteiner, Pao-Yu Oei, and participants at the Kiel Institute Workshop on "The role of public research and innovation measures on mitigating climate change" (May 2023) for valuable comments on an earlier version of this study.

Transition Risk, Preference Shocks, and Climate Policy*

Stefano Carattini† Givi Melkadze‡ Inès Mourelon§

January 2026

Abstract

The financial stability risks associated with decarbonization are a growing concern for policymakers and financial institutions. This paper studies the macroeconomic consequences of transition risk in an environmental dynamic stochastic general equilibrium model with a frictional financial sector. We analyze three sources of transition risk: one policy-driven source of transition risk arising from an increase in carbon tax, and two preference-based sources: a shock to consumer preferences and a shock to investor preferences. For a given emissions reduction target, preference shocks generate larger macroeconomic and financial instability than a carbon tax while delaying environmental benefits. We further show that a tax-and-subsidy scheme on banks' asset holdings mitigates these adverse effects and brings the economy closer to a first-best scenario, where environmental externalities and financial frictions are absent. Overall, carbon pricing and targeted financial sector policies play a central role in mitigating transition risks, ensuring a more stable adjustment path and leading to a long-run equilibrium with fewer distortions.

JEL Classifications: E32; E60; G18; Q43; Q58.

Keywords: Transition Risk; Financial Frictions; Climate Policy; Preference Shocks; Macroprudential Policy.

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Economic valuation of environmental goods under Knightian uncertainty

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January 16, 2026

Abstract: Decision making in environment-economy systems, especially in relation to climate change, is characterized by deep uncertainties. We develop concepts for the economic valuation of welfare changes under *Knightian uncertainty*, where the probabilities of the potential states of nature are not known. Our setting consists of two goods: a market-traded consumption good and a non-market-traded environmental good. We provide ex-ante values in units of sure income for a change from one environmental-economic prospect to another. In analogy to risk, we derive the compensating and equivalent surplus, the uncertainty premium and the insurance value. We find that uncertainty aversion and substitutability between the consumption and the environmental good are key elements for decision making under uncertainty. Our research is relevant for cost-benefit analysis of projects with uncertain benefits or costs, e.g., adaptation to climate change.

Keywords: Knightian uncertainty, environmental goods, valuation, welfare measurement, willingness to pay

JEL-Classification: D81, Q51, Q54

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Energy Transitions in the Long Run: Theory and Evidence from English Coal*

Jevan Cherniwchan Juan Moreno-Cruz

January 1, 2026

PRELIMINARY: DO NOT CIRCULATE OR CITE

Abstract

This paper examines how transitions between energy resources affects economic activity in the long run. We develop a simple theory to show how the introduction of a new energy source affects energy supply, consumption per capita and population growth. We test key theoretical predictions by examining the effects of the first energy transition in England, when coal replaced wood as the primary energy source. Our empirical estimates suggest that the start of the wide-scale exploitation of coal reshuffled the economic landscape in England even prior to the invention of the steam engine.

JEL Codes: N53, N93, R11, O13
Keywords: Energy Transition, Coal, Malthus,

*Moreno-Cruz: Professor, School of Environment, Enterprise and Development and Canada Research Chair University of Waterloo, Waterloo, Canada. Cherniwchan: Spencer Family Associate Professor, Department of Economics, McMaster University, Canada. We would like to thank Jeff Chan and audiences at the University of Buffalo, Wilfrid Laurier University, the annual meetings of the Canadian Economic Association, the Urban Economic Association, and the Canadian Resource and Environmental Economics Association for helpful suggestions and comments that have improved this paper. We would also like to thank Imogen Walks Kowalchuk for excellent research assistance. The original version of this paper under the title "Back to the Future of Green Powered Economies" was coauthored by M. Scott Taylor. This current version is as much his as it is ours.

Resource Extraction and Renewable Capacity: Dynamic Limit Pricing and Climate Policy Effects

Gilbert Kollenbach*, Mark Schopf**

Abstract

We study the effects of different market structures and climate policy instruments on fossil fuel extraction and green energy capacity paths. The representative green energy firm invests in green capacity and delivers green energy at zero marginal costs. If the initial capacity level is sufficiently low, extraction decreases and green energy capacity over time. In case of a price-taking fossil fuel firm, energy consumption decreases over time until extraction ends. While a carbon tax reduces initial extraction, a green capacity or investment subsidy induces the weak green paradox in case of physical exhaustion. In case of a monopolistic fossil fuel firm, we identify two strategic effects: The well-known market power effect which postpones extraction, and a capacity investment effect which postpones green investment. In an empirically calibrated economy, these two effects cause energy consumption to rise initially, then remain virtually constant for a long time before falling sharply at the end of the extraction period. We find that neither a carbon tax nor a green capacity or investment subsidy induces the strong green paradox. Finally, while subsidies perform much worse than carbon taxes in terms of welfare, they imply much higher profits for the fuel firm with comparable climate damages, whether the firm is price-taking or monopolistic.

Keywords: climate policy, energy transition, monopoly
JEL Classification: H23, Q31, Q38, Q41, Q42, Q48 Q54, Q58

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Uncertainty Barrier in Energy Transition Dynamics

Matti Liski, Pauli Murto, and Iivo Vehviläinen

April 27, 2026

Abstract

This paper studies a structural shift in the energy transition—from persistent carbon price uncertainty to the idiosyncratic but predictable variability of renewables. We develop a dynamic equilibrium model in which this shift is endogenous, producing a mechanism that generates gradualism in a distinctive, non-monotonic form: renewable capital and uncertainty exposure are initially dynamic complements, but eventually become substitutes. This feature overturns standard policy predictions, including: higher carbon taxes can reduce prices and their dispersion; greater intermittency can lead to more predictable market outcomes; and carbon-based technologies may themselves become intermittent in use. We provide a quantitative assessment of common policy proposals targeting price stability, accelerated investment, and high-renewable systems with large intermittency.

Keywords: renewable energy, investment, real options, competitive equilibrium, electricity

JEL Classification: D81; D41; L1; Q42.

Cold War on a Warming Planet: Climate Policy in a Divided World

January 14, 2026

Lucas Bretschger[1]

Abstract

The study examines economic growth and climate change when system competition between countries causes drastic changes in their climate policies. The world is divided into two groups of countries: one that implements strict climate policies and another that refrains from doing so due to concerns about the negative economic impacts. A policy tipping point occurs once the economic performance of the proactive group surpasses that of the laggards, prompting the latter to implement comparable climate measures. I find that the impact of policy tipping is significant on emissions but moderate on economic growth. The occurrence of the policy shift depends on policy design and technological progress. In a divided world, subsidies for clean energy research prove more effective than carbon pricing in accelerating global decarbonization because they induce earlier tipping. Achieving the internationally agreed climate targets requires that proactive countries combine ambitious emissions reductions with sustained economic prosperity, an outcome attainable through an efficient mix of taxes and subsidies.

Keywords: Carbon policy; divided world; economic growth; global carbon emissions; policy tipping.

JEL Classification: *Q43, O47, Q56, O41*

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Shock Therapy for Clean Innovation*

Esther Ann Bøler† Katinka Holtsmark‡ Karen Helene Ulltveit-Moe§

December 2025

Abstract

We study how a negative profitability shock in the fossil energy supply chain affects firms' direction of innovation. We develop a stylized model to show that adjustment costs in R&D create incentives for exposed firms to reallocate innovation toward clean technologies. Next, we propose a novel approach to measure firms' exposure to the 2014 oil price collapse, and find that more exposed firms significantly increased clean R&D relative to less exposed peers. The results suggest that firms in the fossil energy supply chain possess transferable capabilities for clean innovation, and that declining fossil profitability—e.g., via carbon pricing—can accelerate the clean transition along the fossil energy supply chain.

JEL codes: D22, F14, F18, O31, Q55, Q56.

Keywords: R&D, clean innovation, supply chains, green transition.

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Wired For Change? Clean Technology Adoption and Labor Market Transitions

Guillaume Wald*

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This version: December 4, 2025

Abstract

Whether the energy transition will harm or benefit workers is a central policy concern. This paper provides the first ex-post estimates of transition costs when small and medium enterprises adopt clean technologies. I study heating service firms in France as they shift from installing fossil fuel boilers to heat pumps. Tracking workers through matched employer-employee data, I document substantial within-firm labor reallocation but low transition costs overall. While displaced workers recover their earnings within one year, stayers adjust by working longer hours. Hourly wages rise for those exposed early to the technology or facing smaller skill gaps, but primarily through employer changes rather than within-firm raises. These results demonstrate that market incentives can facilitate on-the-job skill updating, keeping adjustment costs low even amid significant labor reallocation.

Keywords: decarbonization, transition costs, labor reallocation, skills upgrading

JEL codes: Q52, J24, O33

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THE ENVIRONMENTAL BIAS OF INDUSTRIAL POLICY

Elisa Rottner* Kathrine von Graevenitz†

December 2, 2025

Abstract

We take stock of the current practices of industrial policies in the EU. We show that industrial policies in the EU on average favour more emission intensive sectors over less emission intensive sectors, and more emission intensive firms over less emission intensive firms. On average, between 2016 and 2019, each additional tonne of carbon was awarded a support premium of 7 EUR. We show that this emissions premium does not derive from grants which are more likely to help firms transition toward cleaner production technologies, but from tax advantages. This premium has the potential to substantially decrease incentives set by carbon pricing. We find that the emissions premium inherent in the EU's industrial policies is neither explained by heavier lobbying of emission intensive sectors and firms, nor by higher employment, trade exposure, or upstreamness.

Keywords: Industrial Policy, Carbon Emissions, Manufacturing
JEL-Classification:

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Supply Shocks in Rare-Earths and Innovation for the Clean Energy Transition: Firm-level Evidence from France

Ayse Nihal Yilmaz*
Joelle Noailly†

January 16, 2026

Abstract

How do firms adjust their innovation decisions following supply disruptions in critical minerals? We examine this question by estimating the impact of the 2010 rare-earth elements (REEs) supply shock on the innovation activities of French firms along the clean technology supply chain. Combining patent and customs data for the 2002–2018 period, we exploit heterogeneity in firms' product mixes to measure their exposure to the shock. Using a difference-in-differences framework with continuous treatment, we find that firms more exposed to the REE supply shock significantly increased innovation along the REE clean technology supply chain, particularly in downstream segments such as permanent magnets and wind energy generators.

JEL codes: O33, D24, L94, F14, Q41, Q48, Q54.
Keywords: Rare-Earths, Supply Disruption, Trade, Innovation, Technological Change, Critical Minerals, Clean Energy Transition

*Geneva Graduate Institute, email: ayse.yilmaz@graduateinstitute.ch. We thank Laura Alfaro, Johanness Boehm, Carolyn Fischer, Gerard van der Meijden, Aude Pommeret, Steven Poelhekke, Jan Schymik, Francesco Vona and Chahir Zaki for comments. This study is supported by the Swiss National Science Foundation (Project Division 1, Grant No 100018M_212632).

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Working from home and vehicle electrification as levers for transport decarbonisation: Evidence from Switzerland*

Beaumont Schoeman[†‡] Thomas Schatzmann[§] Beat Hintermann[‡]

May 30, 2026

Abstract

Transport accounts for a third of Swiss final energy use and is the sector furthest from the 2050 net zero target. Two demand side developments shape its outlook: the diffusion of working from home (WFH) and the electrification of the vehicle fleet. Using a stated choice experiment with 1,098 respondents, we estimate how Swiss adults adjust mobility tool ownership and travel demand in response to these changes. We find that transport energy reductions accelerate as WFH intensity rises from a no-WFH baseline: −12%, −20% and −20% from three, four, and five WFH days, respectively. The direct rebound elasticity from switching an internal combustion vehicle to an electric vehicle is modest at 0.04, which means 96% of the engineering efficiency gain translates into realised energy savings. Combining EV adoption with full WFH cuts annual car energy by up to 80% per adopter. For the aggregate we apply the Swiss schedule from the Global Survey of Working Arrangements, which results in a share weighted reduction in commute related transport energy attributable to WFH of only 3%, an order of magnitude smaller than the 34% we obtain under a 50% EV fleet share and the current Swiss vehicle size composition.

Keywords: Energy use; mobility tools; working from home; smartphone tracking.
JEL Codes: H41, Q40, Q52, Q54, R40

*This research has been supported by the Swiss Federal Office of Energy (Grant SI/502124-01).

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Income-targeted subsidies for low-emission cars

January 16, 2026

Abstract

We study the impact of subsidy targeting on additionality in car replacement programs, using administrative micro-level data on vehicle ownership, household income, and program participation covering nearly the entire population of French households. France implemented a large-scale retire-and-replace program between 2015 and 2024, which featured sharp income-based eligibility thresholds and substantial variation in subsidy generosity. Using a regression discontinuity design at these thresholds, we identify the causal effect of higher subsidies on household participation and vehicle replacement behavior. We find that low-income households eligible for the higher subsidy amount increased their participation in the program by around 30%, with similar responses among middle-income households, for electric vehicles (EVs) and non-EVs. While these participation effects are large, our results also imply that 74% to 76% of participants are inframarginal, indicating substantial windfall gains under uniform subsidies. We recover policy-relevant parameters such as the share of inframarginal participants and the slope of demand for replacement subsidies. Thereby we provide empirical evidence consistent with theoretical predictions that targeting can improve the economic efficiency of environmental subsidy programs.

Keywords: subsidies, additionality, electric vehicles, regression discontinuity, policy evaluation

Distributional Effects of Vehicle Emission Standards between Cities

Kenneth Gillingham & Waldemar Marz*

January 16, 2026

WORKING DRAFT – DO NOT CITE OR DISTRIBUTE

Abstract

Vehicle emissions standards, including fuel economy standards and zero-emission vehicle (ZEV) standards, can increase the adoption of more fuel-efficient vehicles and electric vehicles. This study explores how they influence the welfare of different cities. Using rich nationwide data at the zip code level across the United States, we estimate a structural model of the city size and the vehicle market, including the household choice of fuel economy and vehicle type. Counterfactual simulations show that fuel economy and ZEV standards place a higher welfare cost on small, low-income, and low-amenity cities than larger, wealthier cities. Carbon taxes have the opposite effect.

JEL codes: H23, L9, Q48, R4
Keywords: CAFE standards, fuel economy standards, monocentric city, carbon emissions.

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Levers for Change? The Welfare Effects of a Large-scale Public Transport Subsidy in Germany

Working paper draft: January, 2026

(Please do not cite or circulate without permission from authors)

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Abstract

Ever more countries consider reducing the cost of public transport to incentivize shifts to more sustainable transport modes. This paper quantifies the welfare effects of a large-scale, nationwide public transport subsidy in Germany—the so-called *Deutschlandticket*. We pair novel cellphone- and app-based mobility data from several European countries with recent advances in synthetic control methods to examine the impacts on mobility and external costs. Our findings show a persistent increase in train ridership and a substitution away from car travel (number of trips, kilometers driven, and vehicle counts). We find no evidence for latent demand as total mobility remains constant. The substitution is the largest in cities with high-quality public transport as well as for trips of longer distances. The implied CO_2 emissions reduction amounts to around 5.3 million tons per year (3.7% of total road transport sector emissions). In line with our results on less road traffic, we also find strong evidence for reduced air pollution in cities (NO_2 concentration) and lower road congestion (travel time per kilometer). A cost-benefit analysis reveals that the overall benefits of the policy outweigh its associated costs (benefit-cost ratio of 2.1). Similarly, the marginal value of public funds amounts to 1.3, implying that the program costs just €1 for every €1.3 that it provides in benefits.

Keywords: public transport, subsidy, externalities, emissions, congestion
JEL Codes: C23, H23, Q53, Q58, R41, R48

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The need for regulation of climate subsystems

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January 15, 2026

Abstract

We study how Earth subsystems, such as the Amazon rainforest, interact with global climate change through their internal dynamics, heterogeneously amplifying aggregate risk. Our framework captures the long-term value of marginal changes in subsystem states, including feedbacks, via a reduced-form model reflecting realistic geophysical processes. In our quantitative application, explicitely modeling Amazon dynamics raises the global social cost of carbon (SCC) by approximately 6% and implies a marginal value of local carbon storage that is about 33% larger than conventional estimates. This implies that a marginal ton of carbon stored in the Amazon rainforest is 25% more expensive than another type of carbon emissions. These results highlight the need for global climate policy and local conservation to recognize subsystems as dynamically vulnerable systems rather than static stocks.

Keywords : dynamic stochastic climate-economy model, robust environmental policy, Amazon rainforest, climate tipping elements, scientific uncertainty, risk.

*Corresponding author: rfillon@protonmail.com.

IMPACD:
An Integrated Macroeconomic Model of Pandemics, Climate Change, and Deforestation

January 15, 2026

Abstract

We develop an integrated framework that incorporates the feedback effects between the economic incentives of deforestation, permanent loss of biodiversity, the damages and risks from global warming, and the increasing risks posed by emerging infectious diseases (EIDs). Within this framework we estimate the social cost of deforestation (SCD). We find that the major driver for the SCD is what we label the "barrier service effect"—that is, the social value of forest in shielding humanity from zoonotic EIDs. This barrier service effect amounts, today, to USD 11.18 per tCO_2, assuming a 30-year return period and a 4 percent post-pandemic loss of global output. Additional model runs yield a range of USD 2.76–42.39 for plausible return periods and post-pandemic global output losses and allow us to derive a simple intuitive rule for the barrier service effect, in terms of post-pandemic global output loss and the frequency of zoonotic pandemic events or pandemics. Our analysis could help policymakers and decision-makers address the external costs of deforestation.

JEL Codes: C61, D62, O4, Q23, Q54, Q57, Q58

Keywords: Pandemics, Climate Risk, Integrated Assessment, Ecosystem, Forest Tipping Point, Social Costs of Deforestation

Early warning systems

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January 31, 2025

Abstract

Complex systems can undergo sudden, irreversible changes when critical thresholds—known as tipping points—are crossed. While statistical indicators can serve as early warning signals (EWS) of such transitions, their integration into decision-making frameworks remains limited. This paper develops a theoretical framework connecting early warning signals to optimal management of systems prone to tipping. We translate early warning indicators into the formal language of management science, introduce an analytically tractable approximation of tipping indicators, and derive practical insights about the optimal design and value of early warning systems. Our analysis reveals how the optimal design and value of these systems depend on both the magnitude of potential damages and decision-maker risk preferences, providing a foundation for incorporating early warning signals into management decisions.

Keywords: Early warning signals; Tipping points; Critical transitions; Decision theory; Risk management; Uncertainty; Learning.

JEL codes: Q54; Q57; D81; D83.

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ON THE OPTIMAL MANAGEMENT OF WEAKLY INTERACTING NATURAL RESOURCES WITH TIPPING POINTS

ANNE-SOPHIE CRÉPIN[1] AND FLORIAN WAGENER[2]

Abstract. We study the management of natural resources that are weakly connected and exhibit tipping behaviour in their dynamics. We obtain approximate feedback optimal management rules for networks of weakly connected natural resource systems by developing the value function with respect to the interaction strength. The method is general and rigorous, and allows to treat the effects of multiple interactions without suffering from the curse of dimensionality. We show that a system consisting of multiple interacting natural resource systems can be managed close to optimally if the interactions between the systems are weak. This is the case even if the system consists of many connected subsystems. Moreover, if the interaction strengths themselves can be controlled, managers can improve the outcome by only allowing beneficial interactions, and shutting down disadvantageous ones. This brings new options for the management of connected resources with tipping points.

1. Introduction

How should we manage multiple resources that can exhibit abrupt changes in their dynamics and that share connections with each other? The crossing of a tipping point can result in abrupt, persistent, and substantial changes called regime shifts (Biggs et al., 2012). Examples include dynamics of natural resources, ecosystems, pollution recipients, and many other types of systems in which humans and nature interact. Evidence suggests that regime shifts can spread to connected systems in multiple ways, generating a wide range of impacts, including passing tipping points that trigger new regime shifts in other connected systems (Anderies et al., 2006; Kinzig et al., 2006; Krönke et al., 2019; Mueller et al., 2009; Peters et al., 2007; Rocha et al., 2015, 2018; Wunderling et al., 2024).

The optimal management literature related to regime shifts has investigated a wide range of situations that lead to abrupt changes and made substantial progress on the optimal management of lakes and other types of natural resources that can exhibit tipping points; see Li et al., 2024 for a recent overview. There is also a growing literature on the management of spatially connected resources (Brock & Xepapadeas, 2020) but with a few exceptions (Crépin & Rocha, 2021; Rocha & Crépin, 2024), those studies almost never focus on tipping points.

There are multiple ways to measure connectivity between landscapes or ecosystems (Correa Ayram et al., 2016; Keeley et al., 2021; Uroy et al., 2021) mirroring the multitude of ways in which connections between ecosystems can influence their dynamics. The strength or intensity of these[1] connections may vary substantially, some systems being highly connected, while others having only relatively weak connections. Human activities can also, voluntarily or not, influence the degree of connectivity between ecosystems, either by creating barriers such as roads or by promoting connections

Navigating the Dual Challenge: Corporate Climate Strategies under Climate Policy and Energy Market Shocks

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Abstract

We study how firms balance the dual challenge of energy security and decarbonization when exposed to contrasting external shocks: climate policy and energy-market disruption. Using two quasi-natural experiments, the European Green Deal in 2020 and the Russia–Ukraine War in 2022, we examine adjustments in (i) renewable energy adoption, (ii) voluntary carbon market (VCM) activity, and (iii) total energy consumption. We find that the Green Deal induces gradual transition responses concentrated among large firms, while the War generates immediate, broad cuts in energy use that are short-lived and rely primarily on VCM purchases rather than structural shifts in energy portfolios. In contrast, firms with Science-Based Targets initiative (SBTi) commitments exhibit persistent decarbonization efforts irrespective of the shock. Low-energy firms experience reduced cost of debt. Our findings highlight a key asymmetry in corporate climate strategies: policy-driven, commitment-based mechanisms support durable transition paths, whereas energy-market-driven shocks prompt only temporary adaptations.

JEL Classification: G32, Q40, Q54, Q58
Keywords: Energy transition, Climate Finance, Transition Risk, Voluntary Carbon Markets, Corporate Climate Strategy

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Rewiring Supply Chains Through Uncoordinated Climate Policy*

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Emilia Garcia-Appendini¶

January 12, 2026

Abstract

We show that climate transition risks can significantly disrupt global supply chain networks. Using the California cap-and-trade program, we find that suppliers subject to the regulation are significantly more likely to lose customer relationships than otherwise similar peers. The effects are especially pronounced among suppliers facing intense competitive pressure and producing standardized inputs, where switching costs are lower. These suppliers also suffer persistent declines in revenues, assets, and investment. The resulting supply chain rewiring, driven by uncoordinated climate policies, is consistent with carbon leakage: customers sourcing away from cap-and-trade regions increase their overall supply chain carbon footprint.

JEL classification: G32, Q54, Q55

Keywords: Climate finance, Cap-and-trade policy, Carbon emissions, Supply chain, Product market competition, Input specificity

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Green Industrial Policy in a Globalized Economy [*†]

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January 2026

Abstract

This paper studies green industrial policy in an open economy when key energy-transition inputs are internationally tradable. I develop a dynamic multi-country general equilibrium trade model with input–output linkages in which renewable-energy equipment is traded, electricity generation is local, and equipment production features learning-by-doing spillovers. The model highlights a sharp difference between two instruments. Subsidies to renewable generation raise domestic equipment demand and imports, shifting production and learning gains toward foreign suppliers and worsening the subsidizing country's terms of trade. Subsidies to domestic equipment manufacturing expand home production, concentrate learning domestically, and lower the world price of clean equipment, accelerating decarbonization abroad. Quantitatively, applying the framework to the U.S. Inflation Reduction Act implies sizable global CO_2 reductions and small welfare gains, with the U.S. capturing a larger welfare gain than the world as a whole; incidence is shaped by equipment import penetration and the locality of learning.

JEL: F13, F18, O25, Q42, Q54, Q56

Keywords: Green Industrial Policy, Inflation Reduction Act, Energy Transition, renewable-energy equipment trade

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Strategic Recycling of Critical Raw Materials *

Hassan Benchekroun[†] Miao Dai[‡] Francesco Ricci[§]

January 16, 2026

Preliminary and incomplete

Please do not circulate nor cite without the authors' consent

Abstract

We show that governments may have an incentive to subsidize the sector that recycles raw materials from local waste, solely to provide a trade advantage to their national firms. We extend the Brander-Spencer-Dixit model of strategic trade to incorporate local material inputs, specifically recycling. A key assumption is that the marginal cost of recycling decreases with the size of the local market's consumption (i.e. a positive production externality). In the game between non-cooperative governments, subsidies to local recycling are strategic complements. We identify two countervailing forces. On the one hand, due to the rent stealing motive governments tend to choose excessively high subsidies. On the other hand, uncoordinated governments do not fully internalize the benefit resulting from expansion in production (the externality), thus tend to choose insufficiently low subsidies. When these forces balance each other the non coordinated equilibrium turns out to be efficient. Moreover, we show instances where it is preferable to to have myopic policy making, i.e. policy designed ignoring the production externality.

Keywords: Critical Raw Materials; Strategic Trade Policy; Recycling; Economies of Scale; Cooperative Equilibrium; Non-cooperative Equlibrium

JEL Codes: F12; F18; Q37; Q56

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Resource Shuffling & Scrap Trade

January 16, 2026

Abstract

Scrap availability limits how quickly global steel production can decarbonize. This paper shows that a border carbon adjustment can eliminate classic import carbon leakage but triggers resource shuffling: as regulated regions demand more of the cleaner, scrap-based steel, unregulated regions shift towards dirtier one. I develop a dynamic trade model with three steel production routes and endogenous scrap generation from depreciating product stocks. Higher carbon prices raise global scrap demand, improving waste-processing efficiency globally. However, the regulated region absorbs a disproportionate share of scrap supply for newly-created clean demand, driving up scrap prices and forcing the unregulated region into dirty consumption. This resource-shuffling effect diminishes as steel stocks accumulate over time and relax the scrap constraint.

JEL codes: Q53, Q56, Q58, F18

Keywords: carbon border adjustment mechanism, carbon leakage, steel, trade, recycling

Welfare-optimal policy response to border carbon adjustments: An emerging economy perspective*

Simon J. Bolz† TUD

Johannes Gallé‡ PIK Potsdam

December 15, 2025

Abstract

This paper develops a Melitz-style model of asymmetric countries to analyze the optimal environmental policy response when facing a trading partner's Border Carbon Adjustment (BCA). By examining how a unilateral increase in emissions taxes affects endogenous productivity cut-offs, we show that a BCA reduces the relative welfare costs of raising domestic carbon prices. The mechanism operates through a reversal of the policy's effect on the partner's export threshold, which expands imported consumption. Calibrating the model with Indian firm-level data on emissions, productivity, market structure and export performance, we quantify the magnitude of these welfare effects for India when aligning its carbon price with that of the European Union. Structural asymmetries, such as lower productivity in the BCA-affected country, reduce its incentives to raise carbon prices, while firm heterogeneity further amplifies the welfare costs of higher carbon taxes and dampens the welfare smoothing potential provided by a trading partner's BCA.

JEL codes: F18, H23, Q56, Q58
Keywords: Trade and Environment, Border Carbon Adjustment, Carbon Pricing„ Firm Heterogeneity

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Clean Production, Dirty Sourcing: How Embodied Emissions Alter the Environmental Footprint of Exporters*

Till Köveker† Philipp M. Richter‡ Alexander Schiersch§ Robin Sogalla¶

January 15, 2026

Abstract

International trade allows firms to outsource emissions through global supply chains, raising the question of whether exporters – the firms driving globalization – are truly cleaner than domestic producers. We show they are not: once emissions embodied in sourced inputs are included, the conventional exporter's environmental premium reverses, challenging the view that trade reallocates activity toward cleaner firms. Using administrative firm-level data and customs records for German manufacturers combined with fuel- and product-specific emission factors, we construct carbon footprints that include both direct production-related emissions and those embodied in domestic and international supply chains. Four stylized facts emerge: (i) embodied emissions account for more than two-thirds of firms' total emissions; (ii) exporters' production involves disproportionately more of such emissions, particularly via international sourcing; (iii) exporters appear cleaner in production but dirtier in total; and (iv) at the intensive margin, export-demand increases reduce exporters' production-related but not total emission intensity, consistent with substitution from energy toward intermediate inputs. A heterogeneous-firm sourcing model rationalizes this empirical evidence by highlighting the joint role of importing and exporting on firms' emissions footprints. Our findings highlight the importance of accounting for embodied emissions when evaluating the environmental consequences of trade liberalization and designing climate policy.

JEL-Classification: F18, F12, L23, Q54, Q56
Keywords: Embodied emissions; international sourcing; CO_2 emission intensity; Exporter's environmental premium; heterogeneous firms

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Quantifying Climate Damages When Regions Trade: A Structural Gravity Approach

Jeanne Astier,* Geoffrey Barrows,† Raphael Calel,‡ Hélène Ollivier§

January 13th, 2026

Preliminary and Incomplete.
Please do not cite and do not distribute.

Abstract

This paper presents a method for estimating treatment effects of local climate shocks when regions trade with each other. Because of spillovers induced by trade flows, comparing the evolution of outcomes between pre-shock and post-shock periods in regions exposed versus unexposed to local shocks leads to a biased estimate of treatment effect. We model these across-region dependencies using standard assumptions from international trade theory. We use our model-consistent estimation strategy to revisit the literature on the evaluation of impacts from climate change onto country-sector gross output using year-to-year variation in temperature and counterfactual scenarios where the observed warming from 1991 to 2019 would not have occurred or considering future warming predictions.

Keywords: climate change , spillovers, trade, gravity
JEL Classification: Q48, L1, L5

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Climate change beliefs and savings behavior: a macroeconomic perspective

Hannah Römer*
University of Oxford

Job Market Paper

12 November 2025
Latest version

The uncertain nature of climate change leaves room for diverse beliefs and considerable disagreement. This paper investigates the transitional effects of climate beliefs on the macroeconomy through shifts in savings behavior. I incorporate climate damages into an incomplete-markets model with aggregate risk as a non-stationary shift in the stochastic process for productivity. Beliefs about the transitional effects of climate change may be both imperfect and heterogeneous across households. The anticipation of climate damages incentivizes savings and increases capital supply in the short-run, which attenuates output losses as climate change progresses. Crucially, I find that a higher level of capital disproportionally benefits asset-poor households, decreasing wealth inequality. The accumulation of capital is dampened by heterogeneity in beliefs due to downward pressure on asset returns in general equilibrium. To validate the model, I provide observational and causal evidence on a positive relationship between individual savings and climate change concerns from UK survey data.

*Contact: hannah.roemer@economics.ox.ac.uk. Ethics Approval from the University of Oxford, Reference DREC 2189366. For valuable comments I thank Elizabeth Baldwin, Andrea Chiavari, Sarah Duffy, John Hassler, Rustam Jamilov, Per Krusell, Alexandre Kohlhas, Alena Wabitsch, as well as audiences at the following seminars and conferences: EEA 2025, SED 2025, RWTH Aachen, CESifo Junior Workshop on Energy and Climate Economics 2025, University of Oxford, RGS doctoral workshop 2025, AURÖ Workshop 2025.

The Uncertainty Premium of Climate Tipping Points *

Andrea Titton †

January 9, 2026

Find latest version here.

*I am grateful to the Editor and Reviewers for their comments and suggestions. I thank Florian Wagener, Cees Diks, Rick van der Ploeg, Christoph Hambel, Frank Venmans, Luca Taschini, Simon Dietz, Philippa Johnson, Taco Prins, Sebastian Kreuzmair, and Niko Jaakkola for the insightful discussions.

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Abstract

Climate tipping points are shifts in the climate system that could lock the world into a higher-temperature regime. Many tipping points are characterised by Knightian uncertainty, that is, it is difficult to assign prior probabilities to their occurrence. This paper examines the economic costs of this Knightian uncertainty. To do so, I first derive optimal abatement policies for different tipping point scenarios using an integrated assessment model that includes temperature feedback effects. Then, I develop and compute a tipping point uncertainty premium on the social cost of carbon, as a function of different tipping point scenarios. I find that this premium on the social cost of carbon is between 12%-50% relative to complete-information scenarios. For tipping points triggered below 2.5° above pre-industrial levels, this uncertainty increases the social cost of carbon by between 20 and 40 US$ per tonne of carbon equivalent. Finally, I show that early discovery reduces the premium by 9%. This result illustrates that emission abatement policies in the coming decades are crucial in limiting tipping point risk, as early discovery might only offer moderate mitigation to the cost of uncertainty around tipping points.

Uncertain Remedies to Fight Uncertain Consequences: The Case of Solar Geoengineering

Felix D. Meier[#] and Christian P. Traeger[*]

January 16, 2026

Abstract

Solar geoengineering can cool our planet and counteract the warming caused by greenhouse gas emissions. Given current emission trajectories, solar geoengineering has the potential to save lives, reduce severe impacts on economic production, and save ecosystems and island states. Deterministic integrated assessment models tend to show major benefits from solar geoengineering, but are highly sensitive to the assumed and highly uncertain damages from solar geoengineering as well as the effectiveness of cooling the planet. We analyze how uncertainties and the anticipation of learning change the case for solar geoengineering in a world with an uncertain temperature response to carbon dioxide emissions.

JEL Codes: Q54, H23, H43, E13, D80, D61

Keywords: geoengineering, climate change, integrated assessment, uncertainty, learning, social cost of carbon

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Structure, Shocks, and Speed: Learning's Impact on Optimal Climate Policy *

Svenn Jensen[a] Christian Traeger[b]

Abstract: This study explores how learning affects optimal economic policy-making, focusing on climate policy. Dynamic economic models with uncertainty depend on how agents anticipate and adapt to new information. We show that seemingly similar approaches to modeling learning can lead to very different risk premiums in policy decisions. Our analysis focuses on the uncertain climate sensitivity, the temperature response to greenhouse gas accumulation. We distinguish two uncertainty components: natural temperature variability and subjective uncertainty about nature's true climate sensitivity. We provide an analytic formula for optimal carbon pricing under anticipated Bayesian learning. Whereas a decreasing variance over time reduces the risk premium, we show that learning's impact on the prior mean ("updating shocks") has an opposing effect. We explore these two different channels and different model variations in a stochastic dynamic programming version of Nordhaus' DICE model, exploring the trade-off between a "wait-and-see" argument and a more cautious approach.

JEL Codes: Q54, Q00, D90, C63

Keywords: climate change, uncertainty, SCC, Bayesian learning, climate policy, dynamic programming, integrated assessment, DICE

*Svenn Jensen thanks the Research Council of Norway for funding under grant 235573 of the Klimaforsk program.

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The distributional effects of low emission zones: Who benefits from cleaner air?

By Björn Bos, Moritz A. Drupp, and Lutz Sager*

December 17, 2025

Abstract

Low emission zones (LEZ) represent a key environmental policy instrument to address air pollution in cities. LEZs have reduced air pollution and associated health damages in regulated areas, but it remains unclear who has benefited from cleaner air. To examine the distributional effects of LEZs, we combine gridded data on resident characteristics, including income and a proxy for ethnicity, with high-resolution estimates of fine particle ($PM_{2.5}$) concentrations in Germany, the country with the largest number of LEZs. We estimate heterogeneous treatment effects with a difference-in-differences approach and show that $PM_{2.5}$ pollution reductions are distributed unequally across society. While residents with German name origins experience larger improvements within LEZs, residents with foreign names disproportionately live in LEZs and thus benefit more when assessed at a nationwide scale. Monetizing air quality benefits following governmental guidance, we find that they are distributed pro-poor within LEZs, disproportionately benefiting lower-income residents. From a nationwide perspective, however, benefits are distributed almost proportionally, while the sign is sensitive to how benefits from cleaner air scale with income. Overall, our results suggest that LEZs have nuanced distributional implications that differ sharply between a national perspective and local assessments that focus on effects within LEZs.

JEL codes: J15, Q52, Q53, Q58

Keywords: Air pollution, distributional effects, low emission zones, traffic regulation

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Coase Meets Negishi: A Property Rights Rationale for Welfare Weights in Climate Economics *

Simon F. Lang† Matthew Kotchen‡ Matthew Gordon§

January 16, 2026

[Click here for the latest version]

Abstract

The distributional effects of climate change are at the heart of international climate negotiations. This paper shows how different property rights regimes, ranging from "right to pollute" to "right to no pollution", rationalize different welfare weights in climate-economic models with heterogeneous regions. Commonly used Negishi weights separate the issues of climate change and global wealth inequality. However, we show that the separation of these issues does not yield a unique Pareto efficient allocation since climate change and climate policies have distributional consequences of their own. As a result, different property rights characterize a set of efficient allocations. In addition to Negishi weights, which implicitly reflect mixed property rights, we define beneficiary pays and polluter pays weights, derived from liability rules consistent with right to pollute and right to no pollution property rights, respectively. These weights correspond to distinct Pareto efficient allocations that differ only in the distribution of the cost burden of climate damages and abatement, and we show how nations' characteristics shape their preferences for different property rights regimes. Unlike the Negishi solution, the other efficient allocations involve international transfers for abatement and climate damages, providing theoretically grounded definitions for climate mitigation finance and Loss and Damage payments—both widely discussed in international negotiations. We use calibrated simulations to illustrate the distributional implications of different property rights regimes.

*We are grateful to Eli Fenichel, Kenneth Gillingham, Paul Kelleher, Marc Fleurbaey, Paolo Piacquadio, Sarah Spycher, and participants of the Swiss workshop on Environmental, Resource and Energy Economics for their thoughtful comments.

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Intergenerational Discounting and Inequality

Frikk Nesje[1] *and Paolo G. Piacquadio*[2]

Preliminary version: January 15, 2026

Abstract

We study theories of intergenerational justice that disentangle ethical attitudes toward discounting from ethical attitudes toward intergenerational inequalities. We call such criteria modular: each one is uniquely identified by a time-discounting function—capturing attitudes toward time—and a law-invariant aggregator—capturing attitudes toward inequality. We provide an axiomatic characterization of modularity and show its implications. Our framework nests the workhorse criteria used in applied work and yields large, tractable families of alternative criteria obtained by freely combining discounting and inequality attitudes.

Keywords: Intergenerational justice, discounting, inequality.
JEL classification: D30, D60, H43, I31, Q50.

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Regulating the environmental footprint of data consumption: efficiency and distributional effects of taxation and quotas

Mathilde Aubouin* Paolo Melindi-Ghidi† Jean-Philippe Nicolaï‡

Very preliminary version: do not circulate

Abstract

Digital production and consumption represent 4.4% of the French greenhouse gas emissions. This paper investigates and compares the distributional effects an environmental tax and quota on mobile data subscriptions. We develop a theoretical model of a monopolist offering mobile data subscriptions to two type of consumers. The analysis shows that, under price discrimination, the monopolist responds to a carbon tax by reducing both prices and data allowances. Introducing a quota on data consumption negatively impacts the quantity and the price of the bundle for the high-type consumer and does not impact the bundle for the low-type consumer. Moreover, for an equivalent reduction in emissions, a quota leads to a smaller loss in consumer surplus than a tax. The model is then extended to include competition and a continuum of consumer types. We show that the results obtained in the monopolistic setting remain robust under competition with horizontal differentiation. We find that, under a monopolist offering two mobile data subscriptions to a continuum of consumers differentiated by

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their preference for data consumption, the tax and the quota have opposite effects. Because the tax increases the average price per gigabyte in each subscription, some consumers downgrade from the high-type to the low-type subscription, while others exit the market. By contrast, following the introduction of a quota, new consumers enter the market, and some consumers even upgrade from the low-type to the high-type subscription. Finally, using French household data, we assess the distributional effects across income deciles, showing that such environmental policy instruments are not necessarily regressive in this market.

Keywords– Environmental and Digital Regulation; Price Discrimination; Distributive effects

JEL Classification– D1; D4; H2; L1; Q5

Market Structure, Directed Innovation, and the Electrification Transition

Draft: January 2026

Electrification is a key lever for decarbonization. Achieving it requires not only abundant, low-cost clean electricity, but also new technologies that can convert electricity into valuable economic services. While the Directed Technical Change (DTC) literature emphasizes that innovation responds to relative profit opportunities, these profits are shaped by market structure and competition intensity. Building a novel model of directed technical change with endogenous markups across energy generating and consuming sectors, we analyze how imperfect competition and technological linkages jointly shape the pace and direction of electrification. We show that competition effects, in particular free exit and entry of firms, can weaken lock-in effects that typically favor fossil technologies. Furthermore, the competition effects dampen the speed of transition, especially under strong climate policy. Policies that combine carbon pricing with research subsidies and competition policies that reduce fossil-sector markups can direct innovation incentives, achieving faster and more cost-effective electrification. (JEL: H23, L13, O33, Q43, Q55)

Electrification is widely recognized as a major pathway of decarbonization and a central lever for mitigating climate change. Realizing its potential, however, depends on sustained technological progress on both the supply and demand sides of the energy system. On the supply side, delivering affordable and reliable electricity requires innovations that reduce generation costs and address intermittency. On the demand side, electrification hinges on efficient end-use technologies that convert electricity into valuable services, enabled by technologies such as heat pumps, electric vehicles, and high-temperature electric furnaces. Together, these examples illustrate that an evolving portfolio of technologies is critical to large-scale electrification. Understanding how innovation is directed—and how it shapes the feasibility and cost of electrification—is therefore essential.

We study this question in a framework that captures coordinated innovation along both sides of the energy system—generation and utilization—under imperfect competition and sectoral heterogeneity. Specifically, we investigate how endogenous markups and technological linkages across the energy supply chain affect innovation incentives, the sequencing of electrification, and the design of optimal policy mixes.

We show that electrification is slowed down by endogenous entry and exit of firms, and proceeds unevenly across sectors due to initial electric penetration and market structure. Carbon pricing alone is insufficient to spur a rapid transition in

An experimental test of dual discounting for consumption and the environment*

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January 16, 2026

Abstract

Overall economic growth is projected to persist while the state of the environment is stagnating or in decline. Public policy is advised to account for the increasing relative scarcity of nature by uplifting future environmental values or discounting market consumption goods and the environment at differing rates. Yet, no empirical study to date has estimated preference parameters necessary to calibrate dual discount rates. Here, we conduct a laboratory choice experiment to fully specify the canonical dual discounting approach. We find that preference elasticities differ markedly between private consumption and non-market environmental benefits, implying that they are only weak substitutes. Using recent estimates of good-specific growth rates, we find a wedge between the dual discount rates of around 1.5 percentage points. We show that the error made by using a single discount rate and constant relative prices almost exclusively concerns the environmental discount rate. As a key diversion from standard theory, we document an important role of loss aversion, as preference estimates depend on the sign of growth. We show that this motivates a downward level-shift for both discount rates, increasing the general weight of future outcomes for today's decisions. In addition, central assumptions of the workhorse isoelastic utility model are rejected, highlighting the need for discounting frameworks that align better with social preferences.

Keywords: Discounting, environment, substitutability, experiment

JEL Codes: D31, D61, H43, Q51

*Emails: Disque: sdisque@ethz.ch; Drupp: mdrupp@ethz.ch; Groom: B.D.Groom@exeter.ac.uk. This study has been pre-registered in the AEA RCT Registry with the ID *AEARCTR-0015423* and including a pre-analysis plan which was uploaded prior to accessing the data.

Income sharing for common pool resources with uncertain productivity

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Abstract

We address the interconnected issues of externalities in the use of a natural common-pool resource system and adverse effects of environmental uncertainty on risk-averse resource users. We set up a simple, analytical model, and derive conditions such that insurance by means of an income sharing mechanism mitigates externalities, and hence achieves a socially optimal outcome. For this to materialize, we show that the sharing rule must be sufficiently sensitive to individual contributions, and specifically show that a simple, proportional sharing rule can provide incentives for both efficient contributions to the income pool and efficient use of the resource system.

Keywords : Resource Economics | Informal Insurance | Risk Aversion | Diffusion Externalities | Cooperation

JEL Codes : Q2; D81; H2; H4

The Impact of Temporary Group-Level Conservation Incentives across Diverse Institutional Landscapes*

Sabrina Eisenbarth†, Miguel A. Fonseca‡ and Alexander Pfaff§

Abstract

Monetary incentives for conservation often target groups with diverse institutions and capacities for cooperation. We employ an online experiment (N = 1,010) using a modified public-goods game to examine how pre-existing institutions influence the effectiveness of group-level incentives. To replicate the high monitoring costs typical of resource management contexts, we limit individuals' information about peer contributions and, hence, their ability to achieve full cooperation through peer punishment. We use a staggered 2x2 design to introduce two treatments: First, a forum, defined as a voluntary, costly information-sharing institution where participants reveal verifiable contribution data. Second, temporary payments that reward additional contributions exceeding a group's specific pre-payment baseline. Our findings show that average contributions rise by 18% under the forum and 11% under payments. Access to the forum does not significantly raise the effectiveness of payments. Crucially, when the temporary payments end, contributions never fall below the pre-intervention baseline. For groups with high initial cooperation, contributions remain significantly above their original baseline even after incentives are removed — a form of "crowding in".

JEL Classification: C92, Q20, Q23

Keywords: PES, group-level incentives, conservation, institutions, information, experiment.

*We thank Scott Vincent for his help programming the experimental software. This paper has benefited from feedback from Nick Hanley, Luz Rodriguez, Maria Alejandra Velez, Tobias Vorlaufer, Christian Vossler as well as suggestions by participants at AERE 2023, EAERE 2022, BIOECON 2022, the 7th Center for Environmental Economics Montpellier (CEE-M) Workshop on Environmental and Natural Resource Conservation, the Workshop: Resources, Conflict and the Environment at ETH Zurich, the Annual Workshop in Applied Economics at Varna, and seminars at the University of Exeter and the University of St. Gallen. Financial support by a Duke-Exeter Partnership and the Dragon Capital Chair in Biodiversity Economics at University of Exeter is gratefully acknowledged.

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The social cost of waste

Etienne Lorang*

January 16, 2026

Work in progress. Please do not distribute

Abstract

We develop a growth model to estimate the social cost of waste. We integrate material flows into a Brock-Mirman economic growth framework and derive a formula for the social cost of waste. Our calibration for plastic use suggests that the social cost of plastic waste could become significantly higher than its market price, indicating a pressing need for policy intervention. The model shows an increasing historical and future plastic dependency in the economy and substantial GDP losses due to plastic waste if not addressed.

1 Introduction and literature

Integrated assessment models (IAMs) already play a central role in the economic analysis of climate change. Since the seminal contribution of Nordhaus (1993), IAMs have been widely used to estimate the social cost of greenhouse gas (GHG) emissions and to study the interaction between economic growth and the climate system. By contrast, the application of growth theoretical frameworks to other environmental pressures has remained limited. In particular, there is no commonly accepted measure of the social cost of material use and the associated accumulation of waste, despite the growing prominence of material use as an environmental concern. As economies expand, so do the associated challenges: increasing volumes of waste requiring management, rising social and environmental costs of resource extraction, and heightened

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The social cost of carbon when accounting for biosphere integrity and land use change: An extension of the DICE model

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Draft Version. Do not Circulate, Cite or Quote.

Abstract

The intensifying damages from increasing temperatures and unprecedented degradation of the biosphere highlight the critical need for integrated approaches to environmental policy that recognize the interdependent natural processes. Current integrated assessment models mostly focus on single aspects and, for example, address climate change and biosphere integrity loss independently, thereby missing key interactions between these processes. This paper extends the latest Dynamic Integrated Climate-Economy (DICE-2023) model to incorporate three Earth system processes highlighted by the Planetary Boundaries Framework: climate, biosphere integrity and land system change. We add a land use sector to explicitly link economy, climate and biosphere integrity capturing the key dependencies and reciprocities. To explore the intersection between climate change mitigation and biosphere integrity conservation policies, the extended model allows to conduct both classical DICE-style cost-benefit analysis and to investigate the additional welfare cost of remaining within specific targets. Our results show that accounting for biosphere integrity loss in the coupled climate-economy significantly increases the social cost of carbon and leads to more stringent climate policies. Further, we find that land conservation efforts can yield substantial co-benefits for climate mitigation, reducing the overall economic costs of achieving climate targets. The integrated framework presented here provides a valuable tool for policymakers to evaluate the trade-offs and synergies between climate and biosphere integrity policies in a comprehensive and accessible manner.

JEL Codes: C54, C61, D61, E00, H41, Q57, Q24

Keywords: DICE, planetary boundaries, climate change, biosphere integrity, climate policy

Closing the Waste Haven: Innovation Responses to China's 2018 Waste Import Ban

Abstract

This study examines whether the sudden closure of the world's largest waste haven induced technological innovation in waste-exporting countries. For decades, high-income economies relied on China to process post-consumer waste, outsourcing disposal rather than expanding domestic treatment capacity. This equilibrium was abruptly disrupted in 2018 by China's National Sword policy, which banned imports of major categories of foreign solid waste and sharply tightened global waste-processing constraints. Using a novel country-year panel of 38 OECD countries from 2010 to 2020 that combines environmental patent data with bilateral waste trade flows, we exploit the ban as an exogenous shock to global waste-processing capacity. Employing a within-country pre-post design and a continuous treatment difference-in-differences approach that leverages cross-country variation in pre-ban dependence on China for waste exports, we document a significant increase in waste management innovation following the ban, with no comparable response in other environmental technology domains. The innovation response is substantially stronger in countries that were more reliant on China prior to the ban. Domain-level analysis reveals that post-ban innovation is highly concentrated in recycling, sorting, separation, and material recovery technologies, which expand domestic waste-processing capacity. These findings provide causal evidence that the loss of access to a major waste haven induces directed technological change, highlighting innovation as a central adjustment mechanism through which environmental trade restrictions can trigger domestic capability building rather than mere trade diversion.

<Keywords: China's waste import ban; induced innovation; waste management; environmental regulation; waste havens>