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Tinbergen Institute Discussion Paper

Greening the Economy

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Greening the Economy

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Abstract

The economy is traditionally human-centered and has given too little consideration to plants, animals, climate, and nature in general. What should the economy do to become ‘green’? Changing people’s social norms would be ideal but is hard to achieve. Second best is to regulate and constrain the economy through taxes, subsidies, standards, and redistribution. However, setting these to the ‘right’ level is challenging and must address how much humans care about nature, the desire to retain the benefits of economic growth, and the political feasibility of implementing national and international policies that accelerate the transition to a green economy.

Keywords: green economy, climate change, social norms, climate policy, redistribution

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Introduction

The current inter-glacial geological epoch, the Holocene – which started in 9,700 BC – was mostly a period of relatively slow climate change and stability during which nature was abundant to humans (Walker et al. 2009). More recently, however, human activity has grown to an extent that nature has become overwhelmed by humans everywhere, such that the global climate and biosphere are no longer changing slowly. This has lead scientists to propose a new epoch called the Anthropocene, starting roughly mid-20th century, which is characterized by exponential changes in a wide range of metrics such as carbon emissions and the production of plastics and waste (Zalasiewicz et al. 2024). Human population growth and technological and economic growth are at the heart of these changes. Growth has brought benefits to aggregate human well-being, but has come at the expense of nature, which has been neglected and taken for granted. What should the economy do to become ‘green’ and at a minimum prevent further loss of nature?

The economy is traditionally human-centered, focused on improving the lives of *humans*, and has given too little consideration to plants, animals, climate, and nature in general. The lack of consideration given to nature, which has no voice of its own, has lead to actions that more often exploit nature rather than preserve it, such as through a tragedy of the commons and overuse. Some may say that capitalism or even economics as a field of study– “the way in which trade, industry, or money is organized, or the study of this” (*Cambridge Advanced Learner’s Dictionary* 2013) – may be part of the problem. However, economics is also “the science which studies human behavior as a relationship between ends and scarce means which have alternative uses” (Robbins 1935). For most of the Holocene, nature has been boundless relative to human demands, but the advent of the Anthropocene implies that nature has become scarce everywhere. Human behavior and the scale of human impact now affect nature to the extent that the loss of nature also hurts human well-being directly, through pollution, biodiversity loss, and climate change and its associated damages. Once we recognize that nature is scarce, it should start to have value and affect our decision making and behavior. Rather than exploiting it, its alternative use is to preserve it and prevent damages such as those from anthropogenic global warming. However, individuals do not necessarily internalize the effect that their own behavior has on the global total impact. How can a new economy make sure that nature’s scarcity is recognized by *everyone*? This article offers a holistic perspective on the interplay between social norms,

government intervention in the form of taxes, subsidies, standards, and redistribution, the trade-off between the value of nature and the value of economic growth, and the political feasibility of (inter)national policy.

Social norms

Despite good intentions as reflected in the pledges made in the Paris agreement, most countries are far behind on delivering policy stringent enough to close the gap between those intentions and actual implementation.¹ One example of this is an ‘implementation gap’ between existing renewable energy technology and the scale of its deployment needed to close the carbon cycle (Thompson 2023). In turn, this suggests that a change in consumption behavior, perhaps through communication campaigns, may be urgent (Johnson 2024). Social norms, as an established and self-reinforcing pattern of behavior, are a way to anchor such behavior: everyone does their part given the expectation that everyone else will continue to play theirs (Peyton Young 1998). These serve to reduce transaction costs by coordinating expectations and reducing uncertainty, essentially because social pressure through morality prevents deviation from the norm. This process of socialization results in intrinsic preferences for fairness, honesty, and pro-social behavior, but at the individual cost of intrinsic restrictions that curtail selfishness or personal goals (Gross & Vostroknutov 2022). In this light, a pro-nature social norm could result, for example, in flying less, eating less meat, living smaller, lowering the thermostat, and voluntarily paying ‘true prices’ that include the cost of damages.² A key benefit is that a pro-nature social norm would not require government intervention, because taxes are no longer needed to influence consumption decisions. For example, Konc et al. (2021) conclude that carbon taxes can be much lower, if one takes into account that social networks can spread the pro-climate behavior of those directly affected by the tax.³

While the social norm that prevents further global warming is not impossible to achieve, people are not equally sensitive to norms and show a lot of heterogeneity in actual behavior (Kimbrough & Vostroknutov 2016). Moreover, while the scale of damages to nature is global, behavior is individual, such that all humans would need to converge to a similar pro-nature social norm. It may take too long to change norms to a sufficient degree to timely reduce climate change and it is not likely that the global diversity of cultures can all change to a common norm.

Thus far, current initiatives that appeal to people’s pro-nature behavior, such as voluntary compensation for CO₂ emissions when buying flight tickets, have not yet led to a reduction in global demand for air travel (ICAO 2024). There has also not been a reduction in global meat consumption: while beef and pork flattened in high-income countries, poultry is on the rise, as well as all meat consumption in the rest of the world (OECD & FAO 2023), such that related greenhouse gases keep increasing (OECD & FAO 2021).

Regulate

If broad social change cannot reduce emissions and protect nature sufficiently in the near future, then expanding the current system of (Pigouvian) taxes, subsidies and regulations will be needed. Taxing activities that are harmful to nature should reduce their demand, while subsidies can provide goods and promote activities that the economy does not provide on its own (such as nature reserves, or costly renewable energy systems). For example, a very high carbon tax would lead to a much more rapid replacement of dirty capital which would otherwise continue to pollute for a long time (Tong et al. 2019). Taxes also function as a stick to make sure that companies’ corporate social responsibility (CSR) and environmental, social and governance (ESG) initiatives become more than empty shells. Regulations and standards can influence corporate behavior where taxes are impractical, such as air pollution of cars (Jacobsen et al. 2023). The world is making slow progress on this front: 75 carbon pricing instruments now exist worldwide, covering 24% of global emissions, but less than 1% of greenhouse emissions are priced at a level required to reach the Paris goal (World Bank 2024).

One challenge is that taxes are not popular because they raise prices and reduce profits, while subsidies are popular but costly to governments and reduce funding for other important expenses. Both environmental taxes and subsidies may then be set at inefficiently low levels. Moreover, they can have adverse effects on inequality, such as ‘energy poverty’ when heating fuels are taxed, and result in a disproportionate burden on lower incomes (Chancel et al. 2022). Such a system must thus take inequality into account by including rebates, income-dependent progressive tax schedules, and redistribution of tax revenue. While elaborate, it still promises to be the best system to deliver breakthroughs in terms of changes in consumption and production, and implementation of renewable energy sources (Thompson 2017, 2023, Blanchard et al. 2023).

The value of nature versus the value of economic growth

A second challenge is that governments must choose the right level of taxes and subsidies. In theory, these could be high enough to achieve restoration of nature to pre-human or at least pre-industrial levels.

The democratic process could indeed lead to very stringent policy, if only nature could vote.⁴ With humans making decisions on behalf of nature, the question arises how much we (should) value nature. The anthropocentric view is that nature exists for our benefit, while the environmentalist view is that nature is special because we depend on it for our survival and thus deserves full protection. Combining and balancing these two extremes, Collier (2010) argues that we should treat nature as a scarce asset in the sense that it can provide us with an infinite stream of benefits, *as long as we do not exhaust it*. This implies conservation combined with use to further human development. Key is that we take a multi-generational view in which we take custody of this asset in such a way that we leave an equal value behind for future generations. Depleting nature clearly does not satisfy this rule, but it does allow using nature to some extent, as long as we replace it by something that has value for future generations. For example, this can lead to mining to satisfy the demand for metals and minerals as long as these are used for sources of renewable energy. But it can also mean using nature if it can help to reduce poverty, inequality, and, for example, improve literacy and educational attainment. This latter argument derives from the observation that the Anthropocene has also delivered growth not only in terms of income per capita, population, and greenhouse gas emissions (Tol 2023), but also in terms of a large reduction in human suffering: less extreme poverty (from 89% of humans in 1820 to 10% in 2015 ⁵), more literacy (from 12% of adults in 1820 to 87% in 2022 ⁶), and less child mortality (from 48% of children before reaching puberty in 1820 to 4% in 2020 ⁷).

How to balance conservation with growth? Natural assets do not have natural owners, unlike man-made assets, such that government is needed to protect nature and prevent overuse. Government itself must then also refrain from overuse and plunder and good governance depends on the strength of institutions and the type of government. Moreover, nature tends to transcend national man-made boundaries such that international cooperation is required to achieve protection of nature. The extent to which governments agree in part depends on how accountable government is to its citizens, and on the extent to which citizens agree on the value of nature.

Many studies have been conducted to try to elicit the value of nature from individuals using survey methods, with varying success because surveys can suffer from biases such as hypothetical bias and embedding bias (Carson 2012, Hausman 2012).⁸ Without valuation estimates on all (global) natural goods to guide policy, government will likely rely on civil society and the democratic process to set policy measures.

Political feasibility

The term limited set to politicians will in general mean that they pursue policies that get them re-elected, which has thus far led governments to take a very gradual approach to climate and environmental policy. Setting policy too stringent may risk jobs and thus votes, because one fears that companies will move abroad to where policy is lax. To generate support, it is essential that consumers and companies reduce their initial opposition to environmental policy, for example by awareness campaigns that may shift voter preferences and companies' social responsibility, but foremost by addressing inequality in terms of income effects and in terms of 'unfair' competition from those less affected.

The speed of change also matters: faster change brings forward positive change for nature, but is also costly in terms of foregone consumption (especially in poorer countries) and the capacity of individuals and companies to adjust to a new economy. Faster change thus generates more opposition. For example, poorer households may not be able to afford insulation to avoid higher natural gas prices. While we need dirty industries to downsize, their workers need time to adjust, re-skill, and find new employment in greener sectors: policies that facilitate this are rare.

In the case of carbon pricing in the European Union (EU), such risk of carbon leakage has led to promising initiatives (that gradually replace the outright subsidy to dirty producers in the form of free carbon permits) such as the Carbon Border Adjustment Mechanism.⁹ This aims to tax imported goods based on their carbon-content – the amount of carbon emitted in countries outside the EU when the good was produced – with the aim of equalizing the tax incidence between EU and non-EU producers. By leveling the playing field, it also reduces opposition to climate policy, and it incentivises other countries to become more ambitious in their climate policy as well (Nordhaus 2015). However, developing countries deserve and need

help to decarbonize to avoid this new trade barrier.

Redistribution, such as recycling carbon tax revenue to support lower incomes can take the sharp edges off of climate policy and increase public support (Dechezleprêtre et al. 2024, Fabre et al. 2024). Because carbon taxes tend to be regressive in countries with higher income inequality, such a policy is especially helpful in countries with relatively higher income inequality, such as the US (Andersson & Atkinson 2024). Furthermore, environmental policies can in principle also be made income-dependent such that the burden falls less on the poor, and are more effective from an equity perspective than a uniform per capita rebate (Ahlvik et al. 2024). Recent examples are California’s income-based electricity charges, income limits on eligibility for clean vehicle tax credits in the US, and electric car leases for low-income households in France.¹⁰ Redistribution across countries will also help, which requires getting more serious about the UN’s Green Climate Fund to support developing countries and help them transition to a greener economy.¹¹

How to get both more climate policy and more redistribution implemented? Only supporting bottom-up civil society demands for more action such as by informing people of the benefits of climate policy (or relying on behavioral change in consumption patterns) may not work fast enough to reach the Paris goal (Douenne & Fabre 2022). Vested interests typically get in the way of change by supporting opposition and lobbying against more stringent policy. Making donations to politicians public, or no longer allowing donations by companies, such as Brazil has implemented (The Guardian 2015), may help to accelerate change (Casas-Zamora 2016).

Tax revenue can also be used to generate new jobs, promising so-called green growth, by subsidizing innovation towards greener sectors of the economy (Acemoglu et al. 2012, Hart 2019). Corporate subsidies must be designed carefully to avoid perverse incentives and side effects under different institutional and political contexts (Stern & Coria 2012), but early-stage subsidies can have large positive effects on patenting and revenue, especially for small financially-constrained firms (Howell 2017). Clean-tech innovations – as opposed to dirty-sector innovations – lead to more technological innovation in other sectors as well (Dechezleprêtre et al. 2017).

Conclusions

It is not too late to change our economy into a new green economy that values and protects nature and end the dramatic changes that define the Anthropocene. Rather than relying on behavioral

change, all the government's tools are needed to design policy that reduces activities that are harmful to nature, yet preserve the benefits of economics growth for human development. These must include incentives for international government to cooperate and level the playing field between jurisdictions, address inequality by including redistribution, and subsidies that stimulate clean innovation. These side-measures support more direct climate and environmental policy by reducing opposition by consumers and companies, thus increasing the political feasibility of faster change.

Notes

¹See <https://unfccc.int/process-and-meetings/the-paris-agreement> and <https://climateactiontracker.org/>

²One example of this is the ‘true price’ supermarket *De Aanzet* in Amsterdam, which offers voluntary higher prices and promises to use the proceeds of this mark-up to support sustainable farming techniques, a supply-chain-traceability initiative, a child-labor-monitoring system, and investments in community infrastructure (Romeo 2022).

³Taxes may still help to reach the desired social norm (Nyborg et al. 2016). On the other hand, less-nature conscience norms can also weaken the effectiveness of a carbon tax (Ulph & Ulph 2021).

⁴There are however recent examples where nature has been given the status of a legal entity, such as the Whanganui River in Aotearoa New Zealand (Kramm 2020).

⁵Extreme poverty is defined as living on less than 1.90 international-\$ per day. International-\$ are adjusted for price differences between countries and for price changes over time (inflation). See: <https://ourworldindata.org/grapher/world-population-in-extreme-poverty-absolute?stackMode=relative>

⁶Adult illiteracy rate is the percentage of people ages 15 and above who cannot read or write with understanding a short simple statement about their everyday life. See: <https://ourworldindata.org/grapher/literate-and-illiterate-world-population>

⁷See: <https://ourworldindata.org/child-mortality>

⁸Hypothetical bias refers to bias from the fact that the natural public good in question is not actually used by the individual, while embedding bias refers to the fact that individual natural public goods are often valued similarly to multiple natural public goods. The Environmental Values Reference Inventory (EVRI) database collects studies that value nature: 60% of these are based on contingent valuation surveys. See: <https://fundingenaturebasedsolutions.nwf.org/resources/evri-environmental-values-reference-inventory/>

⁹See: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

¹⁰See: <https://www.cpuc.ca.gov/consumer-support/financial-assistance-savings-and-discounts/california-alternate-rates-for-energy>, <https://www.irs.gov/credits-deductions/credits-for-new-clean-vehicles-purchased-in-2023-or-after>, and <https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/france/incentives-legislations>, respectively.

¹¹See: <https://www.greenclimate.fund/>

References

- Acemoglu, D., Aghion, P., Bursztyn, L. & Hemous, D. (2012), ‘The environment and directed technical change’, *American Economic Review* **102**(1), 131–166.
- Ahlvik, L., Liski, M. & Mäkimattila, M. (2024), Dp19117 pigouvian income taxation, Discussion Paper 19117, Centre for Economic and Policy Research (CEPR), Paris & London.
- Andersson, J. J. & Atkinson, G. (2024), ‘The distributional effects of a carbon tax’, *mimeo*.

- Blanchard, O., Gollier, C. & Tirole, J. (2023), ‘The portfolio of economic policies needed to fight climate change’, *Annual Review of Economics* **15**(Volume 15, 2023), 689–722.
- Cambridge Advanced Learner’s Dictionary* (2013), 4th edn, Cambridge University Press, Cambridge.
- Carson, R. T. (2012), ‘Contingent valuation: A practical alternative when prices aren’t available’, *The Journal of Economic Perspectives* **26**(4), 27–42.
- Casas-Zamora, K. (2016), ‘The state of political finance regulations in latin america’, International IDEA Discussion Paper. International Institute for Democracy and Electoral Assistance.
- Chancel, L., Piketty, T., Saez, E. & Zucman, G. (2022), *World Inequality Report 2022*, World Inequality Lab.
- Collier, P. (2010), *The Plundered Planet: How to Reconcile Prosperity With Nature*, Oxford University Press, Oxford.
- Dechezleprêtre, A., Fabre, A., Kruse, T., Planterose, B., Sanchez Chico, A. & Stantcheva, S. (2024), International attitudes toward climate policies, Working Paper 30265, National Bureau of Economic Research.
- Dechezleprêtre, A., Martin, R. & Mohnen, M. (2017), Knowledge spillovers from clean and dirty technologies, Working paper, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.
- Douenne, T. & Fabre, A. (2022), ‘Yellow vests, pessimistic beliefs, and carbon tax aversion’, *American Economic Journal: Economic Policy* **14**(1), 81–110.
- Fabre, A., Douenne, T. & Mattauch, L. (2024), ‘International attitudes toward global policies’, *SSRN Electronic Journal*.
- Gross, J. & Vostroknutov, A. (2022), ‘Why do people follow social norms?’, *Current Opinion in Psychology* **44**, 1–6.
- Hart, R. (2019), ‘To everything there is a season: Carbon pricing, research subsidies, and the transition to fossil-free energy’, *Journal of the Association of Environmental and Resource Economists* **6**(2), 349–389.
- Hausman, J. (2012), ‘Contingent valuation: From dubious to hopeless’, *The Journal of Economic Perspectives* **26**(4), 43–56.
- Howell, S. T. (2017), ‘Financing Innovation: Evidence from R&D Grants’, *American Economic Review* **107**(4), 1136–1164.
- ICAO (2024), Technical report.
URL: <https://www.icao.int/Newsroom/Pages/Passenger-air-traffic-surpasses-pre-pandemic-levels.aspx>
- Jacobsen, M. R., Sallee, J. M., Shapiro, J. S. & van Benthem, A. A. (2023), ‘Regulating Untaxable Externalities: Are Vehicle Air Pollution Standards Effective and Efficient?’, *The Quarterly Journal of Economics* **138**(3), 1907–1976.

- Johnson, B. (2024), ‘The closed carbon cycle in a managed, stable anthropocene’, *The Anthropocene Review* **11**(1), 3–25.
- Kimbrough, E. O. & Vostroknutov, A. (2016), ‘Norms Make Preferences Social’, *Journal of the European Economic Association* **14**(3), 608–638.
- Konc, T., Savin, I. & van den Bergh, J. C. (2021), ‘The social multiplier of environmental policy: Application to carbon taxation’, *Journal of Environmental Economics and Management* **105**, 102396.
- Kramm, M. (2020), ‘When a river becomes a person’, *Journal of Human Development and Capabilities* **21**(4), 307–319.
- Nordhaus, W. (2015), ‘Climate clubs: Overcoming free-riding in international climate policy’, *American Economic Review* **105**(4), 1339–70.
- Nyborg, K., Anderies, J. M., Dannenberg, A., Lindahl, T., Schill, C., Schlüter, M., Adger, W. N., Arrow, K. J., Barrett, S., Carpenter, S., Chapin, F. S., Crépin, A.-S., Daily, G., Ehrlich, P., Folke, C., Jager, W., Kautsky, N., Levin, S. A., Madsen, O. J., Polasky, S., Scheffer, M., Walker, B., Weber, E. U., Wilen, J., Xepapadeas, A. & de Zeeuw, A. (2016), ‘Social norms as solutions’, *Science* **354**(6308), 42–43.
- OECD & FAO (2021), *OECD-FAO Agricultural Outlook 2021-2030*, OECD Publishing, Paris.
- OECD & FAO (2023), *OECD-FAO Agricultural Outlook 2023-2032*, OECD Publishing, Paris.
- Peyton Young, H. (1998), ‘Social norms and economic welfare’, *European Economic Review* **42**(3), 821–830.
- Robbins, L. (1935), *An essay on the nature and significance of economic science*, London: MacMillan and Co.
- Romeo, N. (2022), ‘How much do things really cost? true price, a dutch nonprofit, aims to help us grasp the real costs of consumption’, *The New Yorker*.
- Sterner, T. & Coria, J. (2012), *Policy Instruments for Environmental and Natural Resource Management*, 2nd edn, Routledge, New York.
- The Guardian (2015), ‘Brazilian supreme court bans corporate donations to political candidates and parties’, <https://www.theguardian.com/world/2015/sep/18/brazilian-supreme-court-bans-corporate-donations-political-candidates-parties>. Accessed: 2024-09-09.
- Thompson, R. (2017), ‘Whither climate change post-paris?’, *The Anthropocene Review* **4**(1), 62–69.
- Thompson, R. (2023), ‘International climate targets are achievable, but only in models, not in the real world’, *The Anthropocene Review* **10**(2), 479–493.
- Tol, R. S. (2023), *Climate Economics: Economic Analysis of Climate, Climate Change, and Climate Policy*, 3rd edn, Edward Elgar Publishing, Cheltenham.

- Tong, D., Zhang, Q., Zheng, Y., Caldeira, K., Shearer, C., Hong, C., Qin, Y. & Davis, S. J. (2019), ‘Committed emissions from existing energy infrastructure jeopardize 1.5 °c climate target’, *Nature* **572**(7769), 373–377.
- Ulph, A. & Ulph, D. (2021), ‘Environmental policy when consumers value conformity’, *Journal of Environmental Economics and Management* **109**, 102172.
- Walker, M., Johnsen, S., Rasmussen, S. O., Popp, T., Steffensen, J.-P., Gibbard, P., Hoek, W., Lowe, J., Andrews, J., Björck, S., Cwynar, L. C., Hughen, K., Kershaw, P., Kromer, B., Litt, T., Lowe, D. J., Nakagawa, T., Newnham, R. & Schwander, J. (2009), ‘Formal definition and dating of the gssp (global stratotype section and point) for the base of the holocene using the greenland ngrip ice core, and selected auxiliary records’, *Journal of Quaternary Science* **24**(1), 3–17.
- World Bank (2024), *State and Trends of Carbon Pricing 2024*, World Bank, Washington, DC. License: CC BY 3.0 IGO.
- Zalasiewicz, J., Thomas, J. A., Waters, C. N., Turner, S. & Head, M. J. (2024), ‘The meaning of the anthropocene: why it matters even without a formal geological definition’, *Nature* **632**(8027), 980–984.