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PRICING, DECARBONIZATION, AND GREEN NEW DEALS

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ABSTRACT

This Article evaluates an emerging literature claiming that carbon pricing (emissions trading or carbon taxes) has not performed very well and therefore cannot be the basis for the sort of transformative change now required to address the climate crisis. This is an important claim, as carbon pricing has been viewed as being at the heart of global efforts to address one of our most important contemporary problems.

We provide theoretical and empirical support for these critics' claim that carbon pricing by itself cannot catalyze the technological transformation now required, and that other approaches have done and will likely do better. We also agree with critics that pricing approaches have suffered from insufficient ambition and effectiveness in routine emission reductions. But we do not think that the critics have shown that alternative approaches have and will perform better in those terms. We develop a framework for enhancing empirical evaluation of past programs, as we now have a wealth of experience with both carbon pricing and a variety of alternatives, but a dearth of econometric comparative studies of past performance.

We also explore the normative implications of the critics' claims. We argue that even if they are entirely right, we should welcome even insufficiently ambitious pollution taxes as likely to enhance other programs and raise revenue to support them. We point out, however, that the trading programs now common around the world may undermine rather than support more successful programs and suggest that regulators consider cap-without-trade (imposing mass-based caps on pollution

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sources without allowing the trading of obligations) as an alternative. We also discuss the possibility of overcoming the critics' objections by improving carbon pricing programs.

INTRODUCTION

It has long been an article of faith among many climate policy experts that the objective of climate policy should be to put a price on carbon—either by taxing or regulating greenhouse gases under a cap-and-trade program.[1] No longer.

After decades of experience under a climate change mitigation regime that has made pricing an important policy for achieving greenhouse emission reductions, growing numbers of experts have become disenchanted with the notion that pricing carbon provides a solution to

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[1] William Boyd, *The Poverty of Theory: Public Problems, Instrument Choice, and the Climate Emergency*, 46 COLUM. J. ENV'T L. 399, 402 (2021) (noting the general enthusiasm for trading among experts and policymakers and the dominance of carbon pricing schemes in debates over climate policy).

the climate crisis.[2] The titles of their articles tell the tale: *Why Carbon Pricing Is Not Sufficient*;[3] *Why Carbon Pricing Falls Short*;[4] *Why Carbon Pricing Isn't Working*.[5] One article even announces "*The New Climate Consensus That Carbon Pricing Isn't Cutting It*" in its subtitle.[6]

The recent congressional enactment of the Inflation Reduction Act ("IRA"),[7] which subsidizes clean energy after years of failing to put a carbon price in place, might add fuel to this fire. Its passage suggests that effective carbon pricing, at least in some polities, faces greater political obstacles than state support for clean energy.[8] And the demands that European governments find ways to lower fossil fuel prices that have spiked because of the war in Ukraine, including by restarting coal-fired power plants, suggest that even a public that accepts the need to address the climate crisis will not tolerate the very high carbon prices that some might think would get us to zero emissions.[9]

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[2] *Id.* at 420 (noting the significant amount of commentary discussing problems with climate pricing "over the last several years").

[3] Daniel Rosenbloom, Jochen Markard, Frank W. Geels & Lea Fuenfschilling, *Opinion: Why Carbon Pricing Is Not Sufficient to Mitigate Climate Change—and How "Sustainability Transition Policy" Can Help*, 117 PROC. NAT'L ACAD. SCIS. 8664 (2020).

[4] Jesse D. Jenkins, *Why Carbon Pricing Falls Short*, KLEINMAN CTR. FOR ENERGY POL'Y (Apr. 24, 2019), https://kleinmanenergy.upenn.edu/research/publications/why-carbon-pricing-falls-short-and-what-to-do-about-it [https://perma.cc/PM3J-V396] (arguing that distributional impacts and political economy constraints hold back carbon pricing).

[5] Jeffrey Ball, *Why Carbon Pricing Isn't Working*, 97 FOREIGN AFFS. 134, 135 (2018) (contending that political concerns have kept governments from imposing carbon prices that are high enough and applied broadly enough to have an impact).

[6] Jeffrey Ball, *Hot Air Won't Fly: The New Climate Consensus That Carbon Pricing Isn't Cutting It*, 2 JOULE 2491, 2492 (2018) (arguing carbon pricing is failing because it mostly covers the electricity sector only and prices have not been high enough to significantly curb emissions).

[7] Inflation Reduction Act, Pub. L. No. 117-169, 136 Stat. 1818 (2022) (codified as amended mostly in scattered sections of 26 U.S.C.).

[8] Malcolm Fairbrother, *Public Opinion About Climate Policies: A Review and Call for More Studies of What People Want*, PLOS CLIMATE, May 2022, at 1, 6 (citing studies that have found substantial public opposition to carbon taxes, largely due to political distrust); Ekaterina Rhodes, Jonn Axsen & Mark Jaccard, *Exploring Citizen Support for Different Types of Climate Policy*, 137 ECOLOGICAL ECON. 56, 57 (2017) (concluding that most regulatory and voluntary policies receive high levels of support, while a carbon tax receives the highest levels of opposition).

[9] *See generally How Russia-Ukraine War Has Forced Germany to Turn to the Dirtiest Form of Coal*, FIRSTPOST (Jan. 18, 2023), https://www.firstpost.com/explainers/how-russia-ukraine-war-has-forced-germany-to-turn-to-the-dirtiest-form-of-coal-12005992.html [https://perma.cc/LAX7-MQ5U] (explaining that Germany passed legislation to restart coal-fired power plants in light of anticipated natural gas shortages owing to the war in Ukraine).

The emerging literature casting doubt on carbon pricing makes three basic claims. First, it maintains that carbon pricing has almost always been insufficiently ambitious.[10] Second, it claims that even when ambitious, it fails to produce big absolute reductions in greenhouse emissions.[11] Third, the pricing approach, while useful for incremental change, does not work well in the context of a climate crisis that demands rapid economic transformation.[12]

This literature, however, generally does not recommend the abandonment of pricing, so much as an appreciation of its limitations as an agent for the large structural changes needed to address the worsening climate crisis.[13] And its recommendations regarding what to do about these limitations tend to be a little less unified than its conclusions about pricing's limitations.[14]

This Article evaluates the emerging consensus about carbon pricing's limitations and explores its implications. One of us has shown that economic theory supports the new understanding of climate pricing's insufficiency.[15] We build on these insights here, explaining how an economic dynamic framework supports the claim that pricing tends to favor incremental changes over long-term transformations, as the critics claim, and that pricing alone cannot be sufficiently effective to address the climate crisis. We also propose an interdisciplinary framework to guide further research into the relative performance of pricing and non-pricing approaches.

We find the suggestion that some policy measures may work better than pricing for transformative change sound, and we attempt to flesh out that claim more fully. Economic dynamic theory, which combines precise analysis of incentives for particular actors with an institutional

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[10] *See* Ball, *supra* note 6, at 2492 (discussing the numerous studies exploring carbon pricing's shortcomings and noting fewer than 1% of emissions are covered by a carbon price exceeding the $40 per ton needed to meet Paris temperature targets).

[11] *Id.* at 2493 (stating "even extraordinarily high carbon prices are failing . . . to spur significant carbon cuts").

[12] *See, e.g.*, Anthony Patt & Johan Lilliestam, *The Case Against Carbon Prices*, 2 JOULE 2495, 2495–97 (2018) (explaining why evolutionary economics supports doubt that carbon pricing provides the best tool for decarbonizing). In addition, carbon trading—and especially offset crediting—has suffered from persistent concerns about environmental integrity. Since these challenges are largely limited to one variant of carbon pricing only, emissions trading, we do not explore them in this Article.

[13] *Id.* at 2497.

[14] *Id.* at 2497–98.

[15] *See* Christian Stoll & Michael A. Mehling, *Climate Change and Carbon Pricing: Overcoming Three Dimensions of Failure*, ENERGY RSCH. & SOC. SCI., July 2021, at 1, 2.

economic framework, supports this claim.[16] So too does the history of transformative change now under way in the energy sector.

Critics' general complaints about pricing's stringency and effectiveness, however, invite the question of whether other instruments will directly produce more emission reductions. Surprisingly perhaps, there is little data comparing the environmental performance of pricing mechanisms to other mechanisms.[17] We provide a framework for further research into the implications of pricing's limitations by proposing that we compare the past and likely future performance of pricing and non-pricing alternatives in terms of their production of absolute emission reductions. Because performance of instruments depends in part on political decisions about their stringency, this study must include not only econometrics but also political science.

But questions about instruments of environmental protection have not been either/or propositions. Rather, all societies that seriously address the climate crisis employ suites of instruments. Therefore, we analyze the extent to which pricing supports or undermines other policies, some of which help account for transformations in energy systems now under way.

This Article begins with an explanation of carbon pricing, the virtues its proponents claim, its place in the climate change mitigation regime, and some of the alternatives to pricing that governments have adopted. The first part points out that the term "carbon pricing" is misleading as applied to so-called cap-and-trade programs, because the government does not establish a price for carbon under such a program.[18] Instead, governments establish emission limits.[19] Treating them separately will

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[16] *See generally* DAVID M. DRIESEN, THE ECONOMIC DYNAMICS OF LAW 7–11 (2012) [hereinafter DRIESEN, ECONOMIC DYNAMICS] (explaining economic dynamic analysis); DAVID M. DRIESEN, THE ECONOMIC DYNAMICS OF ENVIRONMENTAL LAW (2002) [hereinafter DRIESEN, ENVIRONMENTAL DYNAMICS].

[17] *Cf.* Carolyn Fischer & Richard G. Newell, *Environmental and Technology Policies for Climate Mitigation*, 55 J. ENV'T ECON. & MGMT. 142 (2008) (ranking alternative policy options for emissions abatement in the power sector, and affirming the superiority of a portfolio of policies over any single policy); Severin Borenstein & Ryan Kellogg, *Carbon Pricing, Clean Electricity Standards, and Clean Electricity Subsidies on the Path to Zero Emissions* 16 (Nat'l Bureau of Econ. Rsch., Working Paper No. 30263, 2022) (arguing carbon pricing can be less efficient as a policy for power sector decarbonization than intensity standards and clean energy subsidies).

[18] David M. Driesen, *Putting a Price on Carbon: The Metaphor*, 44 ENV'T L. 695, 701 (2014).

[19] WORLD BANK GRP. ("WBG") & INT'L CARBON ACTION P'SHIP, EMISSIONS TRADING IN PRACTICE: A HANDBOOK ON DESIGN AND IMPLEMENTATION 77 (2d ed. 2021).

prove helpful in formulating normative conclusions about the relationship between pricing and non-pricing instruments.

The second part examines the literature expressing skepticism about carbon pricing. It reviews the basis for the claims that pricing usually is not sufficiently ambitious and not very effective on the rare occasions when it is ambitious. And it explains how economic dynamic theory supports the claims that pricing cannot by itself create the rapid wholesale transformations that the climate crisis requires.

The third part explores a possible weakness in the pricing critics' case. The assertion that climate pricing has proven insufficiently ambitious and effective invites the question of whether other approaches have proven more ambitious and effective. It insists that evaluation of a claim that policy should focus more heavily on other options might require comparing the environmental achievements of pricing to other measures, such as state economic support for clean energy (like that provided in the IRA) and traditional regulation. We create a framework to guide further research on the question of whether carbon pricing proves less or more effective than competing approaches in reducing absolute emissions. We suggest comparative econometric studies to evaluate past performance of climate policies. And we maintain that political science provides useful data and insights into whether pricing or alternatives make it easier to establish ambitious programs.

We provide some information suggesting, however, that alternatives to pricing have proven more effective at catalyzing transformational change. This transformational effect may prove more important than difficult-to-evaluate questions about comparative value in short-term emission reductions.

The fourth part explores the implications of the critique of carbon pricing. Since the critics generally do not call for cessation of pricing programs, we need a better understanding of how to craft ambitious and effective pricing programs. This Article develops some recommendations about how to do this, and what changes in thinking would be necessary to obtain designs that are ambitious and effective. The required changes in thinking prove so daunting that they tend to vindicate critics' pessimism about carbon pricing.

This last part therefore tackles the question of whether pricing's critics are right to continue to support pricing in light of the flaws they have identified, at least absent the design changes we recommend. We argue that the cost-effectiveness advantages do not suffice to justify carbon pricing if it accomplishes little and interferes with better approaches. We suggest, however, that carbon taxes remain desirable even if they remain insufficiently ambitious, because they can complement and enhance other measures needed to make a transition to a net-zero carbon world. But insufficiently ambitious cap-and-trade programs can interfere with other approaches. That means that governments should consider abandoning trading (but not caps) if they cannot adopt—and subsequently enforce—caps declining to near-zero or even negative emissions within relevant time frames.

We conclude that ambition, efficacy, and allocative efficiency matter as much or more than cost effectiveness, and that this supports focusing more on the implications of the critics' claims for policy. In light of the inevitability of non-pricing measures and their success in making net-zero emissions a feasible goal in key sectors, we should continue pricing only in cases where it complements rather than interferes with more important policies or where governments design a pricing scheme in such a way as to overcome the critics' claims.

I. CARBON PRICING

This Part defines carbon pricing, reviews its proponents' claims, discusses its place in the climate regime, and provides background about alternatives to pricing that governments around the world employ to combat the climate crisis. This discussion includes some critical analysis of conventional thinking about carbon pricing.

A. *What Is Carbon Pricing?*

The literature generally uses the term "carbon pricing" as a reference to either a carbon tax or a "cap-and-trade" program aimed at reducing greenhouse emissions.[20] The term carbon tax provides a shorthand reference for taxes not just on carbon dioxide, but upon any greenhouse gas. A cap-and-trade program, by contrast, requires polluters to reduce the mass of emissions of a pollutant (or groups of pollutants) but allows polluters to escape these obligations by purchasing allowances generated by other polluters able to reduce emissions by a greater amount

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[20] William Nordhaus, *Climate Change: The Ultimate Challenge for Economics*, 109 AM. ECON. REV. 1991, 2003 (2019) (explaining that a price on carbon can be created through cap-and-trade or a carbon tax); WBG, STATE AND TRENDS OF CARBON PRICING 11 (2023), https://openknowledge.worldbank.org/handle/10986/39796 [https://perma.cc/AXM4-4AFC] (including carbon taxes and cap-and-trade systems as examples of carbon pricing policies).

than the cap-and-trade program requires.[21] A cap-and-trade program, properly speaking, refers to a program where a mass-based cap applies to the sources of both credits and debits in a trading program, as in the U.S. acid rain program authorized in 1990.[22] There are few cap-and-trade programs in this strict sense in the climate policy landscape.

Rather, the literature commonly misuses the term to describe programs that impose a mass-based cap on the emissions of a group of targeted pollution sources (such as power plants) but allow credits for greenhouse gas reductions from uncapped sources or even from activities that sequester carbon rather than reduce emissions (such as reforestation).[23] This means governments have designed these programs in a way that will less reliably deliver emission reductions by capped sources than the acid rain program.[24] We will use the term cap-and-trade programs here in the loose sense found in much of the literature describing climate policy instruments, but one should bear in mind that the programs adopted are hybrid environmental benefit trading programs, not pure cap-and-trade programs (or even pure emissions trading programs).

The term carbon pricing is misleading with respect to cap-and-trade programs. The government puts a price on carbon when it establishes a carbon tax by establishing the tax rate.[25] The government does not literally impose a price on carbon when it establishes a cap-and-trade program.[26] Instead, a price emerges that reflects the costs of abatement polluters pay to meet their obligations to stay under the cap.[27] In this respect, a cap-and-trade program is similar to a traditional performance standard, which requires each polluter to reduce emissions to a fixed degree.[28] A performance standard (or a work practice standard that requires

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[21] *See* Driesen, *supra* note 18, at 701 (illustrating this point with a numerical example).

[22] A. DENNY ELLERMAN, RICHARD SCHMALENSEE, ELIZABETH M. BAILEY, PAUL L. JOSKOW & JUAN-PABLO MONTERO, MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM 9 (2000).

[23] *Cf.* David M. Driesen, *Free Lunch or Cheap Fix?: The Emissions Trading Idea and the Climate Change Convention*, 26 B.C. ENV'T AFFS. L. REV. 1, 32–33 (1998) (pointing out the prospect of carbon credits for carbon sequestration rather than emission reductions means the programs envisioned by the Kyoto Protocol constitute environmental benefit trading programs not emissions trading programs in a strict sense).

[24] *See* Michael Wara, *Is the Global Carbon Market Working?*, 445 NATURE 595 (2007) (explaining environmental integrity problems with offsets).

[25] *See* Driesen, *supra* note 18, at 701 (explaining that a government chooses the price of carbon by selecting a tax rate).

[26] *See id.* at 701, 705 (noting the government does not establish a price on carbon in establishing a trading program).

[27] *See id.* at 705.

[28] *See id.* at 703, 709.

specific pollution abatement measures) will also establish a cost associated with carbon dioxide emissions, which firms may pass on to consumers and consider in making investment decisions, just as in a cap-and-trade program or carbon tax.[29] A cap-and-trade program, however, not only incurs a carbon cost (like any regulatory program), but it also makes that cost transparent and easily discoverable, because markets for trading allowances will reveal the cost in the form of prices paid for allowances.[30] Trading enables the compliance cost facing emitters for each unit of pollution to converge at a uniform level, an important feature of carbon pricing that economists cite as key to its cost effectiveness.[31]

Cap-and-trade programs' increasing reliance on auctioned allowances, where polluters must buy allowances to cover all emissions, has blurred the distinction between carbon taxes and cap-and-trade programs.[32] The distinction made above still applies. The government does not establish a carbon price directly in a cap-and-trade program that features an auction. Yet a price emerges not just from allowance purchases on the market (the so-called "secondary market"), but also from purchases of allowances at auctions that government organizes (the so-called "primary market").[33]

B. The Case for Pricing

Scholars agree that carbon pricing leads to cost-effective pollution control. Carbon pricing, economic theory shows, will allow achieving emission reductions at the least cost by enabling polluters to respond to the incentive through cost-effective abatement or payment of the carbon price.[34]

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[29] *See id.* at 707–09 (explaining that both traditional regulation and a cap-and-trade program generate a price for carbon, which companies attempt to pass on to consumers).

[30] *See* WILLIAM J. BAUMOL & WALLACE E. OATES, THE THEORY OF ENVIRONMENTAL POLICY 177 (2d ed. 1988).

[31] *See id.* (showing both cap-and-trade systems and taxes should result in an equilibrium where marginal abatement costs are equalized across all regulated entities).

[32] *See* Andy Coghlan & Danny Cullenward, *State Constitutional Limitations on the Future of California's Carbon Market*, 37 ENERGY L.J. 219, 221, 234, 242 (2016) (noting California's auctioning of allowances "resembles [a] . . . carbon tax").

[33] WGB & INT'L CARBON ACTION P'SHIP, *supra* note 19, at 123, 135.

[34] BAUMOL & OATES, *supra* note 30, at 177; Joseph E. Aldy & Robert N. Stavins, *The Promise and Problems of Pricing Carbon: Theory and Experience*, 21 J. ENV'T & DEV. 152 (2012); Andrea Baranzini, Jeroen C.J.M. van den Bergh, Stefano Carattini, Richard B. Howarth, Emilio Padilla & Jordi Roca, *Carbon Pricing in Climate Policy: Seven Reasons, Complementary Instruments, and Political Economy Considerations*, WIRES CLIMATE CHANGE, July–Aug. 2017, at 1; Fischer & Newell, *supra* note 17.

This leads to a political prediction from some pricing proponents. They suggest that because the costs of pollution control will be lower under a carbon pricing model, governments will find it easier to establish ambitious climate policies through carbon pricing than more costly instruments.[35] This political prediction assumes the total dollar costs of pollution control, rather than general public attitudes, ideology, or cost distribution, determine government decisions.[36] Governments, however, may not be able to predict the prices generated by a cap-and-trade program when they enact the program, nor the level of a carbon tax required to achieve a desired emissions outcome.[37] That problem may lessen or destroy the influence of low costs on political decision-making.

The claim that carbon pricing is cost effective does not mean carbon pricing is allocatively efficient. The term "allocative efficiency" refers to measures that balance costs and benefits at the margin.[38] Thus, for example, a carbon tax would only be allocatively efficient if set equal to an idealized "social cost of carbon"—a dollar figure reflecting all of the damages caused by emitting a ton of carbon into the atmosphere.[39] Because data limitations prevent reasonably reliable quantification and monetization of the most important impacts of the global climate crisis, economic estimates of carbon's social cost function as lower bound estimates of that social cost.[40]

Carbon pricing advocates also sometimes claim that it encourages more innovation than traditional regulation.[41] The small body of credible

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[35] James E. Edmonds, Sha Yu, Haewon McJeon, Dirk Forrister, Joseph Aldy, Nathan Hultman, Ryna Cui, Stephanie Waldhoff, Leon Clarke, Stefano De Clara, Clayton Munnings, *How Much Could Article 6 Enhance Nationally Determined Contribution Ambition Toward Paris Agreement Goals Through Economic Efficiency?*, CLIMATE CHANGE ECON., July 2021, at 1.

[36] *Cf.* Chelsea Peet & Kathryn Harrison, *Historical Legacies and Policy Reform: Diverse Regional Reactions to British Columbia's Carbon Tax*, 173 B.C. STUD. 97, 97–98 (2012) (finding opposition to British Columbia's carbon tax in northern and rural communities stemmed from community identities based on "a sense of regional alienation" rather than the actual costs of the carbon tax).

[37] William A. Pizer, *Combining Price and Quantity Controls to Mitigate Global Climate Change*, 85 J. PUB. ECON. 409 (2002).

[38] *See Allocative Efficiency*, WIKIPEDIA, https://en.wikipedia.org/wiki/Allocative_efficiency [https://perma.cc/3EJB-L5X9] (last visited Feb. 8, 2024).

[39] Aldy & Stavins, *supra* note 34, at 155.

[40] Robert S. Pindyck, *Coase Lecture—Taxes, Targets and the Social Cost of Carbon*, 84 ECONOMICA 345 (2017).

[41] Baranzini et al., *supra* note 34, at 4 (suggesting that, compared with emissions or technology-based standards, carbon pricing provides a continuous and stronger economic

empirical studies of this question shows the opposite. Traditional regulation of power plants' sulfur dioxide emissions has produced more innovation than the well-designed cap-and-trade program addressing acid rain.[42] Economic theory supports, at a minimum, the claim that pricing does not prove superior to traditional regulation of identical stringency in spurring transformative innovation.[43] We will elaborate the relevant economic theory below where we consider critics' claim that pricing favors incremental over transformative abatement measures.

The standard innovation debate, however, tends to compare pricing mechanisms to traditional regulation.[44] Therefore, it does not address a question invited by the critiques we review below: Does a pricing policy perform better in stimulating innovation than government support for new technologies (as in the IRA)?

Finally, a few economists have argued that a carbon pricing program is more effective than traditional regulation.[45] Demonstrating that would seem to require a daunting empirical inquiry that nobody has undertaken. The critiques reviewed below cast doubt on these claims.

C. *Pricing in the Climate Regime*

In 1992, countries around the globe agreed to pursue the goal of avoiding "dangerous" climate disruption by adopting the United Nations Framework Convention on Climate Change ("UNFCCC").[46] In 1997, a

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incentive for adoption of, and research and development on, improved abatement technologies).

[42] David Popp, *Pollution Control Innovations and the Clean Air Act of 1990*, 22 J. POL'Y ANALYSIS & MGMT. 641 (2003) (showing a higher rate of patentable innovation under traditional regulation prior to 1990 than under the subsequent acid rain trading program); Margaret R. Taylor, *Innovation Under Cap-and-Trade Programs*, 109 PROC. NAT'L ACAD. SCIS. 4804 (2012).

[43] *See* David M. Driesen, *Does Emissions Trading Encourage Innovation?*, 33 ENV'T L. REP. NEWS & ANALYSIS 10,094, 10,095–98 (spelling out the theoretical case); David A. Malueg, *Emissions Credit Trading and the Incentive to Adopt New Pollution Abatement Technology*, 16 J. ENV'T & MGMT. 52, 53 (1989) (showing that a model relying on sources selling credits without considering those who buy credits is misleading).

[44] *See, e.g.*, Driesen, *supra* note 43, at 10,094.

[45] *See, e.g.*, *Why Emissions Trading Is More Effective Than Command and Control*, IETA, https://ieta.wildapricot.org/Three-Minute-Briefings/3891688 [https://perma.cc/B8XV-ZDAS] (last visited Feb. 8, 2024); A. Denny Ellerman, *Are Cap-and-Trade Programs More Environmentally Effective Than Conventional Regulation?*, *in* MOVING TO MARKETS IN ENVIRONMENTAL REGULATION 48 (Jody Freeman & Charles Kolstad eds., 2007).

[46] UNFCCC, June 12, 1992, 31 I.L.M. 849; *see* Daniel Bodansky, *The United Nations*

group of economically more advanced countries committed to modest reductions in greenhouse emissions in the Kyoto Protocol to the UNFCCC ("Kyoto Protocol").[47]

While the goal of avoiding dangerous climate disruption appeared inchoate during the 1990s, subsequent scientific work indicated that avoiding dangerous climate disruption would require reducing emissions enough to avoid a 2°C rise in average mean surface temperature above pre-industrial levels, and even a 1.5°C increase would have very substantial dangers, especially for small island states.[48] Efforts to increase the ambition and scope of emission reductions through international agreements failed, however, until 2015, when the international community adopted the Paris Agreement.[49] That agreement adopted an explicit goal of limiting the increase in global temperature to "well below 2°C" and to pursue efforts to limit global warming to 1.5°C.[50] Countries pledged to meet individually determined reduction targets toward these goals.[51] It has become clear, however, that the 1.5°C goal requires achievement of net-zero carbon dioxide emissions by 2050, and the Paris pledges would not suffice for meeting any of these targets.[52]

At first glance, proponents of carbon pricing would appear to have succeeded in advancing the case for carbon pricing even as the context changed. Between 2002 and 2022, the global share of greenhouse emissions covered by a carbon price has increased from 0.44% to 23.17%, growing by nearly two orders of magnitude in two decades.[53] In the same period, the number of carbon pricing systems in place went from seven

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Framework Convention on Climate Change: A Commentary, 18 YALE J. INT'L L. 451 (1993).

[47] Kyoto Protocol to the UNFCCC, Dec. 10, 1997, 2303 U.N.T.S. 162 (entered into force Feb. 16, 2005); *see* SEBASTIAN OBERTHÜR & HERMANN E. OTT, THE KYOTO PROTOCOL: INTERNATIONAL CLIMATE POLICY FOR THE 21ST CENTURY (1999).

[48] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE ("IPCC"), GLOBAL WARMING OF 1.5°C, 33, 35–39, 53, 61 (2018); AVOIDING DANGEROUS CLIMATE CHANGE (Hans Joachim Schellnhuber, Wolfgang Cramer, Nebojsa Nakicenovic, Tom Wigley & Gary Yohe eds., 2006).

[49] Paris Agreement to the UNFCCC, Dec. 12, 2015, T.I.A.S. No. 16-1104 [hereinafter Paris Agreement]; *see* Daniel M. Bodansky, *The Paris Climate Change Agreement: A New Hope?*, 110 AM. J. INT'L L. 288 (2016).

[50] Paris Agreement, *supra* note 49, art. 2, ¶ 1(a).

[51] *Id.* art. 3.

[52] Boyd, *supra* note 1, at 417 n.54 (explaining that the IPCC projects limiting warming to 1.5°C requires net-zero emissions of CO_2 by 2050 and net zero for all gases by the 2060s).

[53] *Carbon Pricing Dashboard*, WBG, https://carbonpricingdashboard.worldbank.org [https://perma.cc/5TZF-QXNG] (last visited Feb. 8, 2024).

to sixty-eight.[54] If nothing else, that growth trajectory alone underscores the importance of better understanding the effects of carbon pricing in the real world beyond the textbook of economic theory.

Initial experiences with carbon pricing were limited to a small number of progressive European countries, especially in Scandinavia, which introduced carbon taxes as a source of revenue to finance reductions in marginal income tax rates.[55] Inclusion of carbon pricing in the Kyoto Protocol served as an early catalyst for its further expansion.[56] During negotiations on that treaty, the United States insisted that a set of flexibility mechanisms—international emissions trading, the Clean Development Mechanism and Joint Implementation—be inserted to offer developed countries alternative compliance options for achievement of their quantified emission limitations and reduction objectives.[57]

With encouragement from the Kyoto Protocol, the European Union ("EU") decided to introduce an emissions trading system for greenhouse emissions from industry and the power sector as a central pillar of its climate policy.[58] Launched in 2005, the EU Emissions Trading System ("ETS") became the largest single carbon pricing policy by geographic scope, emissions coverage, and market volume.[59] Ironically, the EU had originally opposed the introduction of carbon pricing in the Kyoto Protocol,[60] but it subsequently opted to deploy the EU ETS as a way to gain familiarity with market-based approaches and has since doubled down by

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[54] WBG, STATE AND TRENDS OF CARBON PRICING 17 (2022), http://hdl.handle.net/10986/37455 [https://perma.cc/5CF4-2B4H].

[55] RUNAR BRÄNNLUND & ING-MARIE GREN, GREEN TAXES: ECONOMIC THEORY AND EMPIRICAL EVIDENCE FROM SCANDINAVIA (1999).

[56] *See* David M. Driesen, *Sustainable Development and Market Liberalism's Shotgun Wedding: Emissions Trading Under the Kyoto Protocol*, 83 IND. L.J. 21, 33–37 (2008) (describing how the inclusion of emissions trading in the Kyoto Protocol led to the EU ETS).

[57] OBERTHÜR & OTT, *supra* note 47, at 189.

[58] Jørgen Wettestad, *The Making of the 2003 EU Emissions Trading Directive: An Ultra-Quick Process Due to Entrepreneurial Proficiency?*, 5 GLOB. ENV'T POL. 1 (2005); Harro van Asselt, *Emissions Trading: The Enthusiastic Adoption of an 'Alien' Instrument?*, *in* CLIMATE CHANGE POLICY IN THE EUROPEAN UNION: CONFRONTING THE DILEMMAS OF MITIGATION AND ADAPTATION? 125 (Andrew Jordan, Dave Huitema, Harro van Asselt, Tim Rayner & Frans Berkhout eds., 2010); Brettny Hardy, *How Positive Environmental Policies Affected Europe's Decision to Oppose and Then Adopt Emissions Trading*, 17 DUKE ENV'T L. & POL'Y F. 297, 300–06 (2006) (tracing the shift from skepticism about market-based approaches in the EU to adoption of the EU ETS as a central pillar of EU decarbonization).

[59] Hardy, *supra* note 58, at 297–98; WBG, *supra* note 53.

[60] Richard Schmalensee & Robert N. Stavins, *The SO_2 Allowance Trading System: The Ironic History of a Grand Policy Experiment*, 27 J. ECON. PERSPS. 103 (2013).

proposing to extend the scope of carbon pricing to emissions from aviation, shipping, road transport, buildings, and—with the Carbon Border Adjustment Mechanism ("CBAM")—even to imported foreign goods.[61]

Further domestic carbon pricing systems followed at the national and subnational level in high income countries, for instance with the Pan-Canadian Framework on Clean Growth and Climate Change, the Regional Greenhouse Gas Initiative ("RGGI") and the Western Climate Initiative in North America, the New Zealand Emissions Trading System, and systems in Switzerland, Tokyo, and Saitama.[62] More recently, however, momentum has again shifted, with the greatest expansion dynamic currently evident in the developing world. Over the course of the last decade, emerging economies and middle-income countries, including Argentina, Chile, China, Colombia, Kazakhstan, Mexico, Singapore, South Africa, South Korea, and Uruguay, have introduced carbon pricing systems, and additional countries, such as Brazil, India, Indonesia, Malaysia, Thailand, Turkey, and Vietnam, have announced their intention to adopt a carbon tax or emissions trading system in the near future.[63]

A central rationale for these developing countries to embrace carbon pricing is the need to achieve greenhouse emission limitation and reduction pledges, to which they have committed for the first time through their nationally determined contributions submitted under the Paris Agreement.[64] Expectation of fiscal revenue and hope to participate in international carbon market transfers under Article 6 of the Paris Agreement[65] have also motivated uptake of carbon taxes and emissions trading, as has recent interest in limiting the impact of the CBAM and other restrictive trade measures that credit a carbon price paid on goods imported by the imposing country.[66]

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[61] Michael A. Mehling & Robert A. Ritz, *From Theory to Practice: Determining Emissions in Traded Goods Under a Border Carbon Adjustment*, 39 OXFORD REV. ECON. POL'Y 123 (2023) (discussing the CBAM and its proposed design).

[62] For a review of many of the trading programs' design features, see THE EVOLUTION OF CARBON MARKETS: DESIGN AND DIFFUSION (Jørgen Wettestad & Lars H. Gulbrandsen eds., 2018).

[63] WBG, *supra* note 20 (providing country-by-country updates on domestic carbon pricing developments).

[64] *See* U.N. CONF. ON TRADE DEV., CARBON PRICING (2022), https://unctad.org/system/files/official-document/ditctab2022d6_en.pdf [https://perma.cc/E5HQ-E38Z].

[65] Article 6 of the Paris Agreement enables Parties to cooperate voluntarily by transferring mitigation outcomes, providing the accounting framework for an international carbon market. *See* Michael A. Mehling, *Governing Cooperative Approaches Under the Paris Agreement*, 46 ECOLOGY L.Q. 765 (2020) (providing an overview of Article 6 of the Paris Agreement and its regulatory operationalization).

[66] WBG, *supra* note 20 (listing factors underlying interest in carbon pricing among a

Perhaps most importantly, however, these countries have variously benefitted from substantial financial and technical assistance from initiatives specifically created to promote carbon pricing, such as the Partnership for Market Readiness ("PMR"), established by the World Bank Group with an initial funding volume of $125 million[67] that has now entered its second phase as the Partnership for Market Implementation ("PMI").[68] Further bilateral and regional efforts by donor agencies and development banks to advance the case for carbon pricing and its implementation have been instrumental in building support and technical capacity around the world and reflect the strong consensus among multilateral institutions, including the World Bank, the International Monetary Fund ("IMF"), the World Trade Organization, and the Organisation for Economic Co-operation and Development ("OECD"), that carbon pricing should be the central instrument for achievement of agreed climate targets.[69]

The expansion of carbon pricing across the globe, however, conceals a more complicated policy landscape. A closer analysis of carbon price levels reveals that less than 5% of global emissions were covered in early 2023 by a carbon price at or above the range of $50 per 100 metric tons of carbon dioxide equivalent ("tCO_2e") estimated by the High-Level Commission on Carbon Prices to be necessary by 2030 to achieve the

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broader set of countries, and highlighting fiscal pragmatism and border carbon adjustments, along with climate action).

[67] PRAJWAL BARAL & OLUWAFEMI FALEYE, WBG, THE PARTNERSHIP FOR MARKET READINESS: FROM THE GROUND UP—A DECADE OF LESSONS ON CARBON PRICING 22–23 (2021), https://documents1.worldbank.org/curated/en/416741627365320014/pdf/The-Partnership-for-Market-Readiness-From-the-Ground-Up-A-Decade-of-Lessons-on-Carbon-Pricing.pdf [https://perma.cc/R33D-7WDS] (last visited Feb. 8, 2024) (describing the objectives, governance, and funding arrangements for the PMR).

[68] *At COP25, the World Bank Announces Global Partnership for Implementing Carbon Markets*, PMI (Dec. 10, 2019), https://pmiclimate.org/news/cop25-world-bank-announces-global-partnership-implementing-carbon-markets [https://perma.cc/62RS-U9F9] (announcing launch of the PMI).

[69] *Statement: Putting a Price on Carbon*, WBG (June 3, 2014), https://www.worldbank.org/content/dam/Worldbank/document/Carbon-Pricing-Statement-060314.pdf [https://perma.cc/RZ8L-4KV3] (inviting countries to introduce and cooperate on carbon pricing); Jean Chateau, Florence Jaumotte & Gregor Schwerhoff, *Why Countries Must Cooperate on Carbon Prices*, IMF BLOG (May 19, 2022), https://www.imf.org/en/Blogs/Articles/2022/05/19/blog-why-countries-must-cooperate-on-carbon-prices [https://perma.cc/Y4TB-GRM4] (arguing for an international floor price for carbon); Ngozi Okonjo-Iweala, *Adopting a Global Carbon Price Is Essential*, FIN. TIMES (Oct. 14, 2021), https://www.ft.com/content/b0bcc93c-c6d6-475e-bf32-0d10f71ef393 [https://perma.cc/6WZW-7V5W] (appealing to governments and international organizations to develop a common approach to carbon pricing).

upper end of the temperature targets agreed to in the Paris Agreement if deployed as part of a climate policy portfolio that includes other policy measures.[70] If climate policy were to rely exclusively on a carbon price, the projected price level to achieve the 2°C target would have to be even higher, ranging from $15 to $360 per tCO_2e in 2030, $45 to $1000 in 2050, and $750 to $8300 in 2100.[71] What is more, as is discussed elsewhere in this Article, current carbon pricing policies tend to mute the price signal with exceptions and free allocation of allowances for particular sectors, as well as opportunities to use less costly (and less reliable) offset credits as a compliance alternative.[72] While carbon pricing has seen a gradual expansion over time, its implementation in practice still lags significantly behind what its proponents call for.

D. Alternatives to Pricing

While carbon pricing has dominated discourse about the climate crisis and played a role in many polities' approach to it, no government relies exclusively on carbon pricing to reduce greenhouse emissions.[73] Experts have frequently compared pricing to "command and control regulation."[74] The term "command and control" regulation suggests that work practice standards—which dictate the use of pollution reduction techniques chosen by a regulator—provides the alternative to pricing.[75] But pricing proponents in their more careful papers define the term "command and control" regulation to include performance standards, which require each regulated firm to reduce pollution by a fixed amount with

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[70] WBG, *supra* note 20, at 20–21 (citing JOSEPH E. STIGLITZ & NICHOLAS STERN, REPORT OF THE HIGH-LEVEL COMMISSION ON CARBON PRICES 61 (2017), https://doi.org/10.7916/d8-w2nc-4103 [https://perma.cc/3DTV-FU8P]).
[71] IPCC, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE. CONTRIBUTION OF WORKING GROUP III TO THE FIFTH ASSESSMENT REPORT OF THE IPCC 450 (2015).
[72] *See* discussion *infra* Section II.A.
[73] Erik Haites, *A Dual-Track Transition to Global Carbon Pricing: Nice Idea, but Doomed to Fail*, 20 CLIMATE POL'Y 1344, 1344 (2020) (noting every jurisdiction "with a pricing policy also has multiple regulatory policies").
[74] *See, e.g.*, Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333, 1343 (1985); *see also* Michael A. Mehling, *Market Mechanisms*, *in* THE OXFORD HANDBOOK OF INTERNATIONAL ENVIRONMENTAL LAW 920 (Lavanya Rajamani & Jacqueline Peel eds., 2d ed. 2021) (discussing how economists helped shape the terminology in environmental policy with this pejorative term).
[75] *See, e.g.*, Adamo Wrecking Co. v. United States, 434 U.S. 275, 277, 285–87 (1978) (distinguishing between an emissions standard and a work practice standard requiring procedures at a work site without specifying a level of emission reductions to achieve).

whatever techniques the firm wishes to employ.[76] We prefer the less pejorative term "traditional regulation" to refer to both performance standards and work practice standards. All governments we know of use some sort of traditional regulation to require that at least new construction and some retrofits of old buildings meet energy efficiency goals.[77] Standards governing new vehicle emissions—the main catalyst for increasing production of electric vehicles—are often described as traditional regulations.[78]

In addition to pricing carbon, governments often adopt policies that require or incentivize clean energy. For example, most U.S. states employ renewable portfolio standards ("RPS"), which require utilities to buy a fixed percentage of power from renewable sources.[79] While other polities use this approach as well, many countries use a feed-in tariff ("FIT") to encourage more production and use of renewable energy.[80] Under this approach, governments pay renewable energy providers a fixed price in excess of market rates for feeding clean energy into the grid.[81] Recent years have also seen a shift from both RPS and FIT approaches to competitive auctioning as a way to procure renewable energy generation, with project developers bidding deliveries of electricity for a fixed price or market premium.[82]

Finally, increasingly governments use what one might call a Green New Deal approach—where governments fund technological changes

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[76] *See, e.g.*, Robert W. Hahn & Robert N. Stavins, *Incentive-Based Regulation: A New Era for an Old Idea?*, 18 ECOLOGY L.Q. 1, 5 (1991).

[77] *See* David M. Driesen, *Traditional Regulation's Role in Greenhouse Gas Abatement*, *in* THE ENCYCLOPEDIA OF ENVIRONMENTAL LAW (Daniel Farber & Marjan Peeters eds., 2016).

[78] *See* BARRY RABE, CAN WE PRICE CARBON? 222 (2018) (describing the CAFÉ standards as "performance standards"). CAFÉ standards, however, do not require each vehicle to meet the standard. Instead, they establish "corporate average" fuel economy standards—meaning requirements for what level of fuel economy, and therefore greenhouse emission reductions—a vehicle manufacturers' fleet must achieve. While this is very different from a trading system that allows trades throughout an economy or even an industry, it does have some of the flexibility and cost effectiveness of a trading system.

[79] *Renewable Energy Explained: Portfolio Standards*, U.S. ENERGY INFO. ADMIN. (Nov. 30, 2022), https://www.eia.gov/energyexplained/renewable-sources/portfolio-standards.php [https://perma.cc/V8GG-AGGX].

[80] *See, e.g.*, BÉATRICE COINTE & ALAIN NADAÏ, FEED-IN TARIFFS IN THE EUROPEAN UNION: RENEWABLE ENERGY POLICY, THE INTERNAL ELECTRICITY MARKET AND ECONOMIC EXPERTISE (2018).

[81] Marc Ringel, *Fostering the Use of Renewable Energies in the European Union: The Race Between Feed-in Tariffs and Green Certificates*, 31 RENEWABLE ENERGY 1, 6 (2006).

[82] Pablo del Río & Christoph P. Kiefer, *Academic Research on Renewable Electricity Auctions: Taking Stock and Looking Forward*, ENERGY POL'Y, Nov. 2022, at 1.

needed to reduce greenhouse emissions. The aforementioned IRA provides a dramatic recent example of this approach. The Green New Deal itself was a resolution introduced in Congress to require achievement of very ambitious climate, economic, and social goals.[83] This resolution called for massive government investment in clean technology manufacturing and deployment, suggesting government subsidies.[84] The IRA and a predecessor infrastructure bill that funded electricity grid improvements needed for renewable energy and charging stations for electric vehicles both basically adopt this approach.[85] That approach to climate has many antecedents both in the United States and abroad, but rising pressure to address climate change, combined with an acute need to produce cheap power to offset rising prices in fossil fuel markets and to recover from COVID, have led to dramatically increasing government investments around the world.[86]

None of these programs fall within the definition of policies putting a price on carbon as that term is defined in the literature on carbon pricing. But all of these programs influence or generate an implicit price in the form of compliance costs or, in the case of subsidies, a burden on public budgets.

II. THE CRITICS' CLAIMS

The critics claim that carbon pricing fails because it proves insufficiently ambitious, not terribly effective when ambitious, and poorly suited to the transformative change needed to adequately address the climate crisis. We discuss each of these claims in turn.

A. *Insufficient Ambition*

The critics' claim that carbon pricing is insufficiently ambitious has two components. First, critics point out that carbon prices, after decades of advocacy by pricing proponents and significant emphasis under the

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[83] H.R. Res. 109, 116th Cong. (2019), https://www.congress.gov/116/bills/hres109/BILLS-116hres109ih.pdf [https://perma.cc/5F62-GRPS].

[84] *See id.* (calling for funding for community-defined projects to build "resiliency against climate change-related disasters," "repairing and upgrading . . . infrastructure," and investment in "sustainable farming" and clean transportation).

[85] David Elliott, *What Is the US Infrastructure Bill? An Expert Explains*, WORLD ECON. F., https://www.weforum.org/agenda/2021/08/us-infrastructure-bill-explained [https://perma.cc/8UZ7-RHGW] (Nov. 16, 2021).

[86] *See, e.g.*, *A European Green Deal*, EUR. COMM'N, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en [https://perma.cc/722U-2Y35] (last visited Feb. 8, 2024).

climate regime, apply to less than a quarter of global emissions.[87] Even in countries that have adopted carbon pricing, they tend to apply to less than half of emissions.[88] Thus, carbon pricing has only rarely approximated the economy-wide coverage that its advocates envision (although the EU is now taking steps to expand coverage of carbon pricing beyond the roughly 40% of emissions that it covers at the moment).[89]

The insufficient ambition claim also relies upon the low carbon prices established for carbon taxes and generated on markets for tradeable emission allowances.[90] Economists claim that the objective of climate policy should be to put a price on carbon equal to its social costs.[91] Thus, they advocate an allocatively efficient carbon price.

Some critics implicitly use an allocative efficiency benchmark in fleshing out their claim of insufficient ambition.[92] They point out that the carbon price imposed through the pricing programs is lower than the social cost of carbon—the dollar value of quantifiable and monetizable damage associated with a ton of carbon emissions.[93] Economic theory generally suggests policy should aim to achieve allocative efficiency—to balance the costs and benefits of a policy.[94] Since a variety of programs

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[87] WBG, *supra* note 20, at 24.

[88] Erik Haites, Duan Maosheng, Kelly Sims Gallagher, Sharon Mascher, Easwaran Narassimhan, Kenneth R. Richards & Masayo Wakabayashi, *Experience with Carbon Taxes and Greenhouse Gas Emissions Trading Systems*, 29 DUKE ENV'T L. & POL'Y F. 109, 114 (2018) (quantifying emissions coverage across emissions trading systems and carbon taxes).

[89] *See* Council of the EU Press Release 1125/22, "Fit for 55": Council and Parliament Reach Provisional Deal on EU Emissions Trading System and the Social Climate Fund (Feb. 8, 2023) (indicating an agreement to create a second trading system to cover road transport and buildings); *cf.* Haites et al., *supra* note 88, at 135 (indicating British Columbia's carbon tax covers some 70% of greenhouse emissions); Boyd, *supra* note 1, at 463–64 n.256 (noting California's cap-and-trade scheme covers 85% of California's greenhouse emissions).

[90] *Cf.* Haites et al., *supra* note 88, at 128 (finding a social cost of carbon benchmark inappropriate for carbon pricing schemes in part because it is not a known price).

[91] *See, e.g.*, William D. Nordhaus, Keynote Address, Economic Issues in a Designing a Global Agreement on Global Warming (Mar. 2009), https://grist.org/wp-content/uploads/2010/04/copenhagen_052909.pdf [https://perma.cc/69GY-VVBB] (describing the dictum that "all people" must "face a market price for the use of carbon that reflects the social costs of their activities").

[92] Haites et al., *supra* note 88.

[93] Leah C. Stokes & Matto Mildenberger, *The Trouble with Carbon Pricing*, 16 BOS. REV. 122, 128 (2020) (stating "no carbon price in the world comes close" to a climate scientist's estimate of the social cost of carbon); Jenkins, *supra* note 4, at 1 (noting less than 1% of global emissions are subject to a carbon price "equal to . . . a low-end estimate of the social cost of carbon").

[94] Paul A. Samuelson, *The Pure Theory of Public Expenditure*, 36 REV. ECON. & STAT. 387 (1954).

can achieve allocative efficiency, identifying pricing as the goal of climate policy confuses means with ends even if we assume that allocative efficiency should operate as a policy's only goal. The claim that carbon pricing in practice is not allocatively efficient, which is clearly correct, should persuade economists that something is amiss.

The critics, however, often claim (sometimes in the same sentence) that carbon pricing is inadequate because the prices of these programs are insufficient to drive us toward net-zero emissions by at least meeting Paris Agreement pledges.[95] This framing assumes that science and the relatively democratic process of international lawmaking should define the goals of climate policy.[96] It does not accept allocatively efficient pricing as the goal of climate policy but treats it as a means to legally and scientifically grounded aims.

In practice, the critics suggest, the allocatively efficient level of emissions at a future point in time is zero or negative, because it has become clear that the climate crisis creates enormous damage.[97] But the distinction between defining the goal in legal terms and in economic terms will help elucidate some of the philosophical and political issues involved in trying to overcome the problem of insufficiently ambitious carbon pricing.

Using price as a measure of ambition has some problems. It does not jibe with what the legal regime envisions or popular intuition about what climate policy should aim to accomplish. And its use as a metric suggests that if governments could figure out how to achieve zero emissions with modest cost, this would constitute a policy failure. It does, however, speak to economic theory, which equates a high carbon price with achievement of climate goals. Still, a more straightforward metric for evaluating ambition would focus on emission reductions, not price.

B. *Ineffective When Ambitious*

The critics also claim that on the rare occasions when a government has imposed a high carbon price, it has produced disappointing results. They cite the Swedish carbon tax—$137 per ton for many sources in 2022—as a telling example: in spite of this tax, Swedish transport emissions only declined 4% over 15 years.[98] This seems modest both relative

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[95] *See, e.g.*, Ball, *supra* note 5, at 138–39 (stating only 1% of greenhouse emissions are priced high enough to be on a trajectory consistent with Paris pledges).
[96] *Cf.* Pindyck, *supra* note 40.
[97] Stokes & Mildenberger, *supra* note 93.
[98] Endre Tvinnereim & Michael Mehling, *Carbon Pricing and Deep Decarbonisation*, 121

to what effective climate policy requires and what one might expect from what long was the world's highest carbon price. Economists estimate that British Columbia's relatively modest (but broadly applicable) carbon tax has reduced emissions by about 5%.[99]

A few cap-and-trade programs apply to sectors that have experienced large declines in emissions. Because other policies, such as renewable energy policies, apply to the same sectors, it has been difficult to tell whether the trading programs had significant effects.[100] Thus, for example, an econometric study of RGGI—a cap-and-trade program in the northeast United States—found, somewhat surprisingly, that RGGI had a significant influence on emissions during a period of economic decline and lowering of natural gas prices.[101] But the authors did not squarely attribute the decline to the cap, since the RGGI office auctioned off all the allowances, and RGGI states used the revenue to fund energy efficiency improvements and renewable energy.[102] Richard Schmalensee and Robert Stavins doubted that RGGI's cap had a significant effect, as it was set too high to influence emissions.[103] Analysts have claimed California's cap-and-trade system, the only such system with nearly economy-wide coverage, generated relatively few of the emission reductions in the Golden State, which has a raft of other climate policies in place.[104] While the EU ETS has generated emission reductions, its low carbon price during most of its existence so far suggests that it has not done so through the price signal alone.[105] None of the programs analyzed in this literature

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ENERGY POL'Y 185, 186 (2018); *see also* Ball, *supra* note 6; *cf.* Jessica F. Green, *Does Carbon Pricing Reduce Emissions?: A Review of Ex-Post Analysis*, ENV'T RSCH. LETTERS, Mar. 2021, at 1, 10 (noting some studies have not found reductions from Sweden's carbon tax and analysis of other Nordic carbon taxes also yield disparate results).

[99] Brian Murray & Nicholas Rivers, *British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy*, 86 ENERGY POL'Y 674 (2015).

[100] *See* Rohan Best, Paul J. Burke & Frank Jotzo, *Carbon Pricing Efficacy: Cross-Country Evidence*, 77 ENV'T & RES. ECON. 69, 71 (2020) (discussing the difficulty in disentangling the effects of multiple policies).

[101] Brian C. Murray & Peter T. Maniloff, *Why Have Greenhouse Emissions in RGGI States Declined? An Econometric Attribution to Economic, Energy Market, and Policy Factors*, 51 ENERGY ECON. 581, 588 (2015) (finding RGGI caused a 19% decline in emissions).

[102] *See id.* (finding it difficult to separate the RGGI price effects from the "use of auction proceeds for energy efficiency and low-carbon investment").

[103] *Lessons Learned from Three Decades of Experience with Cap and Trade*, 11 REV. ENV'T ECON. & POL'Y 59, 67 (2017).

[104] Boyd, *supra* note 1, at 464 (finding most of California's emission reductions come "from other, more prescriptive policies").

[105] Patrick Bayer & Michaël Aklin, *The European Union Emissions Trading System*

have driven sufficiently ambitious reductions to create a pathway to deep decarbonization.

C. *Pricing Ill-Suited to Transformative Change*

The critics further claim that pricing may work well in fostering cost-effective incremental change but does not do a good job of incentivizing the transformative change needed to reach net-zero emissions.[106] Articles preceding much of the critics' work support this skepticism about pricing's transformative potential.[107]

They point mainly to the history of transformational change.[108] In general, many transformational changes have required massive government subsidies and infrastructure support. These claims draw on a large literature on economic transformations and technological lock-in—the embedding of core technologies in interlocking supportive systems that society cannot easily unravel.[109]

The economic dynamic theory of law and economics supports these charges.[110] This theory aims to understand the shape of change over time and how policy can fruitfully change its direction by analyzing economic incentives in ways that blend targeted institutional economic analysis with precise legal analysis.[111]

Pricing proponents make an important point in stating that a price on carbon provides an incentive to reduce carbon emissions. But sophisticated law and economic analysis of incentives demands examination of some further questions. An economic dynamic analysis begins by

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Reduced CO_2 Emissions Despite Low Prices, 117 PROC. NAT'L ACAD. SCIS. 8804, 8804 (2020) (asserting the EU ETS reduced emissions despite low prices because it was seen as a credible institution that would plausibly become more stringent in the future).

[106] Tvinnereim & Mehling, *supra* note 98, at 188.

[107] *See id.* at 188; Driesen, *supra* note 56, at 69 (explaining that the short-term cost effectiveness of emissions trading may clash with the need for initially expensive transformative innovation, using solar power as an example).

[108] Patt & Lilliestam, *supra* note 12, at 2487.

[109] *See generally* Karen C. Seto, Steven J. Davis, Ronald B. Mitchell, Eleanor C. Stokes, Gregory Unruh & Diana Ürge-Vorsatz, *Carbon Lock-in: Types, Causes, and Policy Implications*, 41 ANN. REV. ENV'T & RES. 425 (2016) (providing a conceptual overview and examples of carbon lock-in).

[110] *See* DRIESEN, ECONOMIC DYNAMICS, *supra* note 16, at 16; DRIESEN, ENVIRONMENTAL DYNAMICS, *supra* note 16.

[111] *See* DRIESEN, ECONOMIC DYNAMICS, *supra* note 16, at 77 (explaining that economic dynamic analysis requires "attention to legal detail" and "bounded rationality").

asking which institutions and people the incentive applies to.[112] It then asks how institutions and people are likely to respond to the incentives, given bounded rationality.[113] In particular, it insists on looking at the particular habits and routines of those subject to the incentives to figure out the relevant bounds of rationality, that is, what information they will pay attention to and how they will respond.[114] And finally, it requires we consider not only the incentives the law creates but competing incentives that might countervail the incentives the law creates.[115] Some of these disincentives stem from technological lock-in.[116]

Despite an observed behavioral effect through which payment of a carbon price can crowd out the motivation to reduce emissions,[117] pricing is likely to encourage short-term cost effectiveness, leading those subject to the price to find the cheapest way to avoid or minimize the costs they know about. But firms cannot predict long-term costs for cap-and-trade programs or for taxes, which legislatures must revise over time to keep pace with technological improvements, new economic conditions, or just changing estimates of the social cost of carbon. Thus, consideration of bounded rationality supports a conclusion that carbon pricing encourages short-term over long-term cost effectiveness.

Precise analysis of the incentives facing particular groups of actors subject to pricing allows us to go further. Carbon pricing provides an incentive to favor minor tweaks over expensive transformative change.[118] A cap-and-trade program incentivizes emitters facing high abatement costs to avoid local abatement, encouraging them to purchase allowances from sources with low-cost abatement options instead of reducing their own emissions.[119] Since transformative innovations usually have high initial costs (until they are widely deployed and learning by doing takes place), the transfer of reductions to low-cost sources that occurs under

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[112] *See id.* at 64 (stating economic dynamic analysis requires studying the habits of "relevant" individuals or institutions to see if they are likely to respond to nominally applicable incentives).
[113] *See id.*
[114] *See id.*
[115] *See id.* at 77 (discussing the need to consider "countervailing incentives").
[116] *See generally* Seto et al., *supra* note 109, at 435, 437.
[117] Karine Nyborg, *Will Green Taxes Undermine Moral Motivation?*, 10 PUB. FIN. & MGMT. 331 (2010) (arguing economic incentives can undermine intrinsic or moral motivation, rendering them counterproductive).
[118] *See* Driesen, *supra* note 56, at 49–57 (explaining global emissions trading does not provide a very good approach to stimulating valuable investment in zero-emissions technology).
[119] *See* Driesen, *supra* note 43, at 10,095; Malueg, *supra* note 43, at 56.

trading facilitates avoidance of transformational change.[120] If necessity is the mother of invention, then cap-and-trade programs reduce the incentives for high-cost innovation below those which would be provided by a traditional regulation of the same stringency.[121] A tax works much the same way, allowing polluters with high abatement costs to pay the tax instead of shutting down or making transformative changes that a traditional regulation requiring such change or a particular environmental outcome might lead to.[122] There is a tension between lowering incumbents' short-term costs and high incentives for transformative innovation in a context in which all reductions, not just the initially cheapest, have to be mobilized in the relatively near term.[123]

The data, however, show that carbon pricing does induce some innovation.[124] While carbon pricing will minimize innovation among sources with high-cost conventional abatement options, owners of sources with low-cost options may tweak their processes, sometimes in innovative ways, to generate credits to sell to high-cost abatement avoiders.[125] The stringency of the standard and its deadline determines the magnitude and duration of high-cost sources' demand for allowances from low-cost sources, and hence the extent of the incentive for low-cost sources to go beyond compliance with their caps.[126]

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[120] *See* Driesen, *supra* note 56, at 53–54 (explaining in detail why this is so).

[121] *See* Margaret R. Taylor, Edwin S. Rubin & David A. Hounshell, *Regulation as the Mother of Innovation: The Case of SO_2 Control*, 27 LAW & POL'Y 348, 350, 372 (2005) (concluding emissions trading encourages less innovation than command-and-control regulation).

[122] Justin Worland, *The New Climate Taxes That May Be Closer Than You Think*, TIME (Feb. 6, 2023), https://time.com/6252955/climate-change-windfall-tax [https://perma.cc/BNP4-NZCH].

[123] Patt & Lilliestam, *supra* note 12, at 2497 (arguing a search for low-hanging fruit becomes irrelevant when "we know we must eventually pick all of the apples on the tree"); Adrien Vogt-Schilb, Guy Meunier & Stéphane Hallegatte, *When Starting with the Most Expensive Option Makes Sense: Optimal Timing, Cost and Sectoral Allocation of Abatement Investment*, 88 J. ENV'T. ECON. & MGMT. 210 (2018) (finding it optimal to start a long-term emissions-reduction strategy with significant short-term abatement investment).

[124] *See* Michael Grubb, Paul Drummond, Alexandra Poncia, Will McDowall, David Popp, Sascha Samadi, Cristina Penasco, Kenneth T. Gillingham, Sjak Smulders, Matthieu Glachant, Gavin Hassall, Emi Mizuno, Edward S. Rubin, Antoine Dechezleprêtre & Giulia Pavan, *Induced Innovation in Energy Technologies and Systems: A Review of Evidence and Potential Implications for CO_2 Mitigation*, ENV'T RSCH. LETTERS, Mar. 2021, at 1, 9–16 (surveying the literature on energy prices' effects on innovation in the sector); Raphael Calel & Antoine Dechezleprêtre, *Environmental Policy and Directed Technological Change: Evidence from the European Carbon Market*, 98 REV. ECON. & STAT. 173 (2016) (inferring a nearly 1% increase in European low-carbon patenting due to the EU ETS).

[125] Driesen, *supra* note 43, at 10,095.

[126] *Id.* at 10,096 (noting stricter regulation "heightens incentives for innovation").

The data tend to bear out what sound economic theory would predict. Most of the energy industry studies find that innovation under a pricing regime tends to focus on energy efficiency and incremental changes in fossil fuel technology, rather than on zero-emission technology.[127]

Consideration of the shape of change over time in the climate context casts doubts on the merits of maximizing short-term cost effectiveness. Short-term cost effectiveness can prove wasteful relative to long-term goals. More than two decades ago, one of us argued that absent far-sighted design changes, environmental benefit trading encourages cheap fixes rather than wise permanent solutions.[128] Just as a homeowner sometimes should eschew cheap roof patches in favor of replacing the roof, society facing the existential threat posed by global climate disruption should often pay high costs upfront to avoid wasting money over time. Emissions trading may encourage unwise investments in making dirty infrastructure (such as coal-fired power plants) marginally cleaner (for example, by encouraging heat rate improvements or inducing a switch to another carbon-emitting fuel such as natural gas) rather than substituting clean infrastructure (such as renewable energy and perhaps nuclear power) for infrastructure that will likely have to be scrapped sooner rather than later. If we know that emissions must go to zero, it makes little sense to invest in more efficient coal-fired power plants if we must shut these down anyway (or retrofit to capture and permanently store 100% of the carbon emitted, if that is possible).[129]

Economic dynamic theory's focus on the shape of change over time requires considering entire systems, not just individual actors. A focus on understanding the shape of change over time helps reveal that getting to zero emissions requires huge increases in energy efficiency so as to minimize the challenges involved in switching to alternative fuel sources for the entire economy.

Consideration of bounded rationality reveals that many actors do not respond optimally or at all to pricing's incentives to enhance energy efficiency.[130] Because carbon pricing of utility emissions does not directly

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[127] Grubb et al., *supra* note 124, at 13–15 (reviewing various studies finding pricing encourages incremental rather than radical innovation).

[128] Driesen, *supra* note 23.

[129] LEAH CARDAMORE STOKES, SHORT CIRCUITING POLICY: INTEREST GROUPS AND THE BATTLE OVER CLEAN ENERGY AND CLIMATE POLICY IN THE AMERICAN STATES 21 (2020); Alexander Pfeiffer, Cameron Hepburn, Adrien Vogt-Schilb & Ben Caldecott, *Committed Emissions from Existing and Planned Power Plants and Asset Stranding Required to Meet the Paris Agreement*, ENV'T. RSCH. LETTERS, May 2018, at 1.

[130] *See* Ball, *supra* note 5, at 138 (pointing out carbon pricing does not work well for buildings because "builders rarely occupy the buildings they build" and therefore do not

apply to the building of new apartment buildings, builders' bounded rationality might not induce them to take a carbon price associated with powering a building into account.[131] Their routines involve purchasing lots of supplies and hiring labor to get projects done, and they are unlikely to pay much attention to costs they will not incur. While a far-sighted builder may see that energy efficiency might provide a selling point, he might think it a very weak one, especially if the buyer is a landlord who will pass energy costs on to tenants instead of incurring them herself.[132] Hence, building codes.

A precise analysis of pricing's effects on specific relevant actors also reveals institutional restraints. Many analysts have pointed out that energy systems feature technological lock-in, where supportive infrastructure built up over time locks in existing technologies in ways that are hard to overcome.[133] Vehicle owners act within a set of opportunities and constraints created by existing fueling infrastructure and available vehicle types. Energy providers must interact with an existing grid.

Electric utilities incentivized by a high carbon price to switch to clean renewable energy face countervailing incentives (even requirements) to maintain a stable grid, which induce them to refrain from a thoroughgoing switch to renewable energy.[134] In other words, technological lock-in creates powerful disincentives to do what pricing might motivate a utility not embedded in a technological system to do. Imposing a high carbon price on fossil-fuel-fired power plants does not by itself lead to any deployment of renewable energy, let alone of nuclear power (which some analysts consider essential to achieving net-zero emissions).[135] Renewable energy and nuclear power require changes in the electricity grid (such as new transmission lines and battery storage for renewables) to make 100% clean energy even plausible.[136] Nuclear power has always

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pay electricity bills); Stoll & Mehling, *supra* note 15, at 3 (discussing the problem of split incentives where landlords, for example, "have little incentive to enhance energy efficiency if tenants pay for electricity and heat").

[131] *See* Stoll & Mehling, *supra* note 15, at 2–3.

[132] *Cf.* Grubb et al., *supra* note 124, at 15 (reporting mixed results on whether high energy prices contribute to patenting technologies in the building sector but noting one study found statistically significant effects only in technologies that a building's occupant could easily change).

[133] *See* Seto et al., *supra* note 109.

[134] Jim Rossi & Michael Panfil, *Climate Resilience and Private Law's Duty to Adapt*, 100 N.C. L. REV. 1135, 1147 (2022).

[135] Ernest Moniz, *Why We Still Need Nuclear Power: Making Clean Energy Safe and Affordable*, 90 FOREIGN AFFS. 83, 84 (2011) (highlighting nuclear power's track record of providing clean and reliable electricity).

[136] Catherine Clifford, *Here's Why the U.S. Electric Grid Isn't Running on 100% Renewable*

been too expensive for utilities to finance on their own.[137] Instead, governments must mobilize the needed capital (usually through bond markets). And they must persuade people to put up with the risks.

As the Swedish example illustrates, pricing proves insufficient by itself to induce dramatic changes in the transport industry for similar reasons.[138] People may wish to avoid driving to reduce high fuel costs. But they face powerful countervailing incentives in the need to get to work, buy food, and get their children to school that may limit their ability to stop driving. Unless they have the option to purchase clean vehicles at comparable cost or use effective and efficient public transportation, they may have no choice but to spend more on continued automobile use. In economic terms, energy proves relatively price inelastic.[139] That said, it becomes more elastic if governments require production of clean vehicles (even though car manufacturers do not pay a price on the carbon emitted by the vehicles) and/or fund robust public transportation. Consumers with the option to purchase a clean vehicle face a disincentive discouraging their purchase, however, if they cannot obtain fuel when traveling.

Clean vehicles are only possible if clean fuel—in this case electricity generated from zero-carbon sources—is available to consumers when and where they need it. Although they may be able to purchase a charger for their home, consumers paying a carbon price cannot by themselves create a network of charging stations. Hence, the IRA and the predecessor infrastructure bill follow the practice of governments that are serious about the climate crisis by funding charging networks.[140] The Swedish tax induced some consumers to switch to diesel fuel but hardly effected a rush to zero-emission vehicles, even at $137 per ton.[141] And while diesel

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Energy Yet, CNBC (Dec. 29, 2022), https://www.cnbc.com/2022/12/29/why-isnt-the-us-electrical-grid-run-on-100percent-renewable-energy-yet.html [https://perma.cc/9EZD-QMAP].

[137] INT'L ENERGY AGENCY, NUCLEAR POWER IN A CLEAN ENERGY SYSTEM 29 (May 2019).

[138] Michael Mehling & Endre Tvinnereim, *Carbon Pricing and the 1.5° Celsius Target: Near-Term Decarbonization and the Importance of an Instrument Mix*, 12 CARBON & CLIMATE L. REV. 50, 52–53 (2018).

[139] *See, e.g.*, David McLaughlin, *How Manitoba Arrived at the Decision to Reject Carbon Pricing Shows the Obvious Political Limits to This Policy Tool*, POL'Y OPTIONS (July 18, 2019), https://policyoptions.irpp.org/magazines/july-2019/manitobas-fickle-relationship-with-carbon-pricing [https://perma.cc/KAA6-8C5M] (explaining that Manitoba resisted a federal demand to raise its carbon tax from $25 to $50 per ton because its modeling showed doing so would add costs without reducing carbon).

[140] *Cf.* Andrew Willis, *Canada Infrastructure Bank Puts up $500-Million to Triple EV Charging Stations*, GLOBE & MAIL (Sept. 28, 2022), https://www.theglobeandmail.com/business/article-ev-charging-stations-canada-infrastructure-bank [https://perma.cc/ET29-ER5F].

[141] We would predict, however, that once zero-emission vehicle production picks up and prices drop, the tax may help accelerate electric vehicles sales in Sweden. In other words,

engines tend to be more fuel efficient,[142] owners of gasoline-powered cars cannot switch to diesel fuel without buying a new vehicle, thus limiting the impact of a fuel tax.

Finally, we would add an environmental justice point that has received insufficient emphasis in economic dynamic theory. In a world of economic inequality, many of those who face rising carbon prices cannot reduce emissions (at least not without enormous hardship), because they do not have the capital necessary to avail themselves of carbon reduction measures to reduce the costs they pay. Thus, low-income homeowners cannot easily insulate their homes or replace functioning furnaces or air conditioners with more efficient models because they do not have capital or access to affordable credit. Pricing can force them to choose between freezing in winter or sweltering in heat waves and just paying while doing nothing to significantly reduce their carbon footprints. That is why many governments fund weatherization programs for low-income homeowners and require utilities to subsidize energy efficiency improvements for middle- and low-income households.[143] Economists acknowledge that carbon taxes prove regressive[144] and recommend rebates to compensate,[145] a recognition that pricing alone cannot equitably address a climate crisis. But the broader point is that the distribution of costs and economic inequality can influence society's ability to optimize in response to prices or other incentives.

The economic dynamic framework insists that the proper role of government focuses on the shape of change over time.[146] It rejects optimization

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carbon taxes can have bigger effects than they might alone if other policies produce cost-effective zero-emission options.

[142] *Diesel Engine Vehicles*, U.S. DEP'T OF ENERGY, https://www.energy.gov/energysaver/diesel-engine-vehicles [https://perma.cc/WEM4-92SN] (last visited Feb. 8, 2024).

[143] *See, e.g.*, *Weatherization Innovation*, U.S. DEP'T OF ENERGY, https://www.energy.gov/scep/wap/weatherization-assistance-program [https://perma.cc/8CVL-NUBN] (last visited on Feb. 8, 2024).

[144] Anders Fremstad & Mark Paul, *The Impact of a Carbon Tax on Inequality*, 163 ECOLOGICAL ECON. 88, 96 (2019) (estimating a carbon tax would cost poor households a higher percentage of their expenditures or incomes than the rich, making it a regressive tax); William F. Lamb, Miklós Antal, Katharina Bohnenberger, Lina I. Brand-Correa, Finn Müller-Hansen, Michael Jakob, Jan C. Minx, Kilian Raiser, Laurence Williams & Benjamin K. Sovacool, *What Are the Social Outcomes of Climate Policies? A Systematic Map and Review of the Ex-Post Literature*, ENV'T RSCH. LETTERS, Nov. 2020, at 1, 11 (finding overall regressive effects from carbon and environmental taxes on household income).

[145] David Klenert, Linus Mattauch, Emmanuel Combet, Ottmar Edenhofer, Cameron Hepburn, Ryan Rafaty & Nicholas Stern, *Making Carbon Pricing Work for Citizens*, 8 NATURE CLIMATE CHANGE 669, 669 (2018) (recommending different ways to recycle carbon pricing revenue depending on the political context).

[146] DRIESEN, ECONOMIC DYNAMICS, *supra* note 16, at 5.

as a government goal. We have free markets precisely because governments can never amass sufficient information to optimize an economy.

From that standpoint, governments should aim to make clean energy cheaper than dirty energy. But at least in the electric utility space, that has largely occurred already. Renewable energy prices have fallen to the point that renewable energy is now competitive and sometimes cheaper than fossil fuel generation.[147] The remaining problems in getting to zero carbon in that sector have little to do with establishing a higher price for fossil fuels. They have to do with improved storage technology, grid integration, and land use.[148] The analysis above and the Swedish case suggest that an economic dynamic analysis of transportation will come to the same conclusion, namely that pricing alone cannot suffice.

Thus, the critics of carbon pricing are right to insist that the problems facing us are ones of technological lock-in that pricing by itself is ill-equipped to address. If power plants were able to sell power to utility customers without an electricity grid, remaining fossil-fueled power plants would shut down much more quickly in favor of renewable energy. But we rely on an integrated electricity grid built up over more than a century to deliver electricity to consumers, and no matter how high the carbon price, we cannot get to zero emissions without re-engineering or abandoning the grid. The technological lock-in creates incentives that countervail price, making pricing alone ineffective at getting to zero emissions.

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[147] *See* MATT GRAY & SRIYA SUNDARESAN, CARBON TRACKER, HOW TO WASTE OVER HALF A TRILLION DOLLARS: THE ECONOMIC IMPLICATIONS OF DEFLATIONARY RENEWABLE ENERGY FOR COAL POWER INVESTMENTS 14–15 (2020) (showing renewable generation costs less than fossil fuel generation in China); LAZARD, LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS—VERSION 16.0 at 12–13 (2023), https://www.lazard.com/media/nltb551p/lazards-lcoeplus-april-2023.pdf [https://perma.cc/B9DH-7DPY] (concluding "certain renewable energy technologies are already cost competitive" in the United States); Daniel Slotta, *Levelized Cost of Energy in China in Selected Years from 2010 to 2021, with a Forecast Until 2024, by Source*, STATISTA (Jan. 3, 2024), https://www.statista.com/statistics/1327637/levelized-cost-of-energy-in-china [https://perma.cc/7V8K-BHEB] (showing renewable energy costs less than fossil fuel in China); MICHAEL TAYLOR, PABLO RALON & SONIA AL-ZOGHOUL, INT'L RENEWABLE ENERGY AGENCY, RENEWABLE POWER GENERATION COSTS IN 2021, at 4–5 (2022), https://www.irena.org/publications/2022/Jul/Renewable-Power-Generation-Costs-in-2021 [https://perma.cc/F7K8-KPWF] (finding almost two-thirds of newly installed renewable power in 2021 had lower cost than the cheapest coal-fired options in the G20 and "the global weighted average LCOE of new utility-scale solar PV and hydropower was 11% lower than the cheapest new fossil fuel-fired . . . generation . . . in 2021").

[148] Patt & Lilliestam, *supra* note 12, at 2497–98 (noting cost has ceased to be the greatest barrier to eliminating CO_2 and the greatest barriers have to do with institutions and infrastructure).

III. EVALUATING THE CRITICS' CLAIMS

Although the critics' claims are sound, they invite some questions. If pricing has proven insufficiently ambitious, will other programs prove more ambitious? And if pricing has proven ineffective, will other programs be more effective? And what sorts of measures will better effectuate an economic transformation?

Some critics do not seriously analyze whether competing measures they advocate will fare any better politically than carbon pricing.[149] And they are much more unified in their criticisms of pricing than in their selection of alternatives. Their criticism performs an enormous service, but if we wish to build on their insights to design more ambitious and effective climate policy, we would do well to analyze policies in comparative terms.

A. Ambition

The question of whether alternative programs will prove more ambitious than carbon pricing requires a political prediction informed by past experience. For political decision-making determines the stringency and robustness of both pricing and non-pricing approaches. Thus, this question of relative ambition lies within the realm of political science. Surveys of public opinion routinely support the conclusion that subsidies are more popular than prices imposed on consumer behavior, such as carbon pricing.[150] Leigh Raymond has stated that "political scientists largely agree . . . that subsidizing renewable energy is politically easier than increasing the cost of carbon intensive energy."[151] This suggests that

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[149] Jonas Meckling, Thomas Sterner & Gernot Wagner, *Policy Sequencing Toward Decarbonization*, 2 NATURE ENERGY 918, 918 (2017) (tracing how low-carbon leaders such as California and the EU have overcome political challenges facing low-carbon policy by following a distinct policy sequence that helps building economic interest groups in support of decarbonization); Michael Pahle, Dallas Burtraw, Christian Flachsland, Nina Kelsey, Eric Biber, Jonas Meckling, Ottmar Edenhofer & John Zysman, *Sequencing to Ratchet up Climate Policy Stringency*, 8 NATURE CLIMATE CHANGE 861, 864 (2018) (noting that conferring policy benefits to concentrated and well-organized groups will facilitate a supportive coalition).

[150] Jon A. Krosnick & Bo MacInnis, *Does the American Public Support Legislation to Reduce Greenhouse Gas Emissions?*, 142 DAEDALUS 26, 26 (2013) (relying on data from national surveys on climate policy preferences to show "support for policies has been price sensitive").

[151] Leigh Raymond, *Policy Perspective: Building Political Support for Carbon Pricing—Lessons from Cap-and-Trade Policies*, ENERGY POL'Y, Nov. 2019, at 1.

ambitious subsidy programs may prove easier to enact than ambitious carbon prices.

The critics who engage the political question partially rely on public choice theory to explain why instruments other than pricing might prove more susceptible to ambitious design. Public choice theorists maintain that political decision-making often reflects bargains among special interests rather than efforts to achieve a public good.[152] They point out that pricing carbon tends to incite intense opposition from the fossil fuel industry and carbon intensive industries, which helps explain the lack of ambition in pricing policies.[153] Instead, they suggest, programs to incentivize the creation and deployment of cleaner technologies will work better because they create a new special interest, which can influence the legislative process in a positive way.[154] Renewable energy providers tend to be much more active in lobbying for strong renewable energy support programs than in influencing carbon pricing, which suggests that public choice theory supports more emphasis on targeted renewables programs than on carbon pricing. And a recent study of seventy-eight countries showed that a stronger domestic renewable energy industry produced more ambitious renewable energy policies.[155] Thus, the critics rely on empowerment analysis as suggested in *The Economic Dynamics of Law*, analyzing whom law empowers in light of public choice theory.[156]

Public choice theory, however, might also suggest that subsidies will fare particularly well politically as the IRA example suggests. As Canadian political scientist Kathryn Harrison puts it, "the promise of concentrated benefits and diffuse costs make[s] subsidies a political winner."[157]

Critics also claim that pricing makes costs visible to the public and therefore tends to excite public opposition.[158] They see competing

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[152] *Cf.* Stoll & Mehling, *supra* note 15.
[153] Stokes & Mildenberger, *supra* note 93.
[154] *Cf.* Laima Eicke & Silvia Weko, *Does Green Growth Foster Green Policies? Value Chain Upgrading and Feedback Mechanisms on Renewable Energy Policies*, ENERGY POL'Y, Apr. 2022, at 1, 2–4 (2022) (summarizing the policy feedback literature's findings).
[155] *Id.* at 4–5 (explaining that a study focused on the seventy-eight countries with significant involvement in patenting or manufacturing renewable technology found increased involvement led to more stringent policies within two years).
[156] *See* DRIESEN, ECONOMIC DYNAMICS, *supra* note 16, at 9–10.
[157] Kathryn Harrison, *A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada*, 29 REV. POL'Y RSCH. 383, 384 (2012).
[158] *See* RABE, *supra* note 78, at 24 (finding alternatives to carbon pricing more politically attractive because they make costs "less explicit or transparent"); *see also* Stefano Carattini, Maria Carvalho & Sam Fankhauser, *Overcoming Public Resistance to Carbon Taxes*,

measures as providing better ways to avoid imposing highly visible costs on consumers.[159]

The notion that price visibility discourages ambition, while plausible, may implicate some of the measures critics put forward as alternatives to carbon pricing. For example, one critic calls for increases in the gasoline tax. If the problem is cost's visibility to the public, it would seem that a gasoline tax would function as much like a lightning rod for public opposition as a carbon tax.[160] If visibility of cost is the problem, then FIT programs might be expected to fail an ambition test even more often than cap-and-trade programs, which only reveal their costs after enactment.[161] On the other hand, one might expect renewable subsidy programs and renewable portfolio standards to yield more ambition than pricing and FITs. Nobody, to our knowledge, has tested these predictions.[162]

The value of these two theories together is that they take into account both the role of special interests and the potential role of public opinion, which is in keeping with the more thoughtful writing of public choice advocates.[163] But critics do not always rigorously apply their theories about why pricing fails to their preferred policy alternatives.

Neither public choice nor price visibility theory take into account the potential of harnessing populist influences to make climate policy

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WIREs CLIMATE CHANGE, May 2018, at 1, 3 (noting public perception that the personal costs of a carbon tax are too high).

[159] *Id.*

[160] Perhaps the gasoline tax skirts the problem of special interest opposition because the public, rather than the fossil fuel industry, pays it. But the same critic recommends phasing out coal-fired power plants, which seems like a good way to arouse special interest opposition. *See id.* at 23–24.

[161] *See* Kathryn Harrison, *The Fleeting Canadian Harmony on Carbon Pricing*, POL'Y OPTIONS (July 8, 2019), https://policyoptions.irpp.org/magazines/july-2019/the-fleeting-canadian-harmony-on-carbon-pricing [https://perma.cc/3FSP-QWF7] (explaining that a carbon tax is more visible to consumers than a cap-and-trade program applying to industrial emitters); *cf.* RABE, *supra* note 78, at 8 (noting cap-and-trade secures more governmental adoption than carbon taxes because it does not require politicians to select a price).

[162] *Cf.* Kayla M. Young, Kayla Gurganus & Leigh Raymond, *Framing Market-Based Versus Regulatory Climate Policies: A Comparative Analysis*, 39 REV. POL'Y RSCH. 798, 814–15 (2022) (explaining that opponents can frame clean energy mandates negatively and cap-and-trade policies positively, complicating predictions about which mechanism gets the most public support).

[163] *See* Dwight R. Lee, *Politics, Ideology, and the Power of Public Choice*, 74 VA. L. REV. 191, 196 (1988) (stating special interests have less influence on legislation's general nature and more on details of implementation and enforcement); Robert D. Tollison, *Public Choice and Legislation*, 74 VA. L. REV. 339, 351 (1988) (pointing out the public choice literature recognizes that legislatures rely on personal value judgments and that the debate in the literature focuses on the degree of value judgments' influence).

more ambitious—a serious oversight in the current age.[164] Many programs that reduced greenhouse emissions drastically in the past, such as France's nuclear power program and Brazil's biofuels policies, have relied on a "populist political economy of climate disruption"—meaning that broad, appealing goals beyond climate benefits motivated adoption of these programs.[165]

Progressives in Congress introduced the Green New Deal, which exemplifies this kind of thinking. The Green New Deal's proponents view climate policy as addressing not just the climate crisis, but also issues of economic inequality and social justice.[166] Pressure from Green New Deal proponents caused President Biden to adopt ambitious climate goals, which eventually led to the IRA.[167]

IRA provisions include populist measures aimed at addressing economic inequality, such as requirements to pay prevailing wages and to establish apprenticeship programs to qualify for tax credits encouraging clean technology.[168] They also make an appeal to populism by providing incentives to manufacture clean technology in the United States and avoid using materials from countries viewed as adversaries.[169] These

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[164] *See generally* David M. Driesen, *Toward a Populist Political Economy of Climate Disruption*, 49 ENV'T L. 379 (2019) (developing a theory of a populist political economy of climate disruption and suggesting the Green New Deal—a forerunner of the IRA—conforms to this model).

[165] *Cf.* Leigh Raymond, *What Climate Policies Do Americans Want from Their Legislatures?*, WASH. POST (July 6, 2022), https://www.washingtonpost.com/politics/2022/07/06/epa-climate-change-states-congress [https://perma.cc/K9TJ-2YWQ] (explaining specific near-term benefits, such as reduced energy costs for homeowners and local air pollution improvements, help improve public support for climate policies).

[166] *See* Lisa Friedman, *What Is the Green New Deal? A Climate Proposal*, N.Y. TIMES (Feb. 21, 2019), https://www.nytimes.com/2019/02/21/climate/green-new-deal-questions-answers.html [https://perma.cc/B9BC-9LUT].

[167] *See* JOHN KERRY ET AL., BIDEN-SANDERS UNITY TASK FORCE RECOMMENDATIONS: COMBATING THE CLIMATE CRISIS AND PURSUING ENVIRONMENTAL JUSTICE (2020), https://joebiden.com/wp-content/uploads/2020/08/unity-task-force-recommendations.pdf [https://perma.cc/GU2M-WQSV] (presenting recommendations adopted by a task force created to reconcile the electoral campaign platform of then-candidate Biden with demands from the progressive wing of his party).

[168] *See* THE WHITE HOUSE, BUILDING A CLEAN ENERGY ECONOMY: A GUIDEBOOK TO THE INFLATION REDUCTION ACT'S INVESTMENTS IN CLEAN ENERGY AND CLIMATE ACTION 2 (rev. 2023), https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf [https://perma.cc/LVY9-VYNN] (discussing prevailing wage and apprenticeship requirements).

[169] *See id.* at 12 (discussing bonus tax credits for projects that meet domestic content requirements).

incentives for local production may violate free trade agreements and impair the IRA's effectiveness, but their inclusion suggests that a populist political economic theory helps explain the passage of the most ambitious climate legislation in U.S. history.[170]

Furthermore, the IRA's financing provisions reveal an important political advantage for subsidies. The government can raise the revenue in ways that reflect sound equitable distribution. The IRA raised taxes on the rich and large corporations.[171] In an age of economic inequality, that may constitute a much more appealing strategy than imposing a carbon price that raises everybody's costs. While governments can ameliorate the inequities of carbon pricing by redistributing revenue, that redistribution can be administratively difficult and not work as well politically as programs that avoid imposing even an initial cost on the vast majority of people.[172]

But the deal leading to the IRA's passage also reflects special interest influence, as it includes subsidies for carbon capture and storage and an agreement to facilitate offshore drilling and siting of natural gas pipelines.[173] Still, the legislation seems likely to make a substantial contribution

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[170] *See* Raymond, *supra* note 151 (suggesting California's cap-and-trade program was extended to 2030 only because it was coupled with a traditional regulation addressing environmental justice advocates' concerns about local air pollution and provided significant benefits to the public through expenditure of allowance revenue); Daisuke Wakabayashi & Claire Fu, *For China's Auto Market, Electric Isn't the Future. It's the Present.*, N.Y. TIMES, https://www.nytimes.com/2022/09/26/business/china-electric-vehicles.html [https://perma.cc/2UEW-9EVA] (Sept. 27, 2022) (noting automaker complaints that because of conditions on the location of manufacturing and the sourcing of batteries "the credit did not apply to many current E.V. models" and manufacturing costs "could increase").

[171] John Buhl, *The Inflation Reduction Act Primarily Impacts Top 1 Percent of Taxpayers*, TAX POL'Y CTR. (Aug. 11, 2022), https://www.taxpolicycenter.org/taxvox/inflation-reduction-act-primarily-impacts-top-1-percent-taxpayers [https://perma.cc/G9LM-SUTR]; Jean Ross & Jessica Vela, *The Inflation Reduction Act Would Only Raise Taxes from Wall Street and Big Corporations*, CTR. FOR AM. PROGRESS (Aug. 2, 2022), https://www.americanprogress.org/article/the-inflation-reduction-act-would-only-raise-taxes-from-wall-street-and-big-corporations [https://perma.cc/EED4-NJPM].

[172] *See* Harrison, *supra* note 157 (noting voters did not believe the British Columbia government's promise of revenue neutrality during a time of high gas prices); Matto Mildenberger, Erick Lachapelle, Kathryn Harrison & Isabelle Stadelmann-Steffen, *Limited Impacts of Carbon Tax Rebate Programmes on Public Support for Carbon Pricing*, 12 NATURE CLIMATE CHANGE 141, 145 (2022) (finding the public ill-informed about rebates from carbon taxes and that their impact is limited).

[173] *See* Lisa Friedman, *Where the New Climate Law Means More Drilling, Not Less*, N.Y. TIMES (Sept. 14, 2022), https://www.nytimes.com/2022/09/14/climate/louisiana-gulf-drilling-fishing.html [https://perma.cc/5UA2-7J8J] (discussing how the provisions authorizing offshore drilling threaten the Gulf Coast).

to achieving Paris agreement goals.[174] Environmental legislation often reflects some combination of public and special interest provisions.

So, one way of predicting what sorts of measures might prove more ambitious than carbon pricing would involve considering theories of politics. Public choice theory might be useful, but it does not tell the entire story.

We also may be able to base predictions on past experience. That requires data. The data support the critics' claims.

Public opinion polls consistently show "renewable portfolio standards, energy efficiency resource standards, . . . tailpipe emission standards," and other programs enjoy more popular and bipartisan support than pricing policies.[175] This suggests that governments may indeed prove more ambitious when focused on non-pricing policy.

The data also show that over the last two decades governments have increased the stringency of non-market-based instruments more than they have increased the stringency of market-based instruments in OECD countries.[176] These data support a claim, not just that pricing proves insufficiently ambitious, but also that alternatives do better.

Finally, leading economists implicitly recognize high carbon prices do not offer a politically sustainable path to decarbonization.[177] Political economy constraints and distributional effects—but also the rising likelihood of emissions leakage—are conceded to represent challenges to the viability of carbon pricing if prices rise excessively. In order to stabilize political support for cap-and-trade systems they have advocated supply management features, where governments add emission allowances when

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[174] *See, e.g.*, MEGAN MAHAJAN, OLIVIA ASHMOORE, JEFFREY RISSMAN, ROBBIE ORVIS & ANAND GOPAL, ENERGY INNOVATION POL'Y & TECH. LLC, MODELING THE INFLATION REDUCTION ACT USING THE ENERGY POLICY SIMULATOR 1 (2022), https://energyinnovation.org/wp-content/uploads/2022/08/Modeling-the-Inflation-Reduction-Act-with-the-US-Energy-Policy-Simulator_August.pdf [https://perma.cc/92F6-BVHA] (estimating a cut of 37–41% in U.S. greenhouse emissions by 2030 compared with a business-as-usual projection of a 24% cut); JOHN LARSEN, BEN KING, HANNAH KOLUS, NAVEEN DASARI, GALEN HILTBRAND & WHITNEY JONES, RHODIUM GRP., A TURNING POINT FOR US CLIMATE PROGRESS: ASSESSING THE CLIMATE AND CLEAN ENERGY PROVISIONS IN THE INFLATION REDUCTION ACT 2 (2022), https://rhg.com/research/climate-clean-energy-inflation-reduction-act [https://perma.cc/6E5Y-KEBY] (reaching similar conclusions).

[175] RABE, *supra* note 78, at 194.

[176] Tobias Kruze, Antoine Dechezleprêtre, Rudy Saffar & Leo Robert, *Measuring Environmental Policy Stringency in OECD Countries: An Update of the OECD Composite EPA Indicator* (OECD, Working Paper No. 1703, 2022), https://www.oecd-ilibrary.org/economics/measuring-environmental-policy-stringency-in-oecd-countries_90ab82e8-en [https://perma.cc/H7NB-FQGN].

[177] *See* James H. Stock, *Driving Deep Decarbonization*, FIN. & DEV., Sept. 2021, at 12, 15.

allowance prices rise above a predetermined threshold.[178] Most cap-and-trade programs to address greenhouse emissions have adopted price or supply management provisions that allow limiting price extremes and basically make the caps non-binding in the face of high prices.[179] Economists' consistent support for price caps suggests that even those most committed to pricing recognize that high carbon prices cannot be the sole means of achieving decarbonization. Instead, policies must lower abatement costs to levels that make decarbonization feasible without voter rebellions, such as the one seen in the Yellow Vest movement in France.[180]

B. *Ineffectiveness*

The critics do not explain why the Swedish carbon tax has been less effective than one might expect. We have provided, in essence, an economic dynamic explanation, showing that bounded rationality and countervailing incentives may make a tax falling mainly on transport fuels only modestly effective, at least by itself. Absent some explanation of why ambitious pricing produces only relatively modest benefits, it becomes difficult to determine which other programs will do better.

One way of trying to test the hypothesis that other programs perform more effectively than sufficiently ambitious pricing might be to compare the environmental performance of ambitious pricing programs to that of ambitious alternatives. This presents some challenges as different programs express ambition with different metrics. How does one, for example, compare the ambition of a subsidy for renewable energy to a cap in a cap-and-trade program?

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[178] *See, e.g.*, Lawrence H. Goulder & Andrew R. Schein, *Carbon Taxes Versus Cap and Trade: A Critical Review*, CLIMATE CHANGE ECON., Nov. 2013, at 1, 13 (stating many economists endorse a "hybrid" approach that includes a price cap for carbon, but pitching it as a remedy to price volatility); Warwick J. McKibbin & Peter J. Wilcoxen, *Designing a Realistic Climate Change Policy That Includes Developing Countries* 6 (Econ. & Env't Network, Working Paper, rev. June 9, 2000) (proposing a maximum permit price of $10 per ton realized through developing country sales of allowances).

[179] Richard Schmalensee & Robert N. Stavins, *Lessons Learned from Cap-and-Trade Experience*, 11 REV. ENV'T ECON. & POL'Y 59 (2017).

[180] Thomas Douenne & Adrien Fabre, *Yellow Vests, Pessimistic Beliefs, and Carbon Tax Aversion*, 14 AM. ECON. J. 81, 81 (2022) (citing representative surveys showing after the Yellow Vest movement, French people would largely reject a tax and dividend policy because they "overestimate their net monetary losses, wrongly think that the policy is regressive, and do not perceive it as environmentally effective"); Daniel Driscoll, *Populism and Carbon Tax Justice: The Yellow Vest Movement in France*, 70 SOC. PROBS. 143 (2023) (arguing the Yellow Vest movement was motivated by social justice concerns and the French carbon tax was seen as corrupt and unfair).

A simpler way of facilitating comparative study of effectiveness would involve defining effectiveness broadly. Instead of separating out ambition and effectiveness, one could measure effectiveness from competing programs without evaluating (at least initially) whether disappointing results stem from weak ambition or poor performance.

Doing so would require a common metric. Absolute emission reductions provide a key metric for evaluating the environmental performance of competing programs.

While traditionally, economic analysis of pricing policies often neglected to evaluate emission reductions, there has been a move to do more of this lately.[181] Indeed, the pricing critics rely upon econometric studies that estimate carbon pricing programs' emission reductions without normalizing for stringency and therefore without separating ambition failures from failed ambitious policy.[182] But such evaluation is tricky. Many factors influence emissions in an economy or an economic sector subject to a carbon pricing policy. These factors include population increases, economic growth, and regulatory and economic incentive programs that act on the same sectors covered by a carbon price.[183] This presents a problem of econometrics. And the econometric studies, while often highly ingenious and sophisticated, acknowledge it is not possible to account for all the variables that might influence emissions taking place at the same time that a price applies.[184] Still, if one wants to study the comparative past effectiveness of different policy instruments, comparisons of emission reductions are important. And by now we have a wealth of experience with both pricing and non-pricing measures to study.

That comparison requires changes in how we evaluate renewable energy and energy efficiency programs. Most evaluations of programs encouraging renewable energy measure the results in terms of the amount

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[181] Geoff Martin & Eri Saikawa, *Effectiveness of State Climate and Energy Policy in Reducing Power-Sector CO_2 Emissions*, 7 NATURE CLIMATE CHANGE 912, 912 (2017) (stating little empirical research has been conducted on power sector policies effects on CO_2 emissions).

[182] *See, e.g.*, Haites et al., *supra* note 88, at 137–40 (compiling mostly econometric studies of British Columbia's carbon tax).

[183] *See id.* at 112 (discussing numerous factors that impact emissions).

[184] Ralf Martin, Mirabelle Muûls & Ulrich J. Wagner, *The Impact of the European Union Emissions Trading Scheme on Regulated Firms: What Is the Evidence After Ten Years?*, 10 REV. ENV'T ECON. & POL'Y 129, 130 (2016); Antoine Dechezleprêtre, Daniel Nachtigall & Frank Venmans, *The Joint Impact of the European Union Emissions Trading System on Carbon Emissions and Economic Performance*, J. ENV'T ECON. & MGMT., Nov. 2022, at 1, 6 (2023).

of renewable energy added to the grid.[185] Adding renewable energy to the grid should reduce emissions (absent growth in electricity sales) by crowding out dirtier sources, for instance causing them to reduce their output or shut down. Increasing energy efficiency also reduces greenhouse emissions by simply lowering the amount of electricity generated and therefore the amount of greenhouse gases emitted.[186] So, it should be possible to calculate the emission reductions realized through renewable and energy efficiency programs.[187]

Yet one recent review of carbon pricing's failure refused to claim a direct causal link between adopted carbon pricing programs and declining emissions.[188] This suggests that some analysts doubt that econometric analysis can disentangle the effects of multiple policies operating on the same sector of the economy.

Yet, the existence of analysis showing the amount of renewable energy generated by renewable energy policies suggests that comparative emission reduction analysis might prove possible. That data, combined with detailed knowledge of transmission rates and emissions in a particular area, should make tracing emission changes possible. One can calculate the emission reductions from energy efficiency programs by multiplying estimates of the amount of energy saved by the emission associated with the energy used, making some estimate of rebound effects—increased use of energy in response to reduced cost—when evidence supports them.

C. Transformative Change

In the previous part, we presented some theory to support the critics' claim that pricing better encourages incremental adjustments than transformative change. Here, we point out that transformative change is under way in sectors that account for the vast majority of the world's greenhouse emissions, supported by a raft of alternatives to pricing policies. These transformative changes came about largely because of the

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[185] *See, e.g.*, STOKES, *supra* note 129, at 25 (stating that states with RPS "have deployed an order of magnitude more renewables than states without these policies").

[186] *See generally* STEVEN NADEL & LOWELL UNGAR, HALFWAY THERE: ENERGY EFFICIENCY CAN CUT ENERGY USE AND GREENHOUSE GAS EMISSIONS IN HALF BY 2050 (2019).

[187] *See, e.g.*, *id.* at 28 (estimating future emission reductions from new energy efficiency policies using Department of Energy forecasts of future emissions).

[188] Haites et al., *supra* note 88, at 112 (declining to make "causal claims" about the relationship between instrument choice and "observed emission reductions" because of the difficulties of disentangling many factors' influence on emissions).

success of traditional standards and support policies such as FITs. While pricing policies have sometimes complemented these policies in useful ways, they do not lie at the heart of the key technological transformations that have put us in position to achieve net-zero emissions for the largest greenhouse gas emitting sectors, the electricity and transportation sectors.

Ambitious standards for new vehicles have led to vastly increased sales of electric vehicles. California helped start the revolution by requiring a share of vehicle sales to be zero-emission vehicles ("ZEVs"), and China likewise played a key role by subsidizing electric vehicles.[189] The U.S. federal government and numerous other countries enacted stricter corporate average fuel economy standards in response to California's success in stimulating the production of zero-emission and hybrid vehicles, and many established quotas for ZEV sales instead of allowing unrestricted averaging across fleets.[190] Over time, the progress in electric vehicle technology made possible by ZEV quotas and stricter emission standards emboldened a growing number of governments to announce plans to phase out the internal combustion engine altogether.[191] Traditional regulation has not accomplished this alone. Instead, governments have supported the creation of an infrastructure of charging stations to make deployment of large numbers of electric vehicles plausible. Recent U.S. federal legislation provides significant additional support to the creation of this infrastructure.[192] And subsidies have encouraged manufacturers to invest in electric vehicle production by making electric vehicles more affordable for consumers than they would otherwise be, thereby

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[189] Nathan Lemphers, Steven Bernstein, Matthew Hoffmann & David A. Wolfe, *Rooted in Place: Regional Innovation, Assets, and the Politics of Electric Vehicle Leadership in California, Norway, and Quebec*, 87 ENERGY RSCH. & SOC. SCI., Dec. 2021, at 1, 8–9 (discussing California's ZEV requirements); Jonas Meckling & Jonas Nahm, *The Politics of Technology Bans: Industrial Policy Competition and Green Goals for the Auto Industry*, 126 ENERGY POL'Y 470, 475 (2019) (noting California's requirement to sell electric vehicles and China's subsidies for them "had a global market-making effect").

[190] *See* Meckling & Nahm, *supra* note 189, at 473 (explaining that at least twenty jurisdictions adopted electric vehicle targets and quotas between 2007 and 2017).

[191] *See id.* at 470 (noting ten jurisdictions announced plans to phase out the internal combustion engine in 2016–2017); *see, e.g.*, Ezra Klein, *What Joe Biden Knows That No One Expected Him To*, N.Y. TIMES (Sept. 18, 2022), https://www.nytimes.com/2022/09/18/opinion/biden-invention-arpa-h.html [https://perma.cc/6J57-SD58] (noting California has decided to ban the internal combustion engine by 2035).

[192] *See, e.g.*, *What Does the Infrastructure Bill Mean for EV Charging?*, EV CONNECT (Jan. 3, 2021), https://www.evconnect.com/blog/what-does-the-infrastructure-bill-mean-for-ev-charging [https://perma.cc/A5TR-PNSX] (noting the infrastructure bill appropriates $7.5 billion to accelerate electric vehicle adoption and build a nationwide network of charging stations).

providing opportunities to lower costs through research and development, learning by doing, and economies of scale.[193] Tesla, a company manufacturing only electric vehicles, has become the most valuable U.S. auto company (after years of barely surviving) as a result of such support policies, and several manufacturers have announced plans to convert to all-electric vehicles.[194] This case highlights how support policies may not always be the most cost-effective option, but their political viability and outcome effectiveness are not in doubt. It also supports pricing critics' claim that effective policy involves sequencing to facilitate cost declines and diffusion of clean technology.[195]

Similar change is happening in the electric utility industry. In recent decades, the price of renewable energy, especially solar, has fallen drastically.[196] FIT programs have encouraged renewable energy providers to increase their profit margins by reducing their costs, although governments revise the tariff downward from time to time to make the programs more efficient. A number of economists credit the German feed-in tariff in particular with lowering the prices of photovoltaic cells around the world.[197] Carrots can better encourage technological development than sticks, especially cost-effective sticks that encourage optimization of established dirty infrastructure rather than economic transformation.

The combination of cheap renewables and natural gas, stemming from development of hydraulic fracturing, has done precisely what a price on carbon should aim to do under economic dynamic theory: make clean energy cheaper than dirty energy. As a result, coal-fired power plants

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[193] NAT'L ACADS. OF SCIS., ENG'G & MED., THE POWER OF CHANGE: INNOVATION FOR DEVELOPMENT AND DEPLOYMENT OF INCREASINGLY CLEAN ELECTRIC POWER TECHNOLOGIES 41–42 (2016), https://nap.nationalacademies.org/catalog/21712/the-power-of-change-innovation-for-development-and-deployment-of [https://perma.cc/N3D4-HP33].

[194] Mike Colias, *Electric Vehicles Took Off. Car Makers Weren't Ready*, WALL ST. J. (Sept. 18, 2022), https://www.wsj.com/articles/electric-vehicles-inventory-supply-chain-batteries-11663504014 [https://perma.cc/E4JF-4UVU] (noting Tesla's market valuation is more than twice that of Toyota, Volkswagen, General Motors, and Ford combined); Meckling & Nahm, *supra* note 189, at 474.

[195] *See* Pahle et al., *supra* note 149.

[196] TAYLOR ET AL., *supra* note 147, at 2 (stating the cost of utility scale solar has declined by 88% and onshore wind power has declined by 68% between 2010 and 2021).

[197] Wolfgang Buchholz, Lisa Dippl & Michael Eichenseer, *Subsidizing Renewables as Part of Taking Leadership in International Climate Policy: The German Case*, 129 ENERGY POL'Y 765 (2019); Todd D. Gerarden, *Demanding Innovation: The Impact of Consumer Subsidies on Solar Panel Production Costs*, 69 MGMT. SCI. 7799 (2023); Ping Huang, Simona O. Negro, Marko P. Hekkert & Kexin Bi, *How China Became a Leader in Solar PV: An Innovation System Analysis*, 64 RENEWABLE & SUSTAINABLE ENERGY REVS. 777 (2016).

have shut down in the United States and some other countries.[198] Some of these shutdowns have occurred in areas where plant operators face no regulation of greenhouse emissions through carbon pricing or otherwise.[199]

An economic dynamic analysis built on these cases suggests that targeted policies may cost-effectively and systematically move us toward zero emissions. When a single government secures production of an affordable zero-emission technology, markets can spread their adoption, and governments can more easily help the technology along. Governments around the world need not impose a lot of cost on the entire economy to drive down the cost of zero-emission technology. Instead, a single government can pay a very small amount of money to catalyze price declines in a transformative innovation, because the existing capital stock of a new innovation is so low.[200]

The widespread adoption of a key technology can trigger the collapse of carbon emissions in a sector. If all drivers eventually purchase zero-emission vehicles, oil companies will stop producing gasoline in response to the disappearance of demand and have powerful incentives to invest in alternatives to fossil fuels.[201] Thus, a key technology has ripple effects that mean a modest initial cost for an ambitious change in a tiny corner of a market can have transformative effects.

Indeed, this is how transformative innovation often works. A technology gets a start as a luxury commodity for those few people who

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[198] *See, e.g.*, GLOB. ENERGY MONITOR ET AL., BOOM AND BUST COAL 2022: TRACKING THE GLOBAL COAL PLANT PIPELINE 31 (2022) (reporting "coal is flickering out in [Europe] and the United Kingdom," noting "98.4 [gigawatts] of the region's operating fleet has closed since 2010, with a record 12.9 GW retiring in 2021" and finding "[Europe's] rapid shift away from coal has primarily been driven by the falling cost of renewables, the adoption of new pollution control standards, rising CO_2 emissions costs, and sustained advocacy"); PHILLIP GRAETER & SETH SCHWARTZ, NAT'L ASS'N OF REGUL. UTIL. COMM'RS, RECENT CHANGES TO U.S. COAL PLANT OPERATIONS AND CURRENT COMPENSATION PRACTICES 3–4 (2020) (showing in the wake of the shale gas revolution coal generation declined from 50% to 28% of total production between 2008 to 2018, while natural gas production rose from 21% to 35% and non-hydro renewables increased tenfold from very low levels).

[199] *See Nearly a Quarter of the Operating U.S. Coal-Fired Fleet Scheduled to Retire by 2029*, U.S. ENERGY INFO. ADMIN. (Nov. 7, 2022), https://www.eia.gov/todayinenergy/detail.php?id=54559 [https://perma.cc/XU8X-WSGU] (noting some states where retirements are slated to take place have no "clean energy policies" encouraging renewables and Michigan, Texas, Indiana, and Tennessee (none of which are subject to a carbon price) have the most capacity slated for retirement).

[200] Patt & Lilliestam, *supra* note 12, at 2497.

[201] This will take time. Even if countries mandated 100% zero-emission vehicles tomorrow, owners of used vehicles would want to continue buying gasoline until their cars were so beat up that they scrapped them.

can pay a lot for it, and producers eventually figure out how to lower costs so the innovation eventually becomes widespread. Government, economic dynamic theory teaches, serves as a source of demand for environmental quality, and when a government demands a lot, even in a small, targeted corner of the economy, it can have substantial effects.[202]

Now that renewable energy costs less than coal-fired power production,[203] no pricing problem prevents shutting down the remaining coal-fired power plants. Getting the price right has little or nothing to do with it. Instead, the limitations impeding further deployment of renewable energy involve the difficulty of relying on very large amounts of intermittent energy without any ability to store it efficiently, failures to extend transmission lines, and local resistance to siting new renewable energy installations.[204]

To the extent that a 100% renewable energy system is not possible, one would probably have to rely on nuclear power to get to zero emissions. Pricing policies have not increased demand for nuclear energy, and it is difficult to imagine that they ever would.

Alternatives to pricing policies that directly encourage zero-emission technologies and enable systems to break technological lock-in do much better in encouraging transformative change than carbon pricing. The history of meaningful technological change in the climate space also suggests that viewing policy as a problem of optimizing fixed costs constitutes a fundamental mistake. Instead, governments can make a lot of progress by establishing measures that drive the costs of clean technology down, leading to its deployment and then diffusion across the economy after it becomes competitive.[205]

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[202] *See* DRIESEN, ENVIRONMENTAL DYNAMICS, *supra* note 16, at 118 (stating "the government role in environmental innovation resembles that of the consumer in the world of material innovation").

[203] Michelle Solomon & Mike O'Boyle, *Renewable Energy Would Provide Cheaper Energy Than 99% of US Coal Plants and Catalyze a Just Energy Transition*, UTIL. DIVE (Feb. 9, 2023), https://www.utilitydive.com/news/renewables-cheaper-energy-than-99-percent-of-us-coal-plants-just-energy-transition/642393 [https://perma.cc/TC3R-KYBN].

[204] Jonathan M. Moch & Henry Lee, *The Challenges of Decarbonizing the U.S. Electric Grid by 2035*, BELFER CTR. FOR SCI. & INT'L AFFS. (Feb. 2022), https://www.belfercenter.org/publication/challenges-decarbonizing-us-electric-grid-2035 [https://perma.cc/CP2C-QJRE]; Brad Plumer, *The U.S. Has Billions for Wind and Solar Projects. Good Luck Plugging Them In.*, N.Y. TIMES, https://www.nytimes.com/2023/02/23/climate/renewable-energy-us-electrical-grid.html [https://perma.cc/33G4-3UKH] (June 20, 2023).

[205] *See* Grubb et al., *supra* note 124, at 4 (suggesting a distinction between deployment at scale while not cost competitive and diffusion after becoming cost competitive and therefore self-sustaining).

IV. ABANDONING PRICING?

Having made a strong case that pricing after decades of government effort has realized only modest successes, the critics generally do not recommend its abandonment.[206] Are they right not to call for pricing's demise? After all, maintaining and updating carbon pricing schemes requires government to invest more time and energy in improving and administering allegedly failed schemes. That time might be better spent designing more effective non-pricing policies.

A. Normative Criteria

Short-term cost effectiveness cannot provide an adequate justification for continuing carbon pricing. It is possible to cost effectively accomplish next to nothing while the world goes to hell. If that is where carbon pricing leads, we should abandon it.

The pricing critics focus on much more normatively important criteria than cost effectiveness. From the standpoint of economic theory, allocative efficiency is much more important than cost effectiveness. From a legal standpoint, climate law establishes net-zero emissions as the goal, because that is what is needed to substantially ameliorate dangerous climate disruption.

None of this means that we should necessarily abandon carbon pricing. It just means that serious evaluation of the question requires attention to the environmental performance of instruments, not just their short-term cost effectiveness.

B. Improving Carbon Pricing

Despite the strong case against the political feasibility of a high comprehensive carbon price, one might argue that the problem of insufficient ambition is not tightly tied to instrument choice.[207] The arguments developed above support the notion that alternatives can do somewhat

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[206] Barry Rabe, *Carbon Pricing Enters Middle Age*, WILSON CTR. (June 8, 2023), https://www.wilsoncenter.org/article/carbon-pricing-enters-middle-age [https://perma.cc/ZM54-QYAK].

[207] *See, e.g.*, Andrea Olive, *Saskatchewan's Long History of Rejecting Carbon Pricing*, POL'Y OPTIONS (July 12, 2019), https://policyoptions.irpp.org/magazines/july-2019/saskatchewans-long-history-of-rejecting-carbon-pricing [https://perma.cc/WD4Z-AHK4] (noting "Saskatchewan has more than 20 years of history of saying no to regulation" and carbon pricing); Young et al., *supra* note 162, at 814–15 (finding Virginia and Ontario political actors used similar frames in discussing pricing and non-pricing policies, but noting there may be differences in the effectiveness of these frames across policies).

better and establish a research agenda for further inquiry. But politics is unpredictable enough that one might doubt that instrument choice has a huge impact on ambition.[208] The history of the IRA illustrates this problem. President Biden pledged a 50–52% cut in U.S. carbon emissions by 2030 and net-zero emissions by 2050.[209] But Congress failed to pass the Build Back Better Act, which Biden put forward as a means toward the end of meeting such targets.[210] The less ambitious IRA should cut emissions by up to 10% and enable the United States to achieve a 40% reduction by 2030, but not a 50% cut.[211] Nor does it seem likely to achieve zero-carbon emissions by 2050. Other countries also appear to have insufficient policies in place to meet their Paris pledges, and the Paris pledges themselves are insufficient to protect us from dangerous climate disruption.[212] This suggests that some political shift, whether motivated by the worsening climate crisis or other factors, must occur for sufficient ambition to be possible for any instrument or suite of instruments.

One might also doubt that any theory of political economy can adequately describe the whole world. While the United States only succeeded in securing significant climate legislation by abandoning pricing, its neighbor to the north, Canada, began to make headway only when the federal government enacted climate legislation featuring climate pricing.[213] Canada, however, may yet vindicate pricing critics, as the opposition party has targeted carbon pricing (but Canada has adopted many other

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[208] *Cf.* Young et al., *supra* note 162, at 799 (framing of the debate over Ottawa's cap-and-trade program was very similar to that over Virginia's renewable portfolio standards); STOKES, *supra* note 129, at 23 (while in some states renewables advocates were able to strengthen renewable energy targets, others were met with opposition by fossil fuel interests that led to "retrenchment").

[209] *See* Rajat Shrestha, Devashree Saha, John Feldmann & Jillian Neuberger, *Achieving Net-Zero Emissions: Can the Build Back Better Act Help Get There?*, WORLD RES. INST. (Sept. 13, 2022), https://www.wri.org/insights/build-back-better-us-net-zero-emissions [https://perma.cc/5MLA-8FBB] (outlining what the Build Back Better Act was aiming to achieve).

[210] *See Towards a Just and Equitable Clean Future: Benefits of Clean Energy Tax Incentives*, CONGR. PROGRESSIVE CAUCUS CTR., https://www.progressivecaucuscenter.org/clean-energy-tax-incentives [https://perma.cc/FN5R-LHTV] (May 9, 2022) (estimating the Build Back Better Act's tax credits would produce 61–69% clean electricity by 2030).

[211] *See* LARSEN ET AL., *supra* note 174, at 3 (estimating that with the IRA, U.S. emissions will decline to 32% to 42% below 2005 levels by 2030, which is up to 10% more than under existing policies without the IRA).

[212] Lindsay Maizland, *Global Climate Agreements: Successes and Failures*, COUNCIL ON FOREIGN RELS., https://www.cfr.org/backgrounder/paris-global-climate-change-agreements [https://perma.cc/7WN3-97XT] (Dec. 5, 2023).

[213] *See* Harrison, *supra* note 161 (describing the federal pricing policy in broad outline and its political history).

ambitious measures at the same time).[214] And provincial responses tend to validate many of the critics' claims.[215] But the more general point is that a world that includes authoritarian China, tax-friendly Sweden, and the tax-rejecting United States might not obey universal fine-grained laws of political economy.[216] Still, the likelihood that non-pricing instruments prove more ambitious and effective than pricing instruments in a variety of polities does suggest critics are right to argue against the primacy of pricing.

If pricing advocates want to continue to support it in spite of its past limitations, it behooves them to be clearer about how pricing might achieve decarbonization. In principle, one can achieve Paris pledges and zero emissions by requiring every carbon emitter to purchase a permit to emit carbon at auction, and to set the number of auctioned permits to decline such that they at least match Paris pledges and then drive emissions to zero or even into negative territory by 2050 and beyond. Alternatively, a country might establish carbon taxes on all emitters that are modeled to produce at least the emission reductions pledged in Paris and then zero emissions. Pricing advocates, by rarely saying anything about the climate regime's established goals and how their policies could achieve them, have made their policy prescriptions seem irrelevant given the urgency of the climate crisis.

Setting this model of adequate stringency out clearly, however, leads to some objections that one must consider. First of all, CO_2 lends itself to reliable estimation, but some other greenhouse gases—especially

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[214] *See id.* (discussing growing opposition to pricing in the provinces after 2016); Leigh Raymond, *Ontario's Carbon Price Experience Is a Cautionary Tale*, POL'Y OPTIONS (July 10, 2019), https://policyoptions.irpp.org/magazines/july-2019/ontarios-carbon-price-experience-is-a-cautionary-tale [https://perma.cc/E52Y-UM5P] (pointing out Ontario changed from a carbon pricing champion to an opponent even as it implemented a coal phase-out).

[215] *See, e.g.*, McLaughlin, *supra* note 139 (explaining that Manitoba rejected federal carbon pricing but was willing to meet carbon reduction goals with more targeted measures); Matto Mildenberger, *New Brunswick's Timid Foray into Carbon Pricing,* POL'Y OPTIONS (July 9, 2019), https://policyoptions.irpp.org/magazines/july-2019/new-brunswicks-timid-foray-into-carbon-pricing [https://perma.cc/V3UF-U2BX] (discussing New Brunswick's effort to evade Canada's requirement to price carbon); Olive, *supra* note 207 (explaining that Saskatchewan rejects carbon pricing but is phasing out coal and has embraced performance standards cutting emissions by 10%).

[216] *Cf.* David Houle & Erik Lachapelle, *Quebec's Political Consensus over Carbon Price System*, POL'Y OPTIONS (July 17, 2019), https://policyoptions.irpp.org/magazines/july-2019/quebecs-political-consensus-over-carbon-price-system [https://perma.cc/W2UW-22BP] (noting that while other provinces in Canada have opposed carbon pricing, Quebec's commitment to carbon pricing has survived big political changes in government, even though the parties do not agree on questions of stringency).

from the land use and forestry sectors—can be more difficult to quantify.[217] So pricing, to work well, may have to be confined to CO_2 emissions and some industrial gases only. If that is the case, governments could apply pricing only to reasonably quantifiable greenhouse gases in the manner described and reach zero emissions only if other programs phase out the remaining greenhouse gases. Furthermore, existing systems are typically not pure cap-and-trade systems, as they allow offset credits.[218] Governments might have to eliminate offset credits if the system is to reliably deliver on Paris pledges, in light of experience showing that offset credits often prove dubious.[219]

Finally, no matter how ambitious the goals of climate pricing, barriers like those mentioned above (such as the need for charging stations and siting of renewable energy facilities) mean that pricing cannot work without supplemental measures.[220] So sufficient ambition would create a case for pricing as a central measure, not as a sole measure.

Pricing advocates also need to understand and address the political impediments to the solutions sketched out above. Governments have reason not to adopt pricing mechanisms that align with the climate regime's stated goals, the governments' own pledges, or allocative efficiency. Politicians concern themselves not just with total theoretical costs but with the distribution of costs.[221] Politicians want to know how a carbon

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[217] *See, e.g.*, Lu Shen, Ritesh Gautam, Mark Omara, Daniel Zavala-Araiza, Joannes D. Maasakkers, Tia R. Scarpelli, Alba Lorente, David Lyon, Jianxiong Sheng, Daniel J. Varon, Hannah Nesser, Zhen Qu, Xiao Lu, Melissa P. Sulprizio, Steven P. Hamburg & Daniel J. Jacob, *Satellite Quantification of Oil and Natural Gas Methane Emissions in the US and Canada Including Contributions from Various Basins*, 22 ATMOSPHERIC CHEMISTRY & PHYSICS 11203, 11240 (2022) (finding regional satellite data show the bottom-up estimates of emissions from natural gas facilities from Canada and the United States between 80% and 40% too low without claiming satellite data can measure emissions from individual facilities).

[218] Robert O. Mendelsohn, Robert E. Litan & John Fleming, *A Framework to Ensure That Voluntary Carbon Markets Will Truly Help Combat Climate Change*, BROOKINGS INST. (Sept. 16, 2021), https://www.brookings.edu/articles/a-framework-to-ensure-that-voluntary-carbon-markets-will-truly-help-combat-climate-change [https://perma.cc/PN59-NG2S].

[219] Raphael Calel, Jonathan Colmer, Antoine Dechezleprêtre & Matthieu Glachant, *Do Carbon Offsets Offset Carbon?* (CESifo, Working Paper No. 9368, 2021) (finding emission reductions were lost through the Clean Development Mechanism, because offset credits were awarded for windfarm projects that would have happened anyway).

[220] Antoine Dechezleprêtre, Ralf Martin & Samuela Bassi, *Climate Change Policy, Innovation and Growth*, *in* HANDBOOK ON GREEN GROWTH 217, 233 (Roger Fouquet ed., 2019) (noting the need to have charging stations in place).

[221] *See* Jenkins, *supra* note 4, at 2 (stating "effective climate policy for the real world . . . requires attention" to distribution of costs and benefits).

price will affect industries that employ their constituents. Will it cause an industry to perish? Or will it lead to a technological change that does not prove terribly disruptive? Will it reduce carbon, or just force a carbon-emitti ng industry or facility to move overseas and keep polluting?[222] Because of the centrality of these questions, cap-and-trade programs are usually technology-based programs—meaning that the caps are based on what regulators think covered sectors can sensibly achieve with existing technology.[223]

Distributional concerns also have almost always produced fragmented policies that cover far fewer sources than pricing advocates envision. Because of this reality, we rarely face a choice between comprehensive pricing programs and sectoral measures. We almost always face a choice among fragmented options.

Economic theory does not support the proposition that governments should pursue allocative efficiency without any regard to equity. It would be silly to do so. There is a big difference between a policy that charges Bill Gates $1 billion to abate carbon emissions and one that imposes the same costs on millions of low-income people who will not be able to put food on the table as a result. Economists express this intuition in recognizing that the marginal value of a dollar to a poor person is higher than the marginal value of a dollar to a rich person.[224] Similarly, studies of climate policies focus on their capacity to add or subtract employment, because the distribution of costs matters.[225] Hence, allocative efficiency, ironically, provides no coherent or politically persuasive rationale for ignoring cost distribution.[226]

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[222] JENNIFER A. HILLMAN, *Changing Climate for Carbon Taxes: Who's Afraid of the WTO?*, GER. MARSHALL FUND, July 2013, at 1, https://scholarship.law.georgetown.edu/facpub/2030 [https://perma.cc/3B92-95NQ].

[223] David M. Driesen, *Capping Carbon*, 40 ENV'T L. 1, 28–33 (2010) (discussing the heavy reliance on best available technology determinations in setting the caps in cap-and-trade programs).

[224] *See* Richard L. Revesz & Samantha P. Yi, *Distributional Consequences and Regulatory Analysis*, 52 ENV'T L. 53, 94 (2022) (explaining that giving a destitute person an extra $1000 would significantly benefit that person but that $1000 would "add very little, if any, utility to Jeff Bezos").

[225] *See, e.g.*, *id.* at 64–65, 77 (mentioning several studies).

[226] We cannot prove this point in a brief article. The foremost advocate of using allocative efficiency as the measuring rod for evaluating policy, Richard Posner, ultimately conceded that wealth maximization—the value at the heart of allocative efficiency—is "morally unattractive." *See* Richard Fallon, Jr., *Should We All Be Welfare Economists?*, 101 MICH. L. REV. 979, 984 n.27 (2003); *see also* David M. Driesen, *The Societal Cost of Environmental Regulation: Beyond Administrative Cost-Benefit Analysis*, 24 ECOLOGY L.Q. 545,

Both a strategy of auctioning off allowances on a schedule declining to zero and of setting a tax equal to the social cost of carbon require governments to largely ignore the costs of emission reductions. One can make a case that politicians and regulators should not view the world in cost-sensitive ways, but that case will require a major shift in elites' thinking, at least in the United States.

In some important cases, environmental law does not allow regulators to take cost into account in setting regime goals.[227] Instead, legislatures sometimes make a value choice, viewing protecting public health and the environment as an imperative.[228] They assume that industry can adapt to stringent demands and accept that if particular plants cannot operate without endangering public health and the environment, they should shut down.[229] Public opinion over the years, even in the United States, has supported protecting the environment regardless of cost.[230]

The Economic Dynamics of Law spells out the normative case for viewing avoidance of systemic risk as an imperative.[231] It defines systemic risk as risks of the collapse of a major economic, political, or ecological system.[232] Just as countries at war try to figure out how to win, not how

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581 (1997) (showing allocative efficiency does not correspond to the economic consequences that matter most). While few if any legal scholars defend allocative efficiency derived from price theory on clear normative grounds today, many defend vaguer ideas of maximizing overall welfare. *See, e.g.*, Louis Kaplow & Steven M. Shavell, *Fairness Versus Welfare*, 114 HARV. L. REV. 961, 967 (2001) (arguing a "welfare-based normative approach should be exclusively used to evaluate legal rules"); *cf.* MATTHEW ADLER, WELL-BEING AND FAIR DISTRIBUTION: BEYOND COST-BENEFIT ANALYSIS (2012) (exploring how to consider "overall well-being" and "fair distribution" in policy decisions).

[227] *See, e.g.*, Whitman v. Am. Trucking Ass'ns, 531 U.S. 457, 471 (2001) (holding the Clean Air Act bars consideration of costs in setting the national ambient air quality standards that establish the goals for state air pollution control programs).

[228] *See* Amy Sinden, *In Defense of Absolutes: Combating the Politics of Power in Environmental Law*, 90 IOWA L. REV. 1405, 1411–12 (2005) (citing the Endangered Species Act and the provision of the Clean Air Act authorizing national ambient air quality standards as examples of absolutist environmental law).

[229] *See* Union Elect. v. EPA, 427 U.S. 246, 259 (1976) (citing S. Rep. No. 91-11196, at 2–3 (1970)).

[230] *See* David M. Driesen, Thomas M. Keck & Brandon T. Metroka, *Half a Century of Supreme Court Clean Air Act Interpretation: Purposivism, Textualism, Dynamism, and Activism*, 75 WASH. & LEE L. REV. 1781, 1795 (2019) (stating "[f]rom 1994 to 2016 between 71% and 80% of the public indicated that we should do whatever it takes to protect the environment"); *Environment*, GALLUP, https://news.gallup.com/poll/1615/environment.aspx [https://perma.cc/2N4A-EJHX] (last visited Feb. 8, 2024) (indicating even in 2020, 52% of Americans indicated environmental protection should take precedence over economic growth).

[231] *See* DRIESEN, ECONOMIC DYNAMICS, *supra* note 16, at 5–6, 11.

[232] *Id.* at 58–59.

to ensure that each decision has benefits outweighing costs, so governments facing other existential threats should focus on efficacy, not optimality. Without some willingness to make the case that the legally adopted goals for the climate regime should be viewed as imperatives, there is simply no philosophically sound or politically imaginable basis for a high, comprehensive carbon price driving emissions to near zero as a foundation of climate policy.

C. Mixing Instruments

We think, however, that the critics' case is strong enough (absent more research refuting the critics' claims) to establish, at a minimum, that pricing should act as a supplement to policies that have proven more effective and central in making zero-carbon technology viable.

1. Carbon Taxes

The case for keeping carbon taxes in the instrument mix proves quite strong, even if the prices induce a limited response and do not apply as broadly as they should. We have reached a point where further progress requires massive investment in charging infrastructure, battery storage technology, improved transmission systems, mass transit, perhaps nuclear power, and much else.[233] Carbon taxes can raise revenue for these purposes.[234] Furthermore, opinion polls suggest public support for carbon pricing increases when policymakers commit to using the proceeds to fund clean energy and energy efficiency.[235]

In sectors where the high cleanup costs continue to provide the primary obstacle to progress, a carbon tax funding cleanup provides a much more powerful tool to drive us toward zero emissions than a carbon tax alone. From an economic dynamic perspective, which sees government as shaping change over time rather than optimizing, the goal of pricing should be to make clean operations cheaper than dirty operations. Where dirty, old technology competes with newer, cleaner technology, taxing the

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[233] *See* STOKES, *supra* note 129, at 19 (discussing the need for batteries, transmission lines, and smart meters).

[234] *See* Jenkins, *supra* note 4, at 5–6 (proposing a moderate carbon price as a means of subsidizing clean energy).

[235] *But see* Raymond, *supra* note 214 (arguing Ontario's failure to devote sufficient revenue to reducing energy costs and communicate adequately about the program's effect on energy costs led to the repeal of the cap-and-trade program); Raymond, *supra* note 151, at 2.

old technology and using the proceeds to subsidize the clean competitor simultaneously provides a much more powerful incentive than taxation alone.[236] Previous analysts studying environmental innovation have found that using negative economic incentives to fund positive economic incentives powerfully supports innovation.[237]

A combination of taxes and subsidies can also drive emission reductions by more ordinary means. The UK simultaneously employed a carbon tax and subsidies for conversion of coal-fired power plants to biofuel that helped produce a 57% reduction of emissions from power plants over just four years.[238]

Furthermore, taxes enhance other policies. An oft-cited example involves the implementation of Canada's nationwide low-emission vehicle standards in British Columbia. Because British Columbians pay a carbon tax, they purchased more hybrid vehicles than consumers in other Canadian provinces.[239] A tax, in this instance, enhanced the effectiveness of a traditional standard.

2. Cap and Trade

Cap-and-trade programs can prove more problematic because they can discourage implementation of more effective measures. An incident from the Netherlands provides a useful illustration. A number of years back, environmentalists and Dutch electric utilities reached an agreement to phase out coal-fired power plants.[240] The competition ministry, however, realized that shuttering Dutch coal-fired power plants would not reduce net emissions.[241] Instead, other polluters covered by the EU's emissions trading system would purchase the credits generated by the shutdown and use them to justify avoiding emission reductions they

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[236] *See* David M. Driesen, *Will Latin's Scheme Replace Fossil Fuels More Quickly Than Existing Approaches?*, 25 VILL. ENV'T L.J. 83, 84 (2014) (explaining this point).
[237] MIKAEL SKOU ANDERSEN, GOVERNANCE BY GREEN TAXES: MAKING POLLUTION PREVENTION PAY 27 (1994) (promoting taxes like the French effluent tax that raise funding for environmental programs); John Brooks, Brian Galle & Brendan Maher, *Cross-Subsidies: Government's Hidden Pocketbook*, 106 GEO. L.J. 1229 (2018).
[238] Marion Leroutier, *Carbon Pricing and Power Sector Decarbonization: Evidence from the UK*, J. ENV'T ECON. & MGMT., Nov. 2021, at 1, 1.
[239] *See* Kathryn Harrison, *The Political Economy of British Columbia's Carbon Tax* 19 (OECD, Working Paper No. 63, 2013) (noting British Columbia has twice the national rate of investment in hybrid vehicles).
[240] *See* David M. Driesen, *Emissions Trading Versus Pollution Taxes: Playing "Nice" with Other Instruments*, 48 ENV'T L. 29, 31 (2018).
[241] *Id.* at 32.

would otherwise have to make.[242] Since the agreement would raise the costs of Dutch electricity generation without reducing carbon emissions, the competition ministry opposed it, and the government did not implement the agreement.[243]

When Germany reached a compromise in early 2020 to phase out coal-fired power generation, addressing the impact on the EU ETS added a layer of complexity to the decision-making process.[244] Ultimately, Germany decided to cancel allowances in an amount commensurate to the emissions avoided with the coal phase-out, yet that necessitated changes to the domestic legislation on emissions trading as well as politically sensitive coordination with the EU, which administers the emissions trading system.[245]

The point can be generalized. Anytime a government enacts another program that affects the emissions of sources eligible to sell credits to capped sources, allowance sales can limit or destroy its contribution to the global effort.[246] This "waterbed effect" can discourage needed measures

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[242] *Id.* at 32–33.

[243] *Id.* at 32 (explaining that the "Dutch government's competition authority derailed this agreement" and would "raise the cost of reducing greenhouse gas emissions in the Netherlands" without reducing net emissions).

[244] Markus Wacket & Riham Alkousaa, *Germany's Cabinet Approves Accelerated Coal Exit by 2030 in Western State*, REUTERS (Nov. 2, 2022), https://www.reuters.com/business/energy/germanys-cabinet-approves-accelerated-coal-exit-by-2030-western-state-2022-11-02 [https://perma.cc/V6XW-8RC5].

[245] *Cf.* Kohleverstromungsbeendigungsgesetz [KVBG] [Coal Power Generation Termination Act], Aug. 8, 2020, BUNDESGESETZBLATT [BGBL I] at 1818 (Ger.), http://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&jumpTo=bgbl120s1818.pdf [https://perma.cc/926X-F93Z] (last visited Feb. 8, 2024).

[246] *See* Goulder & Schein, *supra* note 178, at 16–17 (discussing this problem). Most models of the waterbed effect produce a result indicating the waterbed effect destroys the effectiveness of competing policies. But that result stems from unrealistic assumptions in the model. So, for example, Thomas Eichner and Rüdinger Pethig assume an idealized trading program that "instantaneously" adjusts the cap to keep it binding. *EU-Type Carbon Regulation and the Waterbed Effect of Green Energy Promotion*, 80 ENERGY ECON. 656, 657 (2019). Most trading systems have been non-binding, because the caps have been set too high, especially in their initial stages. And none of them adjust quickly. Even in a binding cap-and-trade system, the amount of reductions lost would be limited to the amount needed to sell credits to satisfy the limited demand from sources above the cap. A very successful renewables program might generate credits increasing emissions at dirty sources at first and then generate additional emission reductions that would not be sold because the market would be satiated. *Cf.* Grischa Perino, Robert A. Ritz & Arthur van Benthem, *Overlapping Climate Policies* 4 (NBER, Working Paper No. 25643, 2022) (noting "the ability of an overlapping policy to combat climate change varies enormously depending on its design, location, and timing").

or simply make measures that might advance the ball ineffective or less effective in terms of net emission reductions when implemented.[247] It may be possible to design cap-and-trade programs to avoid the waterbed effect, but doing so may prove administratively difficult. This means that cap-and-trade programs do not necessarily serve as a backstop for policy failures in other realms, but rather risk becoming mechanisms that dissipate and undermine some of their achievements.

The waterbed effect might prove tolerable in a polity willing to use a comprehensive cap to drive emissions to zero. But in a cap-and-trade system that does not by itself provide for adequate emission reductions, it justifies considering abandoning trading.[248] Keeping a trading program in place that limits or nullifies societal efforts to reduce emissions proves dangerous under current conditions of high emissions and an ongoing climate crisis.

Mass-based emission caps by themselves provide a useful backstop to make sure contemplated carbon reduction goals are achieved, even when more targeted measures fail to perform as planned or economic growth raises emissions above projected levels. But trading is not strictly necessary to get the backstop advantage. It may be worthwhile to substitute mass-based caps without trading for cap-and-trade to avoid the problem of trading away the benefits of more effective policies.

That said, RGGI demonstrates that cap-and-trade programs can serve as funding mechanisms for renewables and energy efficiency when governments auction off all of the allowances and most of the money goes to those purposes.[249] Furthermore, RGGI demonstrates that the revenue can be used to lower energy prices for consumers, thereby securing firmer political support.[250] Of course, without auctioning of allowances and appropriate decisions about spending the money, cap and trade does not generate these advantages. If an auction can be combined with a cap without trading, then this advantage can be secured without a waterbed effect potentially eroding achievements.

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[247] Dallas Burtraw & Amelia Keyes, *Recognizing Gravity as a Strong Force in Atmosphere Emissions Markets*, 47 AGRIC. & RES. ECON. REV. 201, 216 (2018) (noting the waterbed effect can undermine other policies).

[248] Will Kenton, *Cap and Trade Basics: What It Is, How It Works, Pros & Cons*, INVESTOPEDIA, https://www.investopedia.com/terms/c/cap-and-trade.asp [https://perma.cc/GXZ6-DSZP] (Dec. 5, 2020).

[249] *RGGI 101 Fact Sheet*, RGGI, https://www.rggi.org/sites/default/files/Uploads/Fact%20Sheets/RGGI_101_Factsheet.pdf [https://perma.cc/MYT2-RCTT] (Jan. 2024).

[250] *The Regional Greenhouse Gas Initiative: A Fact Sheet*, RGGI, https://www.ceres.org/sites/default/files/Fact%20Sheets%20or%20misc%20files/RGGI%20Fact%20Sheet.pdf [https://perma.cc/9SAY-8G74] (last visited Feb. 8, 2024).

The data indicating that the public more readily supports traditional regulation than pricing and that government has strengthened traditional regulation more often than pricing programs suggest that ambitious caps without trade may be more achievable than strict caps with trading. And coupling caps with auctioned allowances will greatly increase a government's chances of scaling up ambition, as it can reduce costs to consumers. But incumbent interests will likely oppose the elimination of trading, which lowers the compliance costs of covered emitters and minimizes the need for disruptive changes.

CONCLUSION

The critics' claim that pricing tends to maximize short-term cost effectiveness rather than transformative change enjoys strong support both theoretically and from the last several decades of climate policy. Their claims that carbon pricing has not proven sufficiently ambitious or effective given the urgency of the climate crisis is also clearly correct. We need more study, however, of whether competing mechanisms have proven more effective and ambitious in simply producing routine emission reductions and whether they are likely to do so in the future.

The case for competing mechanisms doing better than pricing is strong enough, however, that we should flip the narrative. Instead of only asking whether other measures interfere with pricing's cost effectiveness, we should ask whether pricing interferes with other measures' capacity to catalyze emission reductions and technological transformation. We should keep carbon taxes intact, and strengthen them when feasible as they reinforce other measures, but carefully evaluate the tradeoffs of trading under cap-and-trade programs in light of how these can reduce climate benefits, notably as a result of the waterbed effect, market manipulation or fraud, and the use in some programs of offset credits that have questionable integrity. Despite some shortcomings in the relevant literature, critics of carbon pricing have thus done an important service by shifting the debate from an earlier and largely unquestioned perception of pricing's primacy to focusing instead on the effectiveness of different policy options in driving us rapidly to net-zero emissions.