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CLIMATE CAP AND TRADE AND POLLUTION HOT SPOTS: AN ECONOMICS PERSPECTIVE

Jeff Todd[*]

ABSTRACT

Although cap and trade is overwhelmingly preferred by economists for reducing greenhouse gases and spurring the adoption of renewables and other zero-carbon alternatives, some scholars and advocates worry that it allows firms to concentrate operations in poor and minority neighborhoods, thus leading to hot spots of harmful co-pollutants. Commentators differ on the danger of hot spots and the necessity of adjusting cap-and-trade programs to avoid them, however. This Article therefore surveys ex post *economic studies of cap-and-trade programs to show that they do not lead to hot spots but may actually cool them—perhaps even better than command-and-control regulation. Accordingly, cap and trade unencumbered by unnecessary restrictions should be part of the policy mix for a just energy transition.*

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INTRODUCTION

Federal and state lawmakers have a range of options to guide the transition away from fossil fuels and toward carbon-free alternatives like renewables.[1] States target carbon supply through command-and-control approaches like efficiency standards, which include renewable portfolio standards (RPS).[2] By contrast, tax deductions and credits target the demand for carbon by incentivizing consumers to purchase electric vehicles (EVs) or install residential solar panels.[3] By putting a price on greenhouse gases (GHGs), carbon taxes and cap-and-trade schemes target both the supply and the demand.[4] GHGs are an unpriced externality, so a carbon tax forces firms and their customers to internalize the externality by paying a more accurate price.[5] When emissions permits are auctioned or sold, cap-and-trade programs achieve the same effect,[6] plus the permits create property rights for a

1. *E.g.*, Gary M. Lucas, Jr., *Behavioral Public Choice and the Carbon Tax*, 2017 UTAH L. REV. 115, 125 ("Aside from a carbon tax, the government has three primary options for addressing global warming—cap-and-trade, command-and-control regulation, and green subsidies."); Shelley Welton, *Electricity Markets and the Social Project of Decarbonization*, 118 COLUM. L. REV. 1067, 1083 (2018) ("States are using cap-and-trade programs; renewable-energy procurement requirements; rebates and tax incentives for individuals, businesses, and communities; and novel electricity pricing schemes." (footnotes omitted)).

2. *See* Timothy P. Duane, *Greening the Grid: Implementing Climate Change Policy Through Energy Efficiency, Renewable Portfolio Standards, and Strategic Transmission System Investments*, 34 VT. L. REV. 711, 759–66 (2010) (discussing how RPS works); Felix Mormann, *Clean Energy Equity*, 2019 UTAH L. REV. 335, 354 (writing that "twenty-nine states, the District of Columbia, and three U.S. territories have adopted [RPS]"); Lawrence H. Goulder & Ian W. H. Parry, *Instrument Choice in Environmental Policy*, 2 REV. ENV'T ECON. & POL'Y 152, 158 & n.7 (2008) (categorizing RPS as a type of efficiency standard that targets inputs rather than outputs).

3. *See* Jim Rossi, *Carbon Taxation by Regulation*, 102 MINN. L. REV. 277, 306–08 (2017); Lynsey Gaudioso, *A Billion Grains of Truth: Distributional Impacts of Household-Level Climate Change Tax Subsidies in the United States*, 18 VT. J. ENV'T L. 666, 669 (2017).

4. *See* Dieter Helm, *Economic Instruments and Environmental Policy*, 36 ECON. & SOC. REV. 205, 207 (2005).

5. *See* Shi-Ling Hsu, *A Complete Analysis of Carbon Taxation: Considering the Revenue Side*, 65 BUFF. L. REV. 857, 866 (2017); Yoram Margalioth, *Tax Policy Analysis of Climate Change*, 64 TAX L. REV. 63, 63–64 (2010).

6. *See* Robert N. Stavins, *The Relative Merits of Carbon Pricing Instruments: Taxes Versus Trading*, 16 REV. ENV'T ECON. & POL'Y 62, 63 (2022) ("In theory, carbon taxes and cap-and-trade can be designed to be perfectly equivalent in terms of three attributes (incentives for achieving emission reductions, aggregate abatement costs, and effects on competitiveness), nearly equivalent in terms of potential for raising revenue, and similar in terms of costs to regulated firms and distributional impacts.").

vibrant carbon market.[7] Climate cap-and-trade programs are more efficient than mandates or subsidies because they allow heterogeneous participants to make decisions based on their individual information and capabilities, such as whether or how to produce less carbon or switch to renewable energy sources.[8]

It is therefore no surprise that carbon pricing, whether via taxes or auctioned cap and trade, is overwhelmingly preferred by economists.[9] Many environmental justice scholars and advocates, however, oppose cap and trade because of concerns over hot spots: they worry that firms will buy or trade for permits to concentrate their activities at the dirtiest plants, thus perpetuating, or even exacerbating, the release of harmful co-pollutants in disadvantaged communities.[10] Some commentators have therefore proposed modifying cap and trade in ways that lessen the likelihood of hot spots but sacrifice efficiency.[11] The necessity of

7. *See* T. H. TIETENBERG, EMISSIONS TRADING: PRINCIPLES AND PRACTICE 27 (2d. ed. 2006) (describing how firms with different costs of abatement can take advantage of a cap-and-trade permit market); Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 HARV. ENV'T L. REV. 293, 298 (2008) (describing how allowances are valuable and how trading them sends a price signal that incentivizes firms to reduce emissions).

8. *See infra* Part I.

9. Rory Gillis, *Carbon Tax Shifts and the Revenue-Neutrality Dilemma*, 23 FLA. TAX. REV. 293, 295 (2019); *see* Joseph E. Aldy, Alan J. Krupnick, Richard G. Newell, Ian W. H. Parry & William A. Pizer, *Designing Climate Mitigation Policy*, 48 J. ECON. LITERATURE 903, 918 (2010) (claiming that, for economists, the debate is no longer about market-based or command-and-control approaches but instead over whether carbon taxes or cap and trade is the better option).

10. *E.g.*, Daniel A. Farber, *Pollution Markets and Social Equity: Analyzing the Fairness of Cap and Trade*, 39 ECOLOGY L.Q. 1, 9 (2012) (arguing that "the fairness implications of cap and trade for hot spots of the traded pollutant and accompanying co-pollutants in disadvantaged communities . . . is a major concern of environmental justice advocates"); Uma Outka, *Fairness in the Low-Carbon Shift: Learning from Environmental Justice*, 82 BROOK. L. REV. 789, 812–14 (2017) (surveying environmental justice advocacy groups that have expressed concerns over the inequitable environmental impacts of climate cap and trade).

11. *See, e.g.*, Alice Kaswan, *Reconciling Justice and Efficiency: Integrating Environmental Justice into Domestic Cap-and-Trade Programs for Controlling Greenhouse Gases*, *in* THE ETHICS OF GLOBAL CLIMATE CHANGE 232, 251 (Denis G. Arnold ed., 2011) (arguing that "mechanisms for increasing the equity of co-pollutant consequences, like limiting trading into polluted areas, limiting offsets, and limiting the program to easily-monitored sources, also raise economic efficiency considerations").

these modifications is called into question, however, by those who argue that cap and trade does not lead to hot spots.[12]

In light of the potential for cap and trade to reduce GHG emissions while spurring innovation in, and the adoption of, renewable energy, policymakers should understand the extent to which concerns over pollution hot spots are warranted before rejecting cap and trade as an option or saddling it with restrictions that make it less effective.[13] Given the economic questions raised by a just energy transition,[14] and responding to commentators who have lamented the dearth of attention in the legal literature to the distributional consequences of environmental laws,[15] this Article surveys *ex post* economic studies of cap-and-trade programs to determine whether they have in fact resulted in hot spots.[16] Contrary to popular perception, the survey reveals that cap and trade does not lead to hot spots—with some studies finding that it lowers pollution in minority and low-income communities better than command-and-control regulation.[17]

12. *See, e.g.*, Jonathan B. Wiener, *Disregard and Due Regard*, 29 N.Y.U. ENV'T L.J. 437, 449 (2021) (arguing that hot spots are "not inevitable," so "depending on the patterns of abatement, transport, exposures, harms, and stringency, a cap and trade policy could actually drive greater abatement at sites that reduce harms, including for disadvantaged communities, yielding an improvement in distributional equity").

13. *See* Tatyana Deryugina, Don Fullerton & William A. Pizer, *An Introduction to Energy Policy Trade-Offs Between Economic Efficiency and Distributional Equity*, 6 J. ASS'N ENV'T & RES. ECONOMISTS (SPECIAL ISSUE) S1, S3 (2019) (opining that "policy makers may favor mandates because they lack information, including economic analyses of all the distributional and efficiency consequences of alternative policies").

14. *See* Melissa Powers, *Zero-Sum Climate and Energy Politics Under the Trump Administration*, 49 ENV'T L. REP. 10870, 10882 (2019) ("Ensuring a just transition will require careful policy development and economic design . . . "); Alex Raskolnikov, *Distributional Arguments, in Reverse*, 105 MINN. L. REV. 1583, 1587 (2021) (arguing that the "government should consider . . . distributional consequences both in the design of legal rules and during legal transitions").

15. *E.g.*, Michael A. Livermore, Megan Ceronsky, Richard Morgenstern & Vickie Patton, *Economics & Environmental Policy*, 28 N.Y.U. ENV'T L.J. 49, 75 (2020) (arguing that the study of environmental law and economics needs more consideration of distribution); Cecilia Martinez, *Environmental Justice and the Clean Power Plan: The Case of Energy Efficiency*, 41 WM. & MARY ENV'T L. & POL'Y REV. 605, 607 (2017) (claiming that "only a handful of research efforts . . . focus on equity impacts of domestic climate mitigation policy").

16. *Cf.* Joseph E. Aldy, *Evaluating Regulatory Performance: Learning from and Institutionalizing Retrospective Analysis of EPA Regulations*, 70 CASE W. RSRV. L. REV. 971, 975 (2020) ("The ex post evaluations of the EPA's air-pollution markets in the academic literature provide rigorous evidence about the environmental, public-health, and economic impacts of [pollution markets].").

17. *See infra* Part III.

Accordingly, concern over hot spots should not drive policymakers to forego cap-and-trade programs or to design them in ways that unnecessarily limit their cost-effectiveness for combatting climate change.

Part I describes why cap and trade is more cost-effective than efficiency standards and subsidies for reducing GHG emissions and spurring the adoption of renewables and zero-carbon products. Part II turns to the potential for cap and trade to exacerbate pollution hot spots and describes scholars' mixed opinions about this danger and how to design cap-and-trade programs to avoid it. To bring some clarity to the debate, Part III surveys economic studies on the distributional impacts of cap-and-trade programs to argue that they do not lead to hot spots; to the contrary, they reduce pollution in disadvantaged communities—and may do so more than in well-off areas and better than command-and-control regulation. The Article ends with a brief conclusion.

I. CAP AND TRADE IS COST-EFFECTIVE AT REDUCING GHGS AND INCREASING CARBON-FREE ALTERNATIVES

The United States cannot immediately switch to zero-carbon electricity and vehicles—not only are existing infrastructure and vehicles powered overwhelmingly by fossil fuels but the infrastructure for a decarbonized economy is decades away.[18] Lawmakers can intervene to accelerate the transition, however, with one approach being climate cap-and-trade programs. For sources of carbon and other GHGs, like power plants and industrial facilities,[19] lawmakers can set a series of ever-more-stringent caps on emissions and then issue

18. *See* Rachael E. Salcido, *Rationing Environmental Law in a Time of Climate Change*, 46 LOY. U. CHI. L.J. 617, 626 (2015) ("Thus, both in the production of electricity with coal and natural gas-fired plants, and in the use of fossil fuels for vehicle transportation, the U.S. continues to rely heavily on a fossil fuel energy infrastructure. The U.S. has to build a renewable energy infrastructure before fossil fuel use will abate." (footnote omitted)); Shelley Welton, *The Bounds of Energy Law*, 62 B.C. L. REV. 2339, 2368–69 (2021) (detailing that to meet net-zero carbon emissions by 2050, the U.S. will have to pursue aggressive 5%-to-7% annual reductions in GHG emissions while simultaneously developing the infrastructure for decarbonization via electrification).

19. Aldy et al., *supra* note 9 (writing that permits can be required upstream on mines and wellheads or downstream on power plants and industrial facilities).

permits, with each permit allowing a certain amount of carbon emissions.[20] Although the government could grandfather or give away these permits, an auction system (or at least a combination of grandfathered and auctioned permits) will serve the dual purpose of pricing carbon and raising revenue so that market participants internalize the costs of emissions while governments can lower other distortionary taxes and fund rebates to low-income households to offset the higher costs of carbon-intensive products.[21] Cap-and-trade systems include a market that allows firms that can abate emissions more effectively to sell permits to firms that cannot.[22] As permits become fewer and more expensive, firms will develop and invest in new technologies, wind down carbon-intensive activities, and switch to carbon-free sources like renewable energy.[23]

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20. *See* Ann E. Carlson, *Designing Effective Climate Policy: Cap-and-Trade and Complementary Policies*, 49 HARV. J. ON LEGIS. 207, 209 (2012) ("The idea of cap-and-trade is straightforward. A total amount of allowable pollution is set (the cap). Those subject to the cap are allocated allowances (in sum equal to the cap) that allow them to pollute (typically one ton of pollutant per allowance, with the total number of allocated allowances equal to the cap)." (footnote omitted)).

21. *See* Gilbert E. Metcalf, *Market-Based Policy Options to Control U.S. Greenhouse Gas Emissions*, 23 J. ECON. PERSPS. 5, 12 (2009) (explaining that cap-and-trade programs allow the government to "issue the permits for free to regulated firms or other entities (for example, like state governments), auction the permits, or use some combination of free distribution and auctions"); Robert N. Stavins, *Addressing Climate Change with a Comprehensive US Cap-and-Trade System*, 24 OXFORD REV. ECON. POL'Y 298, 318 (2008) (proposing initial allocation of both grandfathered and auctioned permits that over time becomes auction-only); Joshua Blonz, Dallas Burtraw & Margaret A. Walls, *How Do the Costs of Climate Policy Affect Households? The Distribution of Impacts by Age, Income, and Region* 21–24 (Res. for the Future, Discussion Paper No. 10-55, 2011) (recognizing that all households pay more under cap and trade but describing how bottom quintile households come out ahead under various proposals like tax indexing or dividends); Lawrence H. Goulder, *Climate Change Policy's Interactions with the Tax System*, 40 ENERGY ECON. S3, S9 (2013) (advocating for "devot[ing] a portion of the gross revenues toward some form of a rebate to the neediest households (thereby addressing distributional concerns), while devoting another share toward cuts in marginal income tax rates (thereby achieving some of the benefits in terms of cost-effectiveness)").

22. Carlson, *supra* note 20 ("[Emitters] may cut their pollution to levels below the amount they have been allocated and trade/sell the excess allowances to those who need them. Or they may pollute in excess of the amount of allowances allocated and make up the difference by purchasing allowances from those emitters who don't need all of theirs."); Robert W. Hahn & Robert N. Stavins, *The Effect of Allowance Allocations on Cap-and-Trade System Performance*, 54 J.L. & ECON. (SPECIAL ISSUE) S267, S269–70 (2011) (writing that trading results in emissions allowances being put to their highest use because they cover the emissions that are costliest to abate and spur firms to undertake the least costly reductions).

23. *See* Chad Stone, *Addressing the Impact of Climate Change Legislation on Low-Income*

Lawmakers can and have intervened in other ways, but only carbon taxes are as cost-effective as cap and trade.[24] For example, Carolyn Fischer and Richard Newell evaluated six different policy approaches to climate change and found that emissions pricing, whether via taxes or cap and trade, "is the most efficient single policy for reducing emissions, since it simultaneously gives incentives for fossil energy producers to reduce emissions intensity, for consumers to conserve, and for renewable energy producers to expand production and to invest in knowledge to reduce their costs."[25] They ranked RPS, renewable production subsidies, and research-and-development subsides as fourth, fifth, and sixth best, respectively.[26] Similarly, Karen Palmer and Dallas Burtraw found that abatement costs to achieve carbon emissions reductions under cap and trade were about 50% lower than with RPS and about 75% lower than with renewable energy production tax credits.[27] In a survey of cap-and-trade programs, including several for climate change, Richard Schmalensee and Robert Stavins concluded that these are "environmentally effective and economically cost effective relative to traditional command-and-control approaches"

Households, 40 ENV'T L. REP. 10555, 10555 (2010) (explaining that cap and trade creates a "'price signal' [that] then becomes an incentive for businesses and households to pursue greater energy conservation, and investments in energy efficiency and alternative clean energy technologies, in effect reducing total emissions to the amount allowed under the cap"); Aldy, *supra* note 16, at 976, 977 (writing that "[t]he cap creates scarcity in the right to pollute, which drives the allowances' prices on the secondary market where firms buy and sell the allowances" and that "pollution markets promote innovation in new abatement technology that can both lower costs and increase the efficacy of reducing emissions"); Juan-Pablo Montero, *A Simple Auction Mechanism for the Optimal Allocation of the Commons*, 98 AM. ECON. REV. 496, 513–14 (2008) (arguing that a cap-and-trade scheme with sealed-bid auctions incentivizes firms to invest in research and development of abatement technologies).

24. *See* Mar Reguant, *The Efficiency and Sectoral Distributional Impacts of Large-Scale Renewable Energy Policies*, 6 J. ASS'N ENV'T & RES. ECONOMISTS (SPECIAL ISSUE) S129, S131–32 (2019) (finding that, for 10% reduction in emissions, carbon taxes cost on average $12 per ton of carbon compared to $78 per ton for RPS and $185 per ton for feed-in tariffs).

25. Carolyn Fischer & Richard G. Newell, *Environmental and Technology Policies for Climate Mitigation*, 55 J. ENV'T ECON. & MGMT. 142, 160 (2008).

26. *Id.* at 152–53, 153 tbl.1.

27. *See* Karen Palmer & Dallas Burtraw, *Cost-Effectiveness of Renewable Electricity Policies*, 27 ENERGY ECON. 873, 890–91, 890 tbl.7, 892–93 (2005) (finding that the average cost per ton of carbon abated is $82 for cap and trade, $126 for an RPS of comparable effectiveness, and $144 for the lowest cost renewable energy production credit and concluding that RPS displaces natural gas rather than coal and that renewable energy production credits have minimal impact on reducing carbon while imposing a burden on federal taxpayers).

and that "less flexible systems would not have led to the technological change that appears to have been induced by market-based instruments or the induced process innovations that have resulted."[28]

Other regulatory approaches are not as efficient as cap and trade. For example, technology mandates and performance standards work well when regulators have perfect information and regulated firms are homogenous[29] or if lawmakers desire a modest emissions cap.[30] This is not the situation with climate change, however. One "fundamental problem" is the "mismatch between capabilities and responsibilities": regulators have "too little information" to accomplish their objectives cost-effectively, while the plant managers with the best information have no incentive to accept responsibility voluntarily or to transmit unbiased cost information.[31] Moreover, market participants are heterogeneous, with differing operations, emissions, and costs in seeking to respond to one-size-fits-all standards.[32] A further complication is uncertainty over technological progress: some promising technologies have worked while others have not, so mandates may require low-carbon options based on insufficient information on whether they will be successful.[33] Mandates and performance standards therefore lead to higher compliance costs per unit of abatement.[34] By contrast, cap-and-trade schemes "provide firms with flexibility in achieving emissions reductions and tend to

28. Richard Schmalensee & Robert N. Stavins, *Lessons Learned from Three Decades of Experience with Cap and Trade*, 11 REV. ENV'T ECON. & POL'Y 59, 73–74 (2017) (citations omitted).

29. Cameron Hepburn, *Regulation by Prices, Quantities, or Both: A Review of Instrument Choice*, 22 OXFORD REV. ECON. POL'Y 226, 229 (2006).

30. Lawrence H. Goulder, Marc A. C. Hafstead & Roberton C. Williams III, *General Equilibrium Impacts of a Federal Clean Energy Standard*, 8 AM. ECON. J.: ECON. POL'Y 186, 215 (2016).

31. TIETENBERG, *supra* note 7, at 26; *accord* Goulder & Parry, *supra* note 2, at 157.

32. *See* Aldy et al., *supra* note 9, at 918 n.14; Richard S.J. Tol, *The Structure of the Climate Debate*, 104 ENERGY POL'Y 431, 432 (2017); *see also* Richard Schmalensee & Robert N. Stavins, *Policy Evolution Under the Clean Air Act*, 33 J. ECON. PERSPS. 27, 28–29, 32 (2019) (arguing that, in the context of air pollution, the EPA cannot tailor pollution abatement on a firm-by-firm basis and instead imposes a one-size-fits-all technology or performance standard that risks a high cost per unit of pollution abated).

33. *See* Severin Borenstein & Ryan Kellogg, *Challenges of a Clean Energy Transition and Implications for Energy Infrastructure Policy*, *in* REBUILDING THE POST-PANDEMIC ECONOMY 234, 251 (Melissa S. Kearney & Amy Ganz eds., 2021).

34. Goulder & Parry, *supra* note 2, at 158, 159; Lawrence H. Goulder, Ian W. H. Parry, Roberton C. Williams III & Dallas Burtraw, *The Cost-Effectiveness of Alternative Instruments for Environmental Protection in a Second-Best Setting*, 72 J. PUB. ECON. 329, 339 (1999).

equalize marginal abatement costs across firms."[35] Emissions rights end up in the hands of those who can accomplish policy goals at the lowest cost, solving the problem of information and incentives.[36] Given the call by economists for immediate and ambitious reductions in emissions,[37] cap and trade is therefore more cost-effective than mandates like RPS.[38]

Subsidies and tax incentives are also inefficient. They encourage abatement from substitution but do not discourage the output of carbon.[39] Although subsidies promote substitution with clean energy sources like renewables, they also lead to a reduction in the price of energy, and thus to more production and use of fossil fuels.[40] By contrast, cap and trade targets both the supply and demand side because producers have a cost incentive to use less carbon and seek alternatives to it, or they pass costs along to customers who will consume less or seek their own alternatives, like renewables and

35. Michael A. Livermore & Richard L. Revesz, *Environmental Law and Economics*, *in* 2 THE OXFORD HANDBOOK OF LAW AND ECONOMICS: PRIVATE AND COMMERCIAL LAW 509, 522 (Francesco Parisi ed., 2017).

36. TIETENBERG, *supra* note 7; *see* Metcalf, *supra* note 21 ("With a well-functioning permit trading market, the permit price reflects the opportunity cost at the margin of a firm's emissions. Equating marginal costs across all firms emitting greenhouse gases is a necessary condition for efficiency.").

37. *See, e.g.*, Roberton C. Williams III, *Setting the Initial Time-Profile of Climate Policy: The Economics of Environmental Policy Phase-Ins*, *in* THE DESIGN AND IMPLEMENTATION OF U.S. CLIMATE POLICY 245, 246 (Don Fullerton & Catherine Wolfram eds., 2012) (arguing it is more efficient to phase in climate pricing policies immediately).

38. *See* Goulder et al., *supra* note 30, at 186, 215 (noting that "[e]conomists have tended to view emissions pricing (e.g., cap and trade or a carbon tax) as the most cost-effective approach to reducing [GHG] emissions" but ultimately concluding otherwise).

39. Goulder & Parry, *supra* note 2, at 155, 157 (claiming subsidies "provide the wrong incentives regarding the level of output, which leads to excess entry" and result in "too much abatement from input substitution . . . and too little from reduced output"); Roberton C. Williams III, *Environmental Taxation* 7–8 (Nat'l Bureau of Econ. Rsch., Working Paper No. 22303, 2016) ("[S]ubsidizing a less polluting alternative (such as subsidies for ethanol) provides an incentive only for switching to that alternative, not for any other way to reduce emissions.").

40. José-Luis Cruz & Esteban Rossi-Hansberg, *The Economic Geography of Global Warming* 4–5 (Nat'l Bureau of Econ. Rsch., Working Paper No. 28466, 2021) ("Clean energy subsidies have only a modest effect on carbon emissions and the corresponding evolution of global temperature since, although they generate substitution towards clean energy, they also lead to a reduction in the price of energy which results in more production and ultimately more energy use. These effects tend to cancel each other out.").

EVs.[41] Another problem with tax incentives is that they need to be funded, so if there is no carbon tax or permit auction, governments will need to raise taxes elsewhere, which is bad for the economy.[42] With a cap-and-trade program where permits are auctioned, however, the government raises revenues that can be used to reduce other taxes or be recycled to consumers via lump-sum payments or tax credits.[43]

The rationales supporting climate cap and trade are backed by *ex post* studies of permit markets, which have found that cap and trade leads to lower emissions and improved health—often at lower costs than other regulatory approaches.[44] For example, Brian Murray and Peter Maniloff found that the Northeastern United States Regional Greenhouse Gas Initiative (RGGI) accounted for half of the region's GHG reductions from 2009 to 2012.[45] Notably, their study isolated several factors and found that the RGGI led to a 19% reduction in GHG emissions while the recession, lower natural gas prices, and complementary RPS policies each accounted for only 12% to 14%.[46] Economists have also studied non-climate cap-and-trade programs like

41. Helm, *supra* note 4 (writing that carbon pricing targets both supply and demand); 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*, 8 WIREs CLIMATE CHANGE art. no. e462, at 3 (2017) (writing that both firms and consumers face higher prices and thus "are motived to purchase the cheaper input, product[,] or service" or shift "to options with relatively low direct and indirect emissions").

42. *See* Baranzini et al., *supra* note 41, at 6 (writing that subsidies "generate a burden for public finances"); Gilbert E. Metcalf, *Federal Tax Policy Towards Energy*, *in* 21 TAX POLICY AND THE ECONOMY 145, 169–74 (James M. Poterba ed., 2007) (surveying federal renewable tax credits and finding them "costly" because they must be funded by raising distortionary taxes); Jon Hilsenrath, *New Climate, Tech Bills Expand Role of Government in Private Markets*, WALL ST. J., https://www.wsj.com/articles/new-legislation-expands-role-of-government-in-private-markets-11660321784 [https://perma.cc/RL3J-J529] (Aug. 12, 2022, 12:59 PM) (writing that climate tax expenditures "could make the economy less efficient and slow its overall growth rate, leaving households worse off . . . in the long run").

43. *See* Terry Dinan & Diane Lim Rogers, *Distributional Effects of Carbon Allowance Trading: How Government Decisions Determine Winners and Losers*, 55 NAT'L TAX J. 199, 200 (2002).

44. *See* Aldy, *supra* note 16, at 984–88; Schmalensee & Stavins, *supra* note 28, at 71 (surveying studies of several cap-and-trade programs and finding that "cap-and-trade systems, if well designed and appropriately implemented, can achieve their core objective of meeting targeted emissions reductions cost-effectively").

45. Brian C. Murray & Peter T. Maniloff, *Why Have Greenhouse Gas Emissions in RGGI States Declined? An Econometric Attribution to Economic, Energy Market, and Policy Factors*, 51 ENERGY ECON. 581, 588 (2015).

46. *Id.*

the Acid Rain Program under the Clean Air Act Amendments of 1990, the Regional Clean Air Incentives Market (RECLAIM) in southern California, and the trading program for nitrogen oxides in the eastern U.S.[47] The Acid Rain Program produced cost savings that "were at least 15[%] and perhaps as great as 90[%] of the costs of various alternative command-and-control policies."[48] Scholars attribute this success to the flexibility of the program, such as the deployment of low-cost alternatives and technological change,[49] or the savings of $200 million related to the ability to trade permits between areas with low populations and low abatement costs and those with dense populations and high abatement costs.[50] Similarly, scholars have found RECLAIM and the NO_x Budget Program effective in lowering emissions and the total concentration of ozone,[51] doing so more cost-effectively than more traditional regulation.[52]

II. Mixed Opinions on Pollution Hot Spots and Cap and Trade

Activities like energy generation emit carbon dioxide (which contributes to climate change but is not hazardous to health), along

47. *E.g.*, Schmalensee & Stavins, *supra* note 28, at 59–60.

48. *Id.* at 62; *accord* Curtis Carlson, Dallas Burtraw, Maureen Cropper & Karen L. Palmer, *Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?*, 108 J. POL. ECON. 1292, 1293 (2000) (finding that phase I cost savings could be as much as $800 million annually compared to command-and-control regulation that would have delivered the same aggregate emissions); Gabriel Chan, Robert Stavins, Robert Stowe & Richard Sweeney, *The SO_2 Allowance-Trading System and the Clean Air Act Amendments of 1990: Reflections on 20 Years of Policy Innovation*, 65 NAT'L TAX J. 419, 424–26 (2012) (finding phase II compliance costs were reduced by several hundred million dollars compared with conventional performance standards).

49. Livermore & Revesz, *supra* note 35, at 523–24.

50. *See* H. Ron Chan, B. Andrew Chupp, Maureen L. Cropper & Nicholas Z. Muller, *The Impact of Trading on the Costs and Benefits of the Acid Rain Program*, 88 J. ENV'T ECON. & MGMT. 180, 183 (2018).

51. Olivier Deschênes, Michael Greenstone & Joseph S. Shapiro, *Defensive Investments and the Demand for Air Quality: Evidence from the NO_x Budget Program*, 107 AM. ECON. REV. 2958, 2959 (2017) (finding that the NO_x Budget Program coincided with a 40% decline in emissions and 6% reduction in ozone concentrations); Meredith Fowlie, Stephen P. Holland & Erin T. Mansur, *What Do Emissions Markets Deliver and to Whom? Evidence from Southern California's NO_x Trading Program*, 102 AM. ECON. REV. 965, 967 (2012) (finding that RECLAIM facilities demonstrated 20% more reductions than similar facilities subject to command-and-control regulations).

52. Schmalensee & Stavins, *supra* note 28, at 65 (finding that from 1999–2003, the NO_x Budget Program abatement cost savings were estimated at 40%–47% relative to conventional regulation).

with co-pollutants (that are hazardous to health), such as particulates, sulfur dioxide, nitrous oxides, and carbon monoxide.[53] Although climate cap and trade leads to an overall reduction in these co-pollutants,[54] critics contend that it can result in firms concentrating those co-pollutants in poor and minority neighborhoods. Given the necessity of cap and trade as a component of U.S. climate policy,[55] policymakers must understand the nature and extent of its role in hot spots before modifying—or even abandoning—programs.[56] As this Part shows, however, legal scholars disagree about the relationship of cap and trade to hot spots and therefore offer inconsistent—and even counterproductive—recommendations about how to address the issue.

Cap and trade inherently gives firms flexibility, which also means that firms are not forced to implement abatement technology, to switch to renewables, or to reduce emissions at any particular facility.[57] Instead, those facilities can continue to emit pollutants—or even increase their emissions—if the firm possesses sufficient emissions credits, whether those be grandfathered, auctioned for, or purchased on the trading market.[58] Given the long productive life of industrial facilities, firms have an incentive to keep them in operation for as long

53. Alice Kaswan, *Environmental Justice and Domestic Climate Change Policy*, 38 ENV'T L. REP. 10287, 10298 (2008).

54. *See* Don Fullerton & Catherine Wolfram, *Program Report: Environmental and Energy Economics*, NBER REP., no. 2, 2016, at 1, 5 (explaining that "[m]ost local pollutants are coproduced with greenhouse gases, so many of the policies to reduce GHGs also reduce local pollutants.").

55. *See* Stavins, *supra* note 6 (noting the "widespread agreement among most economists that economy-wide carbon pricing will be a necessary . . . component of any effective policy").

56. *See* Farber, *supra* note 10, at 27–28.

57. *See* Catherine A. O'Neill, *Mercury, Risk and Justice*, 34 ENV'T L. REP. 11070, 11098 (2004) (claiming that cap-and-trade programs "by design say nothing about how the emissions are to be distributed among sources" because "the efficiency gains that are the chief virtue of cap-and-trade approaches are realized precisely because sources within this geographic area are permitted to trade allowances freely among themselves").

58. *See* Stephen M. Johnson, *Economics v. Equity: Do Market-Based Environmental Reforms Exacerbate Environmental Injustice?*, 56 WASH. & LEE L. REV. 111, 114 (1999); Joseph S. Shapiro, *Pollution Trends and US Environmental Policy: Lessons from the Past Half Century*, 16 REV. ENV'T ECON. & POL'Y 42, 57 (2022) (writing that because "markets do not guarantee [the] equitable distribution of pollution . . . [, they] could fail to decrease—or actually increase—pollution in some areas"); Alice Kaswan, *Climate Change, the Clean Air Act, and Industrial Pollution*, 30 UCLA J. ENV'T L. & POL'Y 51, 99 (2012) (explaining that cap-and-trade programs "provide no assurances that emissions will not increase at particular locations").

as they remain profitable.[59] As a consequence, "[i]f facilities with high costs of control are located in polluted areas and rely upon allowance purchases rather than reducing emissions, air quality will not improve."[60] Poor and minority communities located near industrial facilities might then bear the brunt of co-pollutant emissions.[61]

Critics can point to evidence that these concerns are not mere speculation. Because current facilities are often located in low-income and minority areas,[62] facilities will purchase credits to continue their emissions in those communities.[63] In California, for example, where "GHG-emitting facilities are disproportionality located in marginalized communities," one study concluded that the overall reduction of GHGs under California's cap-and-trade program has "yet to yield meaningful reduction in localized pollutants."[64] For a non-climate example, consider the "car scrapping program" of the South Coast Air Quality Management District in southern California, which allowed stationary sources like factories and refineries to avoid installing pollution control equipment by purchasing credits from mobile sources, namely the destruction of older cars.[65] Primarily minority communities located near the stationary programs felt the detriments of this program, while the benefits spread throughout the primarily non-minority areas of Los Angeles.[66]

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59. For this reason, it will be "difficult" to phase out natural-gas-fueled power plants by 2050. Christopher Serkin & Michael P. Vandenbergh, *Prospective Grandfathering: Anticipating the Energy Transition Problem*, 102 MINN. L. REV. 1019, 1029–30 (2018).

60. Kaswan, *supra* note 11, at 240.

61. *Id.* at 236, 241.

62. Solomon Hsiang, Paulina Oliva & Reed Walker, *The Distribution of Environmental Damages*, 13 REV. ENV'T ECON. & POL'Y 83, 88 (2019); Ann Wolverton, *Effects of Socio-Economic and Input-Related Factors on Polluting Plants' Location Decisions*, 9 B.E. J. ECON. ANALYSIS & POL'Y, no. 1, 2009, at 1, 5.

63. Johnson, *supra* note 58, at 131 (explaining that "heavily polluting industrial facilities (the facilities that may purchase pollution credits) will more likely be sited in low-income, urban areas than in middle-to upper-income, suburban areas").

64. J. Mijin Cha, Madeline Wander & Manuel Pastor, *Environmental Justice, Just Transition, and a Low-Carbon Future for California*, 50 ENV'T L. REP. 10216, 10218 (2020).

65. Richard Toshiyuki Drury, Michael E. Belliveau, J. Scott Kuhn & Shipra Bansal, *Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy*, 9 DUKE ENV'T L. & POL'Y F. 231, 246–47 (1999).

66. *See id.* at 251–55.

The existence of past problems, however, does not mean that future climate cap-and-trade policies will necessarily result in hot spots. Effective design and complementing cap and trade with other regulatory approaches provide two keys to avoiding hot spots.[67] Setting a sufficiently stringent emissions cap is one essential design aspect. If the cap is not set below "business-as-usual," then an overallocation of allowances occurs, which results in lower prices and thus reduced incentives to buy or trade for permits.[68] By contrast, lower caps lead to higher carbon prices and therefore result in lower emissions and technological innovation.[69] Accompanying co-pollutant emissions may be low enough to limit hot spots if overall GHG emissions are low enough.[70] Another design aspect depends upon auctioning permits: the government can apply a portion of the revenues to programs that mitigate co-pollutants in the dirtiest locations, thereby countering increased emissions while having minimal impact on the cost-effectiveness of cap and trade.[71]

67. *See* Farber, *supra* note 10, at 28 (noting that "it should be possible to design a cap-and-trade program or related regulations in order to counter [co-pollutants in disadvantaged communities], or to use auction revenues to benefit impacted communities" (footnote omitted)); Kaswan, *supra* note 53, at 10304, 10307–08 (recognizing the "safety net" created by integrating cap and trade with traditional regulation and proposing "design features" to address the environmental justice concerns about cap and trade); Schmalensee & Stavins, *supra* note 28, at 64 (arguing that RECLAIM demonstrates how an "appropriate design can accommodate a nonuniformly mixed pollutant and attendant concerns about potential hot spots").

68. *See* Lesley K. McAllister, *The Overallocation Problem in Cap-and-Trade: Moving Toward Stringency*, 34 COLUM. J. ENV'T L. 395, 410–23 (2009) (providing an explanation of the consequences associated with overallocation). *But see* Robert N. Stavins, *Addressing Climate Change with a Comprehensive US Cap-and-Trade System*, 24 OXFORD REV. ECON. POL'Y 298, 303 (2008) (cautioning against setting the initial cap too low and instead recommending that it be tightened consistently and gradually).

69. Kaswan, *supra* note 53, at 10307 (explaining that "[s]etting a sufficiently stringent cap will be key to a trading program's efficacy in reducing emissions and stimulating technology adoption and innovation").

70. *See* Wiener, *supra* note 12 (claiming that "a tight cap could benefit all sites even with non-uniform harms").

71. Maxine Burkett, *Just Solutions to Climate Change: A Climate Justice Proposal for a Domestic Clean Development Mechanism*, 56 BUFF. L. REV. 169, 215–16 (2008) (proposing using auction revenues to finance green development and adaptation projects in disadvantaged communities); *see* James K. Boyce, *Carbon Pricing and Climate Justice*, *in* THE ROUTLEDGE HANDBOOK OF THE POLITICAL

Unfortunately, commentators disagree on most other aspects of program structure and the role of complementary policies. For example, Alice Kaswan argues that the Clean Air Act "permit system does not fully constrain co-pollutant increases."[72] Accordingly, she urges climate cap and trade to be treated as a supplement to existing regulations rather than a replacement, such as requiring facilities to adopt emissions reduction mechanisms similar to the approach taken by the Acid Rain Program.[73] By contrast, Stavins argues that cap-and-trade programs do not supplant existing pollution controls like local regulations limiting NO_x, so trading to increase emissions in violation of these other regulations will be prohibited.[74] Further, although complementary policies can help address market failures, "the types of complementary policies that have emerged from political processes have instead addressed emissions under the cap, thereby relocating rather than reducing emissions, driving up abatement costs, and suppressing allowance prices."[75] For example, the Acid Rain Program did not achieve optimal cost-effectiveness because of overlapping performance standards and technology requirements that precluded firms "from exploiting the flexibility intrinsic to the cap-and-trade program."[76] Rather than promote the adoption of effective alternatives

ECONOMY OF THE ENVIRONMENT 243, 253–54 (Éloi Laurent & Klara Zwickl eds., 2022) (arguing that using a portion of carbon pricing revenue for public investment is justified because governments account for a substantial amount of GHG emissions); Stavins, *supra* note 6, at 76–77 (conceding that using revenue to finance equity concerns is not the best option, but that it may be necessary to secure political support for cap and trade and thus is "a key step toward more effective climate policy action").

72. Kaswan, *supra* note 11, at 241–42.

73. *Id.* at 245–46.

74. Stavins, *supra* note 7, at 354.

75. Schmalensee & Stavins, *supra* note 28, at 73 (internal quotation marks omitted); *accord* Carlson, *supra* note 20, at 209–10 (arguing that efficiency standards can be a cost-effective complement to cap and trade but that RPS are not); *see* Johnson, *supra* note 58, at 162–63 (noting problems with command-and-control safety nets like the time and expense of data collection and the need to define terms like "low-income community").

76. Aldy, *supra* note 16, at 992–93; *see also* Carlson et al., *supra* note 48, at 1318–19 (finding compliance in the SO_2 market resulted in around $300 million more in costs than estimated in a least-cost compliance scenario); Elaine F. Frey, *Technology Diffusion and Environmental Regulation: The Adoption of Scrubbers by Coal-Fired Power Plants*, 34 ENERGY J. 177, 178, 180 (2013) (claiming that firms covered by the SO_2 cap-and-trade program had to invest in scrubbers required under SO_2 state-specific performance standards).

like renewable energy, complementary prices might instead "diminish incentives for technological change."[77]

Other recommendations to restrict cap and trade because of hot spot concerns are likewise disputed. One proposal is to restrict trading for facilities located in high-pollution areas, such as by placing a hard cap on emissions, limiting the number of permits facilities can receive, charging higher auction prices, or introducing a system of government oversight to approve only those trades that will not lead to hot spots.[78] Similarly, because "[o]ffsets are reductions or carbon sequestration achieved outside the regulated sector," their use could be limited to reducing co-pollutants in specific areas or tailored to achieve co-benefits.[79] To ensure reductions in co-pollutants in the regulated area, trading for permits from outside that area (such as from facilities in other states or countries) could be capped or used at a ratio greater than 1:1.[80] Finally, to prevent firms from continuing to pollute for years, programs could restrict the ability of firms to bank emissions permits, such as imposing "time limits or requiring a greater than 1:1 ratio" for their use.[81]

Each of these proposals would negate the aspects of cap and trade that make it effective. For example, imposing pollution control requirements or performance standards can stymie the flexibility that leads to innovation.[82] Further, offsets lead to additional cost savings by reducing tax liability or allowance requirements, so "excessive

77. Stavins, *supra* note 6, at 69.

78. Kaswan, *supra* note 11, at 249–50; *see* Jonathan Remy Nash & Richard L. Revesz, *Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants*, 28 ECOLOGY L.Q. 569, 624–28 (2001) (proposing a system that would allow regulators to reject trades if computer simulations show a "violation of an ambient standard at any receptor point"); Johnson, *supra* note 58, at 166 (recognizing that limits on trades may be necessary to prevent disparate impact in minority communities).

79. Kaswan, *supra* note 11, at 243, 249–50; *cf.* Carlson, *supra* note 20, at 225–26 (recognizing that the "gaming" of offsets that do not produce additional emissions reduction may require complementary policies); Nash & Revesz, *supra* note 78, at 624 (calling offset markets "fraught with complexity").

80. Kaswan, *supra* note 53, at 10307.

81. *Id.* at 10308.

82. *See* Stavins, *supra* note 6, at 72–73 (citing studies that concluded that "under less flexible systems, market-based instruments would not have induced as much technological change or process innovation" (citations omitted)).

constraints" can render them "ineffective for cost containment."[83] Trading permits across jurisdictions allows firms "to take advantage of lower-cost abatement opportunities," thus increasing cost savings.[84] The banking of emissions permits "can be crucial for regulated entities to achieve compliance at a reasonable cost,"[85] such as under the Acid Rain Program, where banking accounted for more than half of the Acid Rain Program's cost savings.[86] Banking also allows firms to respond to "allowance price spikes."[87]

The need to dilute the cost-effectiveness of cap and trade is called into further doubt by commentators who argue that these programs have a limited role—if any—in hot spots. Indeed, Daniel Farber claims that "the use of offsets, the availability of credit banking, or the initial allocation scheme" do not affect the distribution of emissions reductions.[88] After all, the risk of hot spots depends on a variety of factors, such as how emissions permits are traded, the flow patterns for pollutants, the degree to which the exposure causes harm, and, as mentioned above, "the stringency of the cap."[89] Depending on these factors, climate cap-and-trade programs "could actually drive greater abatement at sites that reduce harms, including for disadvantaged communities, yielding an improvement in distributional equity."[90] Further, cap-and-trade programs typically target emissions at large stationary sources like power plants and industrial facilities.[91] Most

83. *Id.* at 64, 73.

84. *Id.* at 68. Some critics also argue that inter-zone trading prohibitions are ineffective and counterproductive. *See* Nash & Revesz, *supra* note 78, at 616–18.

85. Schmalensee & Stavins, *supra* note 28, at 64.

86. *Id.* at 63.

87. Ann E. Carlson, *Regulatory Capacity and State Environmental Leadership: California's Climate Policy*, 24 FORDHAM ENV'T L. REV. 63, 74–75 (2013) (explaining that California's cap-and-trade program included banking to avoid the allowance price spikes that happened under RECLAIM).

88. Farber, *supra* note 10, at 29 (claiming that "under most circumstances, the analysis of how emissions reductions are distributed among sources does not turn on the details of the cap-and-trade system such as the use of offsets, the availability of credit banking, or the initial allocation scheme—provided that the system is sufficiently credible (and any offsets are sufficiently expensive) and that emission allowances have a price greater than zero").

89. Wiener, *supra* note 12.

90. *Id.*

91. *See* Aldy et al., *supra* note 9 (noting that cap-and-trade systems can be imposed on "downstream emitters at the point where fuels are combusted . . . [which] would apply to 10,000 or more power plants and large industrial smokestacks").

pollution that is harmful to humans, however, is produced by mobile sources like automobiles or small point sources.[92]

In light of the disagreement about hot spots, it is important to understand the extent of the threat before declining to adopt cap and trade or enacting policies with restrictions that reduce its effectiveness. The next Part seeks that understanding through a survey of economic studies of cap-and-trade programs.

III. ECONOMIC ANALYSES: CAP-AND-TRADE PROGRAMS DO NOT RESULT IN HOT SPOTS

Although economists have traditionally been concerned only with the cost-effectiveness of environmental policy, they have started to show more interest in distributional effects.[93] As shown by the survey in this Part, this interest includes numerous *ex post* studies of the distribution of pollution under cap-and-trade programs. Although a few have found a correlation between cap and trade and hot spots, those results have been criticized for looking only at emissions and not considering their dispersal or for failing to isolate the effects of cap and trade from effects relating to overlapping regulations. The clear majority has instead found that cap and trade does not lead to hot spots—and may even correct the unjust distribution of pollutants better than command-and-control regulation.

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92. David E. Adelman, *The Collective Origins of Toxic Air Pollution: Implications for Greenhouse Gas Trading and Toxic Hotspots*, 88 IND. L.J. 273, 277 (2013) (reviewing data that show that "industrial facilities rarely account for more than ten percent of aggregate toxic emissions from outdoor sources at the county- or census-tract level," and, instead, "mobile sources . . . and small point sources (for example, dry cleaners, gas stations, and landfills) dominate toxic emissions and risks in most jurisdictions"); David E. Adelman, *Unfounded Fears About Pollution Trading and Hotspots*, 44 ENV'T L. REP. 10299, 10302 (2014); *see also* Ann E. Carlson, *The Clean Air Act's Blind Spot: Microclimates and Hotspot Pollution*, 65 UCLA L. REV. 1036, 1048 (2018) (proposing vehicle electrification to target the problem of "microclimates" of pollutants caused by mobile sources).

93. *E.g.*, Geoffrey Heal & Bengt Kriström, *Distribution, Sustainability and Environmental Policy*, *in* HANDBOOK OF SUSTAINABLE DEVELOPMENT 175, 175–76 (Giles Atkinson, Simon Dietz, Eric Neumayer & Matthew Agarwala eds., 2d ed. 2014) (claiming that the sum of costs and benefits are all that matter in the "routine use of the Kaldor-Hicks criterion in cost-benefit analysis" but that "there has been a surge of interest in environment and distribution").

A. California's Climate Cap-and-Trade Program

Three studies have considered the possibility of hot spots with California's cap-and-trade program. The first, though not by economists, has been cited by economists.[94] Lara Cushing and her co-authors found that facilities covered by California's cap-and-trade program were disproportionately located in disadvantaged communities: 38% of neighborhoods within 2.5 miles of a facility versus 19% of those outside 2.5 miles were designated as disadvantaged under CalEnviroScreen, a statewide metric of "environmental quality and population vulnerability."[95] Further, the proximate communities also had a higher proportion of minority, poor, less-educated, and low-English-proficiency residents.[96] The authors studied emissions for the two years before and the three years after the program started in 2013,[97] finding that a slight "majority of facilities . . . increased their annual average $PM_{2.5}$, [Volatile Organic Compounds], and air toxics emissions during this time period (51%, 57%, and 52% of facilities, respectively), while a [slight] minority increased their annual average NO_x and SO_x emissions (46% and 44%, respectively)."[98] Compared to neighborhoods with decreased GHG emissions, neighborhoods with both increased GHGs and co-pollutants were more likely to be disadvantaged, so the authors concluded that "the cap-and-trade program has not yielded . . . localized improvements in environmental equity."[99]

Economists have criticized this study on at least two grounds. First, it fails to consider "confounding factors that impacted facilities

94. *See, e.g.*, Boyce, *supra* note 71, at 253.

95. Lara Cushing, Dan Blaustein-Rejto, Madeline Wander, Manuel Pastor, James Sadd, Allen Zhu & Rachel Morello-Frosch, *Carbon Trading, Co-Pollutants, and Environmental Equity: Evidence from California's Cap-and-Trade Program (2011-2015)*, 15 PLOS MED., July 2018, at 1, 5, 10 & tbl.1, https://doi.org/10.1371/journal.pmed.1002604 [https://perma.cc/69GP-DNWB].

96. *Id.* at 9–10 (finding a "34% higher . . . proportion of residents of color, 23% higher . . . proportion of poor residents, 64% higher . . . proportion of residents with low educational attainment, and 80% higher . . . proportion of linguistically isolated households").

97. *Id.* at 5.

98. *Id.* at 10.

99. *Id.* at 13, 15.

differently over this time period (such as recession impacts)."[100] Second, the conclusions are based only on facility emissions rather than the actual dispersion of pollution, so although Cushing and her co-authors show the proximity of disadvantaged communities to (sometimes higher) *emissions*, they do not address whether cap and trade resulted in disadvantaged communities being exposed to more *pollution*.[101]

A more recent study by economists Danae Hernandez-Cortes and Kyle Meng not only accounted for these shortcomings but also included a longer timeframe: they looked as far back as 2008 to establish a baseline "environmental justice gap"—the difference between pollution in advantaged and disadvantaged ZIP codes as defined by CalEnviroScreen—and they included data for five years of the program (from 2013 through 2017).[102] The authors segregated regulated facilities into those covered only by the cap-and-trade program and those that were also regulated by other laws, like RPS or fuel mandates, which allowed the authors to measure the effects of cap and trade unaffected by confounding factors.[103] They also combined facility emissions data with dispersion models to determine pollution concentrations and not just increases or decreases in emissions.[104] Not only did the authors find that emissions of GHG and co-pollutants for the "pure" cap-and-trade facilities declined under the program,[105] but their approach also led to more pertinent insights about hot spots. They found that the environmental justice gap worsened from 2008 to the

100. MEREDITH FOWLIE, REED WALKER & DAVID WOOLEY, CLIMATE POLICY, ENVIRONMENTAL JUSTICE, AND LOCAL AIR POLLUTION 11 & n.12 (2020), https://www.brookings.edu/wp-content/uploads/2020/10/ES-10.14.20-Fowlie-Walker-Wooley.pdf [https://perma.cc/Z44U-K7YD]; *see* Cushing et al., *supra* note 95, at 16 (recognizing that the Great Recession of 2008 affected implementation of the California cap-and-trade program, such as a lower allocation than expected of initial allowances).

101. *See* Lori Snyder Bennear, *Energy Justice, Decarbonization, and the Clean Energy Transformation*, 14 ANN. REV. RES. ECON. 647, 662 (2022).

102. *See* Danae Hernandez-Cortes & Kyle C. Meng, *Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market* 2, 4, 9, 21 (Nat'l Bureau of Econ. Rsch., Working Paper No. 27205, 2020) (revised 2022).

103. *Id.* at 3, 11–12.

104. *Id.* at 3–4, 14–16.

105. *See id.* at 21 (finding annual emissions reductions from 2012 to 2017 of "9%, 5%, 4%, and 3% for GHG, $PM_{2.5}$, PM_{10}, and NO_x, respectively," with all of them statistically significant except for SO_x).

start of the cap-and-trade program, but under the program, the gap reversed and started to close.[106] In short, California's cap-and-trade program—isolated from confounding factors like other regulatory requirements—did not result in co-pollutant hot spots but instead cooled them.[107]

In part to respond to Hernandez-Cortes and Meng, several of the authors of the Cushing article performed a new study that focused on differences between emissions prior to cap and trade (2011–2012) and a more recent compliance period (2016–2017).[108] Although the study found an overall reduction in all co-pollutants (except for SO_x, which remained unchanged), the results differed when facilities were split into thirds that they categorized as "most improved," "middle group," and "least improved."[109] The study found that the least-improved tercile—which actually had slight increases in co-pollutant emissions—were uniformly located within 2.5 miles of communities that had larger percentages of disadvantaged residents than those within 2.5 miles of the most-improved facilities.[110] The results were similar for the finer scale of block groups.[111] They therefore concluded that communities with higher shares of disadvantaged residents were "more likely to live near cap-and-trade facilities and . . . less likely to have seen improvement in pollution emissions."[112]

The Hernandez-Cortes and Meng study better answers the key question about whether cap and trade results in co-pollutant hot spots; indeed, the non-economists' own data cut against their contrary

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106. *Id.* at 24–25.

107. *Id.* at 32 (finding "that disparities in local air pollution concentrations from industrial facilities subject only to California's carbon market fell following its introduction").

108. MANUEL PASTOR, MICHAEL ASH, LARA CUSHING, RACHEL MORELLO-FROSCH, EDWARD-MICHAEL MUÑA & JAMES SADD, UP IN THE AIR: REVISITING EQUITY DIMENSIONS OF CALIFORNIA'S CAP-AND-TRADE SYSTEM 9 (2022), https://dornsife.usc.edu/assets/sites/1411/docs/CAP_and_TRADE_Updated_2020_v02152022_FINAL.pdf [https://perma.cc/LH3L-4KDR].

109. *Id.* at 15–16, 15 n.19 (noting that GHGs and all co-pollutants had fewer emissions, except that SO_x remained unchanged).

110. *See id.* at 6, 16–18.

111. *See id.* at 20–24; *cf.* FOWLIE ET AL., *supra* note 100 (critiquing Hernandez-Cortes and Meng for not addressing inequities at finer spatial scale like neighborhoods).

112. PASTOR ET AL., *supra* note 108, at 33.

assertions.[113] For example, the non-economist authors of the Cushing article included charts and tables to demonstrate that a slightly higher percentage of residents who are minority or classified as disadvantaged live near the *least*-improved facilities; those same graphics show that a higher percentage of residents who live near the *most*-improved facilities are also minorities or disadvantaged.[114] In other words, minority and disadvantaged persons were the primary beneficiaries of the reduction in co-pollutants resulting from California's cap-and-trade program.[115]

Further, Hernandez-Cortes and Meng replied to the non-economists study by pointing out two shortcomings.[116] First, the non-economists continued to focus on facility emissions and not the dispersal of pollutants: drawing a 2.5 mile circle around facilities does not capture "pollution disparity consequences" because pollutants can spread over large areas (greater than twenty miles), dispersion varies by pollutant, and the direction of dispersal also varies.[117] Second, the non-economists considered emissions by all facilities governed by California's cap-and-trade program.[118] By contrast, Hernandez-Cortes and Meng's approach allowed for a control group of facilities subject to additional environmental regulations, so they isolated the effects of cap and trade specifically and thereby avoided confounding influences.[119] In sum, all three studies actually evince reductions of co-

113. *See* Hernandez-Cortes & Meng, *supra* note 102, at 24–25.

114. For emissions of $PM_{2.5}$, PM_{10}, NO_x, and SO_x, the percentage of people of color who live within 2.5 miles of the least improved facilities ranges from 66%–68%, while for the most improved facilities it is 60%–64%. *See id.* at 17–18. Similarly, the percentage of disadvantaged persons based on the CalEnviroScreen who live within 2.5 miles of the least improved facilities averages about 65%, while for the most improved facilities it ranges between 50% and 60%. *See id.* at 21–22, 25, 27.

115. *See id.* at 32–33.

116. Danae Hernandez-Cortes & Kyle C. Meng, The Importance of Causality and Pollution Dispersal in Quantifying Pollution Disparity Consequences: Reply to Pastor et al., at 2 (2022) (unpublished manuscript), https://hernandezcortes.github.io/assets/pdf/HCM_response_capandtrade.pdf [https://perma.cc/9RZV-K2D4].

117. *Id.* at 4–5. For example, southern California has "significantly different air quality conditions along coastal areas in comparison with eastern portions" because of differing wind conditions. Holger Sieg, V. Kerry Smith, H. Spencer Banzhaf & Randy Walsh, *Estimating the General Equilibrium Benefits of Large Changes in Spatially Delineated Public Goods*, 45 INT'L ECON. REV. 1047, 1063 (2004).

118. Hernandez-Cortes & Meng, *supra* note 116, at 3.

119. *Id.* at 3–4; *see also* Hernandez-Cortes & Meng, *supra* note 102, at 3, 11–12.

pollutant emissions in disadvantaged communities by facilities regulated by California cap and trade; plus, Hernandez-Cortes and Meng show that the disparity in exposure to actual pollution narrowed for facilities regulated only by the cap-and-trade program.[120]

B. Studies of Other Cap-and-Trade Programs

A number of economic studies have addressed the issue of hot spots with other cap-and-trade schemes like RECLAIM and the Acid Rain Program. Although these schemes target pollutants other than GHGs, scholars nevertheless recognize the potential for such studies to provide insight for designing climate cap-and-trade programs.[121] These studies have almost uniformly found that cap and trade does not result in hot spots but instead lowers pollution in disadvantaged communities—perhaps more effectively than more traditional regulation.

The RECLAIM program established a cap-and-trade scheme to control pollutants like nitrous oxides emitted by power plants and industrial sources.[122] A trio of economics articles have addressed the distributive effects of RECLAIM. The first compared NO_x emissions at RECLAIM facilities with similar California facilities that were not part of RECLAIM but were in nonattainment and therefore subject to command-and-control regulation.[123] The authors looked at populations

120. The authors subsequently published the results of their working paper in a peer-reviewed journal, and they reached the same conclusion that California's cap-and-trade program narrowed the environmental justice gap. Danae Hernandez-Cortes & Kyle C. Meng, *Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market*, J. PUB. ECON., no. 104786, 2023, at 1, 2.

121. *See* Aldy, *supra* note 16, at 979 ("[T]he extensive academic literature on the performance of pollution markets can provide lessons for other policies . . . ."); Fowlie et al., *supra* note 51, at 965 (claiming that GHG regulation has brought cap and trade "to the fore" so they analyze RECLAIM because "questions remain about how emissions trading is working in practice"); Schmalensee & Stavins, *supra* note 28, at 64 (stating that the overallocation of allowances in the RECLAIM program provided a lesson that "later became important for several carbon dioxide (CO_2) cap-and-trade systems").

122. *See* Schmalensee & Stavins, *supra* note 28, at 63–64 (explaining that RECLAIM was launched "in 1993 to reduce NO_x emissions and in 1994 to reduce SO_2 emissions from 350 affected sources, including power plants and industrial sources in the Los Angeles area that emitted four or more tons per year of either pollutant").

123. Fowlie et al., *supra* note 51, at 966–67.

"within a half, one, and two miles of each facility" and considered census block group data of median household income as well as ethnicity and race.[124] Although the authors saw disparities (for example, high-income white communities saw the largest reductions while low-income Black communities the least[125]) they found that "[a]lmost all affected block groups had a net reduction in emissions from RECLAIM."[126] Of most relevance for this Article, the authors compared the distribution of emissions between RECLAIM facilities and those subject to command-and-control regulation and found that both groups had similar spatial patterns of emissions, which means that, relative to command-and-control regulation, emissions trading under "RECLAIM did not contribute to hotspots."[127]

The second RECLAIM article built on the first by considering changes in ambient pollution (thus relaxing the assumption that emissions are uniformly distributed) by employing a dispersion model to emissions from RECLAIM and non-RECLAIM facilities.[128] The authors concluded that the environmental justice impacts of cap and trade versus command and control are mixed: "areas with higher income experience a larger reduction in pollution" while high-poverty areas experienced smaller reductions, and Black communities received a "significantly larger reduction" while Hispanic communities experienced a smaller reduction relative to white communities.[129] Of note, the authors excluded electricity generation facilities because they were not covered by RECLAIM over the entire sample period of 1990–2005; when included, however, there was no "significant correlation between any socioeconomic group and NO_x reduction."[130]

124. *Id.* at 976.

125. *Id.* at 980.

126. *Id.* at 990.

127. *Id.* at 980, 989. The authors note that, most importantly, "the relative emissions comparisons suggest that no group was exposed to more emissions due to emissions trading." *Id.* at 980.

128. *See* Corbett Grainger & Thanicha Ruangmas, *Who Wins from Emissions Trading? Evidence from California*, 71 ENV'T & RES. ECON. 703, 704, 707 (2018).

129. *Id.* at 718–19.

130. *Id.* at 707–08, 708 n.4. Notably, the authors' focus on relative reductions of pollution across neighborhoods means that they make no findings that pollution stayed the same or increased in any disadvantaged community. *See id.* at 710–15.

The third article built on the first two by comparing pollution dispersion under RECLAIM with a counterfactual, except that the authors sought to measure "policy impacts on individuals" rather than facility emissions and thus the "inequality of pollution exposure."[131] In other words, the authors studied how members of different affected populations (divided by race and income) would rank the different policy approaches for reducing NO_x.[132] They concluded that "[e]ach racial/ethnic group and each income category would unambiguously prefer the RECLAIM distribution over the corresponding command-and-control alternative."[133] They further concluded that there was "little evidence to suggest that RECLAIM systematically favored [w]hite or high-income groups over minority or low-income groups."[134]

Several scholars have also studied the Acid Rain Program and found that it "did not generate significant hot spots."[135] For example, Ronald Shadbegian, Wayne Gray, and Cynthia Morgan employed a "spatially-detailed air pollution dispersion model . . . to evaluate the impact of SO_2 emission reductions" during Phase I of Title IV of the Clean Air Act Amendments of 1990 compared with emissions under the former command-and-control regime.[136] Not only did the health benefits of the program outweigh the costs in general terms—$56 billion in benefits versus $558 million in costs or "$100 in benefits for every $1 in abatement costs"—but Black and Hispanic communities saw a greater share of those benefits than the costs.[137] Although they found that poor communities received a slightly higher share of costs than benefits, that finding was based on the assumption that poor

131. Erin T. Mansur & Glenn Sheriff, *On the Measurement of Environmental Inequality: Ranking Emissions Distributions Generated by Different Policy Instruments*, 8 J. ASS'N ENV'T & RES. ECONOMISTS 721, 727, 733 (2021).

132. *Id.* at 754.

133. *Id.*

134. *Id.*

135. *E.g.*, Richard Schmalensee & Robert N. Stavins, *The SO_2 Allowance Trading System: The Ironic History of a Grand Policy Experiment*, 27 J. ECON. PERSPS. 103, 108–09 (2013).

136. Ronald J. Shadbegian, Wayne Gray & Cynthia Morgan, *Benefits and Costs from Sulfur Dioxide Trading: A Distributional Analysis*, *in* ACID IN THE ENVIRONMENT: LESSONS LEARNED AND FUTURE PROSPECTS 241, 242 (Gerald R. Visgilio & Diana M. Whitelaw eds., 2007).

137. *Id.* at 243.

communities purchase as much electricity as wealthy communities, so they conceded that costs for poor communities are likely overstated.[138] A more recent economics article focusing on Massachusetts found that trading between 1990 and 2014 reduced SO_x emissions by 98%, a reduction that was consistent in all counties.[139] This same reduction was found in Bristol County, which has "clear indicators of marginalization in comparison to the rest of Massachusetts (higher unemployment, lower educational attainment, etc.)" and accounted for half of the total sulfur emissions in the state;[140] thus, the trading program disproportionately benefitted this marginalized county. Finally, a pair of articles by non-economists found that the Acid Rain Program did not lead to increased emissions in poor and minority communities.[141]

Because critics differ on whether offsets should be a part of cap-and-trade programs, a study analyzing a dozen emissions offset markets under the Clean Air Act is also worth addressing.[142] The authors compared the socioeconomic status and racial makeup of the communities for facilities that purchase offsets versus those that sell them.[143] They found that these communities had similar demographics and concluded that there is "little evidence that the tradability feature of the offset program has disproportionately moved pollution to lower-

138. *Id.* One study of California found that homes in the bottom quintile used about 50,000 Btus of electricity per day compared to 80,000 Btus for the highest quintile. *See* Chris Bruegge, Tatyana Deryugina & Erica Myers, *The Distributional Effects of Building Energy Codes*, 6 J. ASS'N ENV'T & RES. ECONOMISTS (SPECIAL ISSUE) S95, S112 & tbl.1 (2019).

139. Devon Lynch, Chad J. McGuire & Joy A. Smith, *Assessing the US Sulfur Reduction Programme in Massachusetts from an Environmental Justice Framework: Is There Evidence of Disproportionality?*, 9 J. ENV'T ECON. & POL'Y 97, 98 (2020).

140. *Id.*

141. Jason Corburn, *Emissions Trading and Environmental Justice: Distributive Fairness and the USA's Acid Rain Programme*, 28 ENV'T CONSERVATION 323, 324, 327 (2001) (analyzing emissions data for the first three years of the Acid Rain Program and finding that there was not an uneven distribution of SO_x emissions increases or decreases in predominantly poor or minority communities); Evan J. Ringquist, *Trading Equity for Efficiency in Environmental Protection? Environmental Justice Effects from the SO_2 Allowance Trading Program*, 92 SOC. SCI. Q. 297, 298, 315–17 (2011) (studying emissions from 1995 to 2009 and finding, for both ZIP code and distance from regulated facility, that minorities and the poor were exposed to less SO_2 although less-educated persons were exposed to more).

142. Joseph S. Shapiro & Reed Walker, *Where Is Pollution Moving? Environmental Markets and Environmental Justice*, 111 AEA PAPERS & PROC. 410, 410 (2021).

143. *Id.* at 410–11.

income communities or communities of color over the past [thirty] years."[144]

CONCLUSION: A JUST ENERGY TRANSITION WITH CAP AND TRADE

Economists argue that cap and trade must be a significant part of climate change policy because it reduces GHGs and incentivizes the switch to alternatives like renewables (and does so at least as well as more costly RPS or subsidies).[145] In light of the differing views on the relationship of cap and trade to hot spots, this Article surveyed economic studies to show that these programs do not lead to hot spots and may even be more effective than traditional regulation at reducing pollution in poor and minority communities. This survey therefore supports the continued use, and even the expansion, of cap-and-trade programs, and it suggests that encumbering them with incompatible complementary policies and restrictions on trade and offsets is unnecessary. This is not to advocate for the elimination of all constraints, because some checks can guard against hot spots while having a limited impact on efficiency, such as setting a stringent cap and dedicating a portion of auction revenues to co-pollutant abatement measures. Nor does this Article purport to be the last word on the interrelationship of cap and trade and hot spots: regulators and economists should continue to engage in *ex ante* and *ex post* distributive analyses.[146] This Article does, however, bolster one economist's claim that carbon pricing policies like cap and trade can

144. *Id.* at 411.

145. *See, e.g.*, Aldy, *supra* note 16, at 979 ("Pollution markets can serve as a key element of implementing a durable, long-term U.S. climate policy."); Stavins, *supra* note 6 ("There is widespread agreement among most economists that economy-wide carbon pricing will be a necessary (although not sufficient) component of any effective policy that can achieve meaningful and cost-effective CO_2 reductions in large and complex economies.").

146. Farber, *supra* note 10, at 30 ("Detailed quantitative modeling of particular industries and regulatory schemes should be undertaken to search for potential inequitable changes in the geographic distribution of pollutants."); Don Fullerton, *Six Distributional Effects of Environmental Policy*, 31 RISK ANALYSIS 923, 929 (2011) (noting that it "may require multiple analyses to characterize all the distributional effects of one [climate] policy").

help "advance the transition to a clean energy economy in a manner that is both effective and equitable."[147]

147. Boyce, *supra* note 71, at 254.