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EMISSIONS TRADING VERSUS POLLUTION TAXES: PLAYING "NICE" WITH OTHER INSTRUMENTS

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INTRODUCTION

In 2013, Dutch electricity producers and environmentalists reached an agreement to phase-out the Netherlands' 1980s vintage coal-fired power plants by 2017.[1] Coal-fired power plants around the world emit more carbon dioxide than any other pollution source.[2] And carbon dioxide constitutes the most important greenhouse gas unleashing global climate disruption, which threatens the planet with higher average temperatures causing sea level rise, inundation of populous coastal areas, drought, more violent weather events, and widespread ecosystem destruction.[3] Because of the importance of fossil fuel use generally and coal-fired power in particular to global climate disruption, climate experts recommend replacing coal-fired power with clean energy as quickly as possible.[4] But governments have considered wholesale replacement of coal-fired power impossible, at least in the near term. So, no country has phased out coal-fired power to address global climate disruption.[5]

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[1] Social and Economic Council, *Energy Agreement for Sustainable Growth* 10 (2013), http://www.ser.nl/~/media/files/internet/talen/engels/2013/energy-agreement-sustainable-growth-summary.ashx (agreeing to shut down three coal-fired power plants in 2016 and the two remaining ones in 2017); *see* Eric Kloosterhuis & Machiel Mulder, *Competition Law and Environmental Protection: The Dutch Agreement on Coal-Fired Power Plants,* 11 J. COMP. L. & ECON. 855, 858 (2015) (noting that the council creating this agreement included environmental NGOs and energy firms); Chris Fonteijn & Jarig van Sinderen, *Economic Analysis as a Tool to Improve Decision-Making*, 11 COMPETITION L. INT'L 61, 66 (2015) (noting that in this agreement "Dutch electricity producers" agreed to "close down a number of coal-fired power plants").

[2] *See* Greenpeace, *Why We Must Quit Coal*, http://www.greenpeace.org/international/en/campaigns/climate-change/coal/ (last visited Dec. 7, 2016).

[3] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY 13 (2016) (listing these and other impacts); IPCC, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE 6 (2014) (finding that CO_2 accounts for 78% of global greenhouse gas emissions). The term "global climate disruption" more meaningfully characterizes the problem described in these scientific reports than the conventional terms "global warming" or "climate change." *See* DAVID M. DRIESEN, ROBERT W. ADLER, & KIRSTEN H. ENGEL, ENVIRONMENTAL LAW: A CONCEPTUAL AND PRAGMATIC APPROACH 25 (2016) (employing this term because it flags warming's capacity to profoundly disrupt ecosystems and human experience on earth).

[4] *See* ECOFYS, *The Incompatibility of High-Efficient Coal Technology with 2° C Scenarios* (2016), http://www.ecofys.com/files/files/ecofys-2016-incompatibility-of-hele-coal-w-2c-scenarios.pdf (stating that the IPCC has called for decarbonizing the electricity sector and finding coal use incompatible with keeping temperature increase below 2°C).

[5] *Cf.* N. Dakota v. Heydinger, 825 F.3d 912, 915–16 (8th Cir. 2016) (noting that a Minnesota statute prohibits meeting Minnesota demand with electricity from new coal-fired power plants); Climate Action Network, *Government Policies on the Phasing out of Coal*, 2 (November, 2015), http://www.caneurope.org/docman/coal-phase-out/2811-coal-briefing-3-phase-out-of-coal/file (explaining that Great Britain has announced a plan to phase out coal-fired power by 2025); Derek Leahy, *Ontario's Electricity is Officially Coal-Free,* DESMOG CANADA (April 19, 2014), https://www.desmog.ca/2014/04/17/ontario-s-electricity-officially-coal-free (showing that the Canadian province of Ontario has phased out coal-fired power).

The Dutch phase-out agreement offered the potential to establish a model with important implications for governments around the world.[6] Because the Netherlands is an advanced industrial society with substantial greenhouse gas emissions, the successful implementation of this agreement might constitute an important step toward demonstrating the plausibility of phasing out coal entirely.[7] In order to implement this agreement, the Netherlands would have to confront the challenge of powering a modern industrial economy with cleaner energy, including how to develop more renewable energy and integrate that intermittent energy into an electricity grid.[8] Doing this successfully would likely create demand for more advanced technologies, lower their costs, and show how all of this could be done. If successful, other countries might well follow suit, creating a new sense of what level of ambition is possible for climate policy. This enhancement of ambition matters, because, in spite of significant progress at the recent Paris Conference on global climate policy, fulfillment of existing national pledges of greenhouse gas emission reductions will not suffice to prevent dangerous climate disruption.[9]

The Dutch government's competition authority, however, derailed this agreement between electric utilities and environmental groups, because of how it would interact with the European Union's Emissions Trading Scheme (EU ETS), the first multinational emissions trading program aimed at reducing greenhouse gas emissions.[10] Absent an emissions trading program, phasing out the most important source of greenhouse gas emissions in a major industrial country would, if nothing else, directly add emission reductions to the global effort to avoid dangerous climate disruption. Reductions matter a lot to the low-lying Netherlands, which faces an existential threat from rising seas.[11] But under a trading program, phasing out coal-

[6] *See* Letter from Jan Boersema et al., *Closing Coal-fired Power Plants an Important Signal for Climate Change Conference Paris* (2016), http://www.fern.org/sites/fern.org/files/Letter_Coal%20plants_Rotmans%20etal_EN.PDF.

[7] *Cf.* Kloosterhuis & Mulder, *supra* note 1, at 859 (noting that coal-fired power provides about 10% of Dutch generating capacity).

[8] *See id.* at 858 (noting that the deal closing down coal-fired power plants also calls for subsidies for offshore wind parks); Eduardo Porter, *Embrace of Renewables Has Hidden Costs,* N.Y. TIMES, JULY 20, 2016, at B1 (discussing the difficulties renewables face in meeting fluctuating demand for energy in real time).

[9] *See* Andrew Jones et al., *Deeper, Earlier Cuts Needed to Meet Paris Goals* 1 (April 16, 2016), https://www.climateinteractive.org/wp-content/uploads/2015/12/Stronger-Pledges-April-2016.pdf (pointing out that full implementation of Paris pledges would lead to warming of 3.5°C by 2100 and that the Paris agreement provides a mechanism for countries to submit strengthened pledges of greenhouse gas emission reductions to address this shortfall).

[10] *See Analysis by the Netherlands Authority for Consumers and Markets of the Planned Agreement on Closing Down Coal Power Plants from the 1980s as Part of the Social and Economic Council of the Netherlands' SER Energieakkoord,* 4, 7 (September 26, 2013) https://www.acm.nl/en/publications/publication/12082/ACM-analysis-of-closing-down-5-coal-power-plants-as-part-of-SER-Energieakkoord/ [*ACM Analysis*] (indicating that the agreement violates competition law because it does not deliver net benefits to consumers, since it provides no net carbon dioxide reductions).

[11] *See* Vanessa McKinney, *Sea Level Rise and the Future of the Netherlands* (2007), http://www1.american.edu/ted/ice/dutch-sea.htm (pointing out that climate disruption could impact the Netherlands "drastically" because half of the country lies less than a meter above sea level).

fired power in the Netherlands might *not* reduce net greenhouse gas emissions.[12] Instead, the pollution reductions could generate credits for greenhouse gas emission reductions, which Dutch utilities could sell to other polluters in Europe.[13] These other polluters would then use these credits to justify not lowering their own emissions, as they would otherwise have to do (absent a credit purchase) to meet their obligations under the EU ETS.[14] Thus, the phase-out of coal-fired power in the Netherlands might simply redistribute the reductions already required by the ETS. Furthermore, this coal phase-out would likely raise the cost of reducing greenhouse gas emissions in the Netherlands, as Dutch utilities (and ultimately Dutch citizens) would likely bear the cost of this ambitious transformation.[15]

Traditionally, scholars debating the relative merits of emissions trading and pollution taxes as instruments of environmental policy have not considered these market mechanisms' interactions with other policies, like the Dutch phase-out proposal. Instead they have considered these market-based environmental protection instruments in isolation.[16] But governments almost never rely on taxes or trading exclusively to address significant environmental problems.[17] Instead, these instruments almost always operate in conjunction with other policies.[18]

The existence of multiple policies raises the question of which of these two market-based instruments works best with other environmental policy instruments. This article focuses on this question. It compares trading's interaction with supplementary policies to tax's interaction with supplementary policies primarily in the context of global climate disruption. But in the end it considers the question of whether the lessons drawn from the climate context apply to other contexts.

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[12] *See ACM Analysis, supra* note 10, at 4 (explaining that under the EU ETS closing the plants will encourage increased emissions elsewhere, which cancel out the carbon dioxide reductions from the closures).

[13] *Cf. ECOFYS, The Waterbed Effect and the EU ETS: An Explanation Using the Potential Phase Out of Dutch Coal Fired Power Plants as Example* (February 22, 2016), http://www.ecofys.com/en/news/the-waterbed-effect-and-the-eu-ets-an-explanation-using-the-potential-phase/ (recognizing this "waterbed effect" but claiming that the market stability reserve dampens the effect).

[14] *See* Kloosterhuis & Mulder, *supra* note 1, at 870 (pointing out that because electricity producers can sell the permits they do not need after shutdown, the closure has "no net effect" on CO_2 emissions).

[15] Id. at 868 (projecting an increase in electricity prices stemming from the plant closures); *ACM Analysis*, *supra* note 10, at 5.

[16] *See* Lori Snyder Bennear & Robert N. Stavins, *The Second-Best Theory and the Use of Multiple Policy Instruments,* 37 ENVT. RES. ECON. 111, 125 (2007) (noting that economic research has focused on individual instruments "with few exceptions"); Paul Twomey, *Rationales for Additional Climate Policy Instruments Under a Carbon Price,* 23 ECON. & LAB. REL. REV. 7, 12 (2016) (stating that the environmental economic literature has focused on single instruments or comparisons between two instruments); *cf.* Ann E. Carlson, *Designing Cost Effective Climate Policy: Cap-and-Trade and Complementary Policies,* 49 HARV. J. LEG. & POL'Y 207, 210 (2012) (explaining that complementary policies may interfere with the market forces relied upon for cap-and-trade).

[17] *See* Benjamin Görlach, *Emissions Trading in the Climate Policy Mix—Understanding and Managing Interactions with Other Policy Instruments,* 25 ENERGY & ENV'T 733, 737 (2014) (noting that "any country" pursuing climate policy relies on a mix of instruments).

[18] Bennear & Stavins, *supra* note 16, at 112 (noting that the use of multiple instruments to address an environmental problem is common in the policy world).

Consideration of the ability to "play nice" with other instruments as a factor in the debate about whether taxes or emissions trading is preferable constitutes a new contribution to the instrument choice literature. But recently a small literature has appeared discussing the desirability of supplementing market-based mechanisms with other programs or simply describing how interactions between market-based mechanisms and other programs work.[19] This article will draw on this literature to address the questions of which instrument plays most nicely with other instruments and of what role playing nice should play in the taxing/trading debate.

This article's first part provides basic background, explaining how pollution taxes and emissions trading work and what the literature has to say about their comparative value. It discusses standard arguments about the relative efficiency and simplicity of the two approaches and shows that these arguments have limited value. It also discusses an approach to evaluating instruments addressing global climate disruption based on their capacity to induce developing country participation, finding that this "participation efficiency" approach yields uncertain guidance even in this important but limited context. It closes by demonstrating the prevalence of multiple policies addressing global climate disruption and other environmental problems and discusses some of the values motivating reliance on supplemental programs even when a trading program or a pollution tax applies to the same pollution.

The second part explains why programs supplementing pollution taxes add environmental benefits while lowering tax bills. Because of these attributes, pollution taxes may encourage adoption of successful supplemental programs. By contrast, trading tends to lower the environmental benefits of supplemental programs while raising cost.[20] This loss of environmental benefits may discourage enactment of supplemental programs, as it did in the Dutch case, or even spark opposition to existing policies.[21] When a government perseveres and enacts or continues a policy supplementing trading, it may not deliver substantial environmental benefits. Thus, taxes work better with other instruments than trading.

The third part examines the question of whether a pollution tax's propensity to play more nicely with other instruments than emissions trading should count as a substantial argument for pollution taxes. Many economists and other policy experts

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[19] *See, e.g.,* Christoph Bertram*, et al., Complementing Carbon Prices with Technology Policies to Keep Climate Targets Within Reach,* 5 NATURE CLIMATE CHANGE 235 (Mar. 2015); Louis-Gaetan Giraudet, Celine Guivarch & Philippe Quirion, *Comparing and Combining Energy Saving Policies: Will Proposed Residential Sector Policies Meet French Official Targets*?, 32.SI1 THE ENERGY J. 213, 214 (2011) (characterizing policy combination as "poorly investigated in the economics literature" before evaluating a French package of policies aiming to enhance energy efficiency); Twomey, *supra* note 16; Adam Whitmore, *Puncturing the Waterbed Myth: The Value of Additional Actions in Cutting ETS Greenhouse Gas Emissions* (October, 2016), https://sandbag.org.uk/reports/puncturing-waterbed-myth/ (analyzing interactions between the EU ETS and supplemental programs).

[20] *See* Carlson, *supra* note 16, at 210 (pointing out that complimentary policies can increase the cost of pollution control and decrease the flexibility offered by trading).

[21] *See, e.g.,* Neil Perry & Paul Twomey, *Carbon Markets: Inherent Limitations and Complementary Policies,* 23 ECON. & LAB. REL. REV. 1, 2 (2016) (describing criticism of Australia's renewable energy target as interfering with a carbon pricing policy as an attack on "the most successful national policy to reduce carbon emissions").

who attach great value to economic efficiency might argue that trading's tendency to discourage additional policies would constitute an advantage. Since pollution taxes and trading are cost effective, many economists argue against supplementing them with less cost effective policies.[22] This section, however, explains that additional policies may have value in addressing risk/risk problems, correcting market failures that persist under taxing or trading, reaching pollution or sources that neither trading nor taxes can effectively address because of monitoring difficulties, making up for inadequacies in the design of market-based instruments, catalyzing innovation, and fostering government learning and experimentation to foster progressive policy evolution over time. It argues that these factors, especially additional programs' value in fostering policy evolution over time, matter a lot in the context most often considered these days, that of international efforts to address global climate disruption. At the same time, it acknowledges that for some narrow problems, complete reliance on market mechanisms has merit. Furthermore, whether or not governments should enact additional measures, they almost always do. Hence, the ability to play nice with other instruments matters in practice, regardless of whether it should matter in theory.

I. Emissions Trading, Taxation, and the Continuing Role of Other Policies.

This part provides basic background. It explains emissions trading, which has served as focal point of efforts to address global climate disruption in many countries, and an instrument preferred by many analysts—a pollution tax.[23] This explanation also builds some theoretical understanding of economic efficiency concepts, which play a role in the subsequent analysis. It then reviews the literature about the choice between these instruments, emphasizing that most of this literature treats this choice as one made in isolation. This part closes with some explanation of why policymakers do not use one of these market-based instruments in isolation to address climate disruption, but instead employ a variety of approaches simultaneously.

[22] Jesse D. Jenkins, *Political Economy Constraints on Carbon Pricing Policies: What are the Implications for Economic Efficiency, Environmental Efficacy, and Climate Policy Design?,* 69 ENERGY POL'Y 467, 468 (2014) (noting that most economists favor carbon pricing and generally argue against "a mix of overlapping policy instruments").

[23] Elaine Fahey, *The EU Emissions Trading Scheme and the Court of Justice: The "High Politics" of Indirectly Promoting Global Standards,* 13 GERMAN L. J. 1247, 1247 (2012) (describing the EU emissions trading scheme as "a cornerstone" of the EU's effort to mitigate climate disruption); Jonathan Baert Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L. J. 677, 682-83 (1999) ("The standard analysis crowns taxes as the presumptive first choice for optimal environmental regulation.").

A. Emissions Trading.

Emissions trading cleverly solves an economic efficiency problem with a traditional performance standard.[24] Regulators may employ uniform performance standards for an entire industry, applying the same pollution reduction requirement to each plant in an industry. Uniform performance standards, however, do not imply uniform costs.[25] Implementation of the same pollution reduction requirement throughout an industry may generate very high costs at some facilities and very low costs at others, because plants have different equipment and configurations. This implies that uniform performance standards regulate inefficiently.[26]

For example, imagine an industry with just two facilities in it. (This is an unrealistic assumption, but it facilitates explanation). The regulator requires 100 tons of reductions from each facility. But these reductions cost $20 a ton to generate at one facility (call it Cheap) and $50 a ton to generate at the other facility (call it Expensive). A uniform standard would impose a cost of $7,000 for 200 tons of total reduction: (100 X $20) + (100 X $50). Suppose, however, that instead Cheap made all 200 tons of the required net reductions. This would reduce the cost of realizing the 200-ton total reduction to just $4,000 (200 X $20). In other words, a rearrangement of pollution reduction obligations could meet the same environmental goal at lower cost. Regulators, however, usually lack detailed marginal control cost information for each facility, so that government tailoring of regulation to realize least cost abatement would prove very difficult or impossible.[27]

Emissions trading works around this informational problem by using a market in emission allowances to realize cost effective pollution abatement.[28] The regulator establishes a pollution limit, just as she would in establishing a traditional regulation, but she authorizes polluters to trade their obligations among themselves. If the regulator applied the same 100 ton limit to each of the two facilities discussed above through a trading program, Expensive's owner would likely pay Cheap's owner to overcomply. Cheap makes 200 tons of reduction, 100 tons to satisfy its reduction obligation and another 100 tons to sell to Expensive's owner. Expensive's owner does not reduce Expensive's emissions, but instead complies with the purchased credits

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[24] *See* David M. Driesen, *Traditional Regulation's Role in Greenhouse Gas Abatement, in* ENCYCLOPEDIA OF ENVIRONMENTAL LAW, I CLIMATE CHANGE LAW 415, 416-17 [hereinafter CLIMATE CHANGE LAW] (Daniel Farber & Marjeen Peters eds. 2016) (defining traditional regulation as including performance standards).

[25] *See* David M. Driesen, *Is Emissions Trading an Economic Incentive Program? Replacing the Command and Control/Economic Incentive Dichotomy,* 55 WASH. & LEE L. REV. 289, 307 (1998) (pointing out that uniform standards do not generate uniform costs because abatement costs more at some facilities than at others).

[26] *See* Wiener, supra note 23, at 716 (pointing out that performance standards impose substantially higher costs than market-based instruments).

[27] *See* Robert W. Hahn & Robert N. Stavins, *Incentive-Based Regulation: A New Era for an Old Idea?,* 18 ECOLOGY L. Q. 1, 6 (1991) (explaining that government does not have detailed control cost information for each facility and could only secure such information "at great cost, if at all").

[28] *See* Görlach, *supra* note 17, at 734 (if the market works properly, emissions trading will realize a policy target "in a cost minimizing way").

reflecting the extra reductions made at Cheap. Thus, a trading program authorizes polluters to trade their pollution control obligations in order to realize cost effective abatement.

EPA began experimenting with trading through the offset programs of the late 1970s and 1980s.[29] These offset programs authorized polluters to forego otherwise required pollution abatement at one source if they purchased or realized extra reductions from another source not subject to a mass-based cap. These programs saved polluters a lot of money, but often did so by facilitating evasion of emission limits.[30] Often polluters could not show that they had made reductions that they claimed credit for.[31] In other cases, they claimed credits for activities that would have reduced pollution anyway from unregulated sources.[32] The happenstance of an emissions reduction somewhere in the economy could allow a regulated polluter to avoid a required reduction, even if a State still needed that required reduction to meet pollution reduction goals. The modern trading literature refers to the vice of relying on emission reductions that would have happened anyway to avoid an otherwise required emission reduction as a problem of "additionality."[33] Adding to the woes that this additionality problem created, these programs applied to volatile organic compounds, which defied reliable measurement.[34]

In 1990, however, Congress created a cap-and-trade program to address acid rain.[35] Most of the sulfur dioxide emissions causing acid rain came from electric power plants. So, Congress capped the sulfur dioxide emissions of these plants, limiting the tons of sulfur dioxide each could emit in a year.[36] But it made these

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[29] I use the term "offset program" in its modern sense—as a program that allows polluters to use credits generated by sources not subject to a mass-based cap. The literature more often refers to the offset programs of the 1970s and 1980s as "bubble" programs (because they treated regulation of multiple sources within a plant as if they were encased by a bubble) and frequently reserved the term "offset" for a subset of the bubble programs during these years. *See* DRIESEN, ADLER, & ENGEL, *supra* note 3, at 272-73 (explaining that the term "offset" originally referred to requirements to offset emissions leftover after the application of new source controls, but now applies to all programs allowing credits from uncapped sources).

[30] *See* RICHARD A. LIROFF, REFORMING AIR POLLUTION REGULATION: THE TOIL AND TROUBLE OF EPA'S BUBBLE, 22, 28-29 (1986).

[31] *See, e.g.,* California Air Resources Board & United States Environmental Protection Agency, *Phase III Rule Effectiveness Study of the Aerospace Coating Industry* (1990) (finding that polluters subject to a bubble in this industry could not demonstrate compliance).

[32] *See, e.g.,* Citizens Against the Refinery's Effects v. EPA, 643 F.2d 783 (4th Cir. 1981) (approving use of credits from a Virginia highway department change in asphalt formulation implemented to lower costs as an offset for emissions from a new petroleum refinery).

[33] *See* Riti Chandiok, *Climate Change Law in California and Massachusetts: Lessons for State Policymakers*, 21 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 249, 258 (2015) (discussing a recent controversy over rules designed to ensure additionality for offset credits).

[34] Richard Toshiyuki Drury et al., *Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy*, 9 DUKE ENVTL. L. & POL'Y F. 231, 281 (1999) (explaining that California dropped volatile organic compounds from a trading program because the monitoring problems were so severe).

[35] *See* Brennan Van Dyke, Note, *Emissions Trading to Reduce Acid Deposition,* 100 YALE L. J. 2707 (1991) (evaluating the legislative design).

[36] *See id.* at 2709-2711 (discussing this tons-per-year cap).

allowances tradable, meaning that owners of electric power plants who overcomplied could sell the extra allowances to polluters who undercomplied.[37] Because of rigorous monitoring requirements (which were technically possible for sulfur dioxide) and because Congress confined all trades to capped sources this program succeeded in delivering significant environmental benefits, and did so at much lower than anticipated cost.[38]

Encouraged by the acid rain program's success, the United States government pushed hard to include trading in the international regime addressing global climate disruption.[39] As a result, the Kyoto Protocol to the Framework Convention on Global Climate Change (Kyoto Protocol)—the first international agreement to reduce greenhouse gas emissions—authorizes broad international environmental benefit trading.[40]

Although most observers refer to trading programs addressing climate disruption as "cap-and-trade" programs, these programs conform to a hybrid model combining some of the features of the successful acid rain cap-and-trade program with features of the failed offset programs.[41] These hybrid programs apply a mass-based cap to the emissions of targeted sources (as the acid rain program had), but authorize the capped sources to trade outside the cap, i.e. to purchase offset credits from uncapped sources to satisfy some or all of their obligations (like the failed offset programs).[42]

The trading programs enacted under the Kyoto Protocol have not always performed well, but governments have improved them over time. The EU pioneered trading under the Kyoto Protocol with its ETS. The EU ETS produced few emission reductions, mostly because member states established insufficiently stringent caps

[37] *See id.* at 2708 (explaining that the acid rain program authorizes polluters to trade emission allowances among themselves).

[38] *See* U.S. Envtl. Prot. Agency, *Cap and Trade: Acid Rain Program Results,* https://grist.files.wordpress.com/2009/06/ctresults.pdf (last visited Dec. 7, 2016).

[39] David M. Driesen, *Sustainable Development and Market Liberalism's Shotgun Wedding: Emissions Trading Under the Kyoto Protocol,* 83 INDIANA L. J. 21, 33-34 (2008) (pointing out that the US lobbied for "liberal international emissions trading" in the Kyoto Protocol).

[40] *See id.* at 35 (pointing out that the Kyoto Protocol establishes three trading mechanisms). I use the term "environmental benefit trading" here rather than the more conventional term "emissions trading", because the Kyoto Protocol contemplates allowing credits from projects that sequester carbon rather than reduce emissions. *See* David M. Driesen, *Free Lunch or Cheap Fix?: The Idea and the Climate Change Convention,* 26 BOST. COLL. ENVTL. AFF. L. REV. 1, 32-33 (1998) (pointing out that by allowing credits for protecting or enhancing carbon sinks the Kyoto Protocol goes beyond the concept of emissions trading to create "environmental benefit trading").

[41] DRIESEN, ADLER, & ENGEL, *supra* note 29, at 282 (explaining the hybrid concept); Alan Ramo, *The California Offset Game: Who Wins and Who Loses?*, 20 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 109, 119 (2014) (characterizing California's trading program as a "hybrid approach" because it combines caps with offsets).

[42] *See* Tyler McNish*, Carbon Offsets Are a Bridge Too Far in the Tradable Property Rights Revolution,* 36 HARV. ENVTL. L. REV. 387, 388 (2012) (noting that "all extant GHG cap-and-trade systems" allow use of offset credits).

for their sources.[43] The offset credits used in the program also exhibited the same sorts of additionality problems that had plagued the early offset programs in the United States.[44] The EU, however, has tightened the cap recently and made other improvements that create some hope of success in the future.[45]

The first climate trading program in the United States, the Regional Greenhouse Gas Initiative (RGGI) (an initiative of northeastern States) also suffered from an inadequate cap, which the regulating authority has recently revised.[46] In spite of this problem, the regulated electric utilities significantly reduced emissions, partly because cleaner natural gas became cheaper than dirty coal during RGGI's first phase and RGGI States used allowance revenue (realized by auctioning pollution

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[43] NATIONAL ALLOCATION PLANS IN THE EU EMISSIONS TRADING SCHEME: LESSONS AND IMPLICATIONS FOR PHASE II (Michael Grubb, Regina Betz, & Karsten Neuhoff, eds. 2007) (analyzing overallocation of allowances in Phase I of the EU ETS and presenting some preliminary analysis of phase II allocation); SABINA MANEA, THE INSTRUMENTALIZATION OF PROPERTY: LEGAL INTERESTS IN THE EU EMISSIONS TRADING SCHEME 4 (2014) (discussing how overallocation of allowances threatened the "environmental credentials of the EU ETS"); David B. Hunter & Nuno Lacasta, *Lessons Learned from the European Union's Climate Policy,* 27 WIS. INT'L L.J. 575, 583, 585-89 (2009) (discussing clear overallocation in the EU ETS' first phase and ambiguity regarding its achievements in the second phase); Sonja Klinsky, Michael Mehling & Andreas Tuerk, *Beyond Déjà Vu: Opportunities for Policy Learning from Emissions Trading in Developed Countries*, 6 CARBON & CLIMATE L. REV. 291, 296 (2012) (describing the first two phases of the EU emissions trading scheme as generating an "excessive supply of allowances"); *cf.* European Commission, *The EU ETS is Delivering Emission Cuts* (2014), https://ec.europa.eu/clima/sites/clima/files/docs/factsheet_ets_emissions_en.pdf (claiming an 8% cut by 2010 from 2005 levels); *but see* Will Denayer, *Why the Market Approach Fails to Lower Greenhouse Gas Emissions. Part 2: the Failure of the EU Emissions Trading System,* ECOLOGY AND GROWTH, ECON. POL'Y, EUROPE, May 12, 2016, http://www.flassbeck-economics.com/why-the-market-approach-fails-to-lower-greenhouse-gas-emissions-part-2-the-failure-of-the-eu-emissions-trading-system (arguing that the reduction reported by the EU Commission stems from the financial crisis, not the cap, because of overallocation).

[44] Sam Headon, *Offsets in the International Emissions Market: Do Buyers Get What They Pay For*?, 4 CARBON & CLIMATE L. REV. 406, 415 (2008) (discussing problems with the carbon offset market); Lambert Schneider, Inst. For Applied Ecology, *Is the CDM Fulfilling its Environmental and Sustainable Development Objectives? An Evaluation of the CDM and Options for Improvement* 14 (2007), http://www.oeko.de/oekodoc/622/2007-162-en.pdf (same); Michael Wara, *Is the Global Carbon Market Working*?, 445 NATURE 595 (2007) (same).

[45] *See* Directive 2003/87/EC of the European Parliament and of the Council, Consolidated Version of 13 October 2003 Establishing a Scheme for Greenhouse Gas Emission Allowance Trading Within the Community and Amending Council Directive 96/61/EC, 2003 O.J. (L 275) 32, amended by Directive 2004/101/EC, 2004 O.J. (L 338) 18 (Nov. 13, 2004); Directive 2008/101/EC, 208 O.J. (L 8) 3 (Jan. 13, 2009); Regulation (EC) No 219/2009, 2009 O.J. (L 87) 109 (Mar. 31, 2009); Directive 2009/29/EC, 2009 O.J. (L 140) 63 (Jun. 5, 2009), Art. 10a(7), http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2003L0087:20090625:EN:PDF; *cf.* Claudia Kettner, *The EU Emissions Trading Scheme: First Evidence on Phase 3, in* CARBON PRICING: DESIGN, EXPERIENCE, AND ISSUES 63, 69-72 (Larry Kreiser et al., eds. 2015) (suggesting that notwithstanding recent adjustments, allowance surpluses continue to hamper the ETS).

[46] *See* Lesley K. McAllister*, The Overallocation Problem in Cap-and-Trade: Moving Toward Stringency,* 34 COLUM. J. ENVTL. L. 395, 443 (2009) (discussing overallocation under RGGI).

allowances) to fund energy efficiency and renewable energy (both of which reduce emissions).[47]

California has recently enacted a trading program for greenhouse gas emissions. Critics have pointed out that it allows a lot of offsets, which might interfere with the program's success, and that the cap may be inadequate.[48] But this program's implementation has just begun and we cannot yet fully assess its results.[49]

Trading programs addressing greenhouse gas emissions have spread across the globe.[50] In the last few years, China—the world's largest emitter of greenhouse gases— completed pilot trading programs in seven cities and provinces.[51] All of these programs use the hybrid trading model, thereby potentially authorizing credits from a wide variety of unregulated pollution sources to substitute for compliance by the targeted sources (mostly large industrial facilities, including power plants).[52]

Thus, emissions trading provides for cost effective abatement. It has a mixed track record suggesting that environmental performance depends heavily on design variables— primarily the stringency of the cap, the role of offsets, and the strictness of monitoring requirements.[53]

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[47] Chris Hastings, *Implementing A Carbon Tax in Florida Under the Clean Power Plan: Policy Considerations*?, 42 FLA. ST. U. L. REV. 1035, 1046 (2015) (noting that emissions from the power sector regulated by RGGI "fell by more than 40 percent"); Silvio Marcacci, *Latest RGGI Auction: Time To Reconsider "Success" In Carbon Markets?*, CLEANTECHNICA (Sept. 15, 2013), http:// cleantechnica.com/2013/09/15/latest-rggi-auction-time-to-reconsider-success-in-carbon-markets/,archived at http://perma.cc/8NYK-V2KU (noting that fracking and economic recession drove declining emissions in the RGGI states, not the cap, but explaining that allowance revenue purchased carbon reductions through investments in renewables and energy efficiency); Susan Vermillion, *Lessons from China's Carbon Markets for U.S. Climate Change Policy*, 39 WM. & MARY ENVTL. L. & POL'Y REV. 457, 476 (2015) (noting that the RGGI states have "agreed to cut the program's cap by 45% starting in 2014, and by another 2.5% every year after that until 2020").

[48] *See* Ramo, *supra* note 41, at 142 (noting that a trial court found that California's rules allow offsets in lieu of 85% of the planned reductions and that these reductions have a very good chance of being non-additional).

[49] *Cf.* David Gamage & Darien Shanke, *Using Taxes to Improve Cap and Trade, Part II: Efficient Pricing,* 81 STATE TAX NOTES 807, 808-09 (2016) (suggesting that the California Air Resources Board may believe that it has overallocated allowances so that trading is not driving reductions).

[50] *See* Raphael Calel & Antoine Deschezplepêtre, *Environmental Policy and Directed Technological Change: Evidence from the European Carbon Market,* 98 REV. ECON. & STAT. 173, 173 (2016) (noting that that Australia, Quebec, and New Zealand have launched trading programs and that Japan, South Korea, Brazil, Mexico, and Chile have made "moves toward launching their own").

[51] *See* Qin Tianbao & Zhang Meng*, Emissions Trading in China, in* CLIMATE CHANGE LAW, supra note 24, 400, 402.

[52] *See* Hao Zhang & Christopher Arup*, Beyond the CDM: Regulating China's Domestic Offset Scheme,* 45 ENVTL. L. REP. (Envt. L. Inst.) 10049 (2015).

[53] Daniel H Cole & Peter Z. Grossman, *When Is Command-and-Control Efficient? Institutions, Technology, and the Comparative Efficiency of Alternative Regulatory Regimes for Environmental Protection*, 1999 WISC. L. REV. 887 (discussing the importance of monitoring and enforcement to successful trading programs and the lack of monitoring capability prior to 1990); David M. Driesen, *Trading and Its Limits,* 14 PENN STATE ENVTL. L. REV. 169, 170 (2006) (discussing the mixed track record's correspondence with monitoring capabilities); Driesen, *supra* note 25, at 311-19 (discussing emissions trading's track record).

B. Pollution Taxes.

A pollution tax, like emissions trading, facilitates cost effective abatement.[54] To see this, imagine that a regulator imposes a $100 a ton tax on a pollutant. Those facility owners who can make pollution reductions costing less than $100 a ton will likely reduce pollution in lieu of paying the entire tax. Those facility owners facing abatement costs exceeding $100 at ton will likely choose to pay the tax rather than reduce pollution. Hence, a pollution tax encourages cost effective abatement by only encouraging abatement that costs less than the tax rate.

The standard theory recounted here about the efficiency of pollution taxes and emissions trading depends heavily on a narrow understanding of efficiency.[55] The standard theory focuses on the *cost effectiveness* of reducing a single pollutant, *i.e*. the least cost method for achieving any specified pollution reduction goal.[56] The climate regime, however, shows that one can stretch this efficiency definition a little bit without undermining market-based mechanisms' claim to efficiency. The climate regime addresses the principal "greenhouse gases" causing global climate disruption collectively. Accordingly, the trading programs authorize interpollutant trading based on the relative global warming potential of greenhouse gases.[57] So, the efficiency claim for market mechanisms in the climate context requires a minor adjustment. Market mechanisms cost effectively reduce greenhouse gases as a group. This efficiency claim focuses on the means of environmental protection, not its ends.

Market mechanisms achieving cost effective abatement, however, often fail to achieve economic efficiency defined more broadly as *allocative* efficiency.[58] Economists define measures that balance costs and benefits at the margin as allocatively efficient.[59] Allocative efficiency therefore measures the economic optimality of a goal, not the cost effectiveness of a chosen means of meeting a goal.[60] Market mechanisms only prove allocatively efficient under very restrictive conditions and other mechanisms also prove allocatively efficient if they meet those conditions. Thus, an emissions trading program will prove allocatively efficient if the cap

[54] *See* David M. Driesen, *Putting a Price on Carbon: The Metaphor,* 44 ENVTL. L. 695, 700 (2014) (explaining why a tax cost effectively lowers emissions).

[55] Görlach, *supra* note 17, at 735 (describing the idea of trading maximizing efficiency as "based on a rather narrow notion of optimality").

[56] *See* Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333, 1351-1355 (1985) (advocating emissions trading as a reform allowing politically chosen goals to be met at least cost, whilst rejecting formal cost-benefit analysis as the basis for goal setting).

[57] *See* Clive L. Spash & Alex Y. Lo, *Australia's Carbon Tax: A Sheep in Wolf's Clothing,* 23 ECON. & LAB. REL. REV. 67, 69 (2016) (explaining that the "regulatory approach" to climate disruption "convert[s] all [greenhouse gases] to CO_2-equivalent emissions").

[58] *See* Bennear & Stavins, *supra* note 16, at 112 (distinguishing between cost effectiveness and efficiency defined as "a level of pollution control that maximizes net benefits").

[59] *See* WILLIAM J. BAUMOL & WALLACE E. OATES, THE THEORY OF ENVIRONMENTAL POLICY 23 (1975) (noting that a pollution tax fixes a misallocation of resources when the tax rate equals the social cost of pollution).

[60] *See* David M. Driesen, *The Societal Cost of Environmental Regulation: Beyond Administrative Cost-Benefit Analysis,* 24 ECOLOGY L. Q. 545, 564 (1997) (pointing out that allocative efficiency is "goal-determinative" and that achieving it does not necessarily imply cost effectiveness).

underlying the program equalizes costs and benefits at the margin.[61] But a traditional regulation equalizing costs and benefits at the margin will likewise prove allocatively efficient.[62] And a carbon tax set to equal the social cost of carbon—the dollar value of the harms the carbon causes—will provide for optimal carbon reductions, as only polluters with control options costing less than the social cost of carbon will choose to reduce emissions.[63] But if the carbon tax is set at a lower or higher rate than this, it will not prove allocatively efficient. Similarly, a cap not set to equalize costs and benefits at the margins does not lead to allocatively efficient reductions. Market mechanisms not aiming for optimal reductions will still, however, cost effectively reduce emissions.

Furthermore, economic theory associates allocative efficiency with a balance of *total* costs and benefits.[64] Many changes that abate greenhouse gas emissions reduce or increase other types of pollution and trigger additional safety, environmental, or health problems or benefits. So, for example, most measures reducing emissions of emissions of carbon dioxide—the principal greenhouse gas—also reduce urban smog.[65] This implies that an emissions trade where a polluter foregoes carbon dioxide reductions and purchases credits reflecting additional reductions of some other greenhouse gases foregoes potentially important local air quality benefits. In China, for example, where urban air pollution causes more than a million deaths per year, such a trade may carry substantial environmental costs.[66] Conversely, if a trading program authorized credits for nuclear power, credits realized through construction of nuclear power plants might create a risk of nuclear accidents that could be avoided by choosing other means of reducing greenhouse gas emissions. For that reason, the EU ETS disallows credits for nuclear power generation, even though nuclear power reduces direct greenhouse gas emissions to zero.[67] A claim about the allocative efficiency of market-based mechanisms' carbon reductions does not necessarily imply that those mechanisms are allocatively efficient in terms of total benefits and costs.

The law and economics literature generally seeks to match a single measure to a single environmental problem and seeks to maximize efficiency for that narrow

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[61] *See* Brian Galle, *Carrots, Sticks, and Salience,* 67 TAX L. REV. 53, 59 (2014).
[62] *See id.* (applying this definition to all quantity restrictions).
[63] *See id.*; R. Denniss, M. Grudnoff, & A Macintosh, *Complementary Climate Policies: A Framework for Evaluation,* 23 ECON. & LAB. RELAT. 33, 37 (2016) (stating that a "carbon price should reflect the full cost of the harm done to others"). The term "carbon tax" refers to a tax on greenhouse gases based on CO_2 equivalence. *See* Spash & Lo, *supra* note 57, at 70.
[64] *See* Cass R. Sunstein, *The Real World of Cost-Benefit Analysis: Thirty-Six Questions (and Almost As Many Answers)*, 114 COLUM. L. REV. 167, 190 (2014) (pointing out that under Office of Information and Regulatory Affairs (OIRA) guidance CBA is based on "full accounting" including co-benefits of targeted pollutants).
[65] *See* NATIONAL RESEARCH COUNCIL, LIMITING THE MAGNITUDE OF CLIMATE CHANGE 167-168 (2010) (discussing the specifics of these co-benefits).
[66] *See* Edward Wong, *Air Pollution Linked to 1.2 Million Premature Deaths in China,* N.Y. TIMES A9 (April 1, 2013).
[67] *See* MANEA, *supra* note 43, at 41 (pointing out that EU ETS does not allow the use of credits from "projects at nuclear facilities").

problem.[68] But in practice problems often overlap and measures that cost-effectively address one risk may exacerbate or ameliorate another.[69]

The United States has an aversion to taxation, which has prevented accumulation of experience with pollution taxes here. But several advanced countries have used pollution taxes to attack environmental problems.[70] Many carbon taxes have been less effective than they might be, because they exempt carbon intensive industries.[71] Still, carbon taxes, such as the carbon tax in British Columbia, have sometimes proven quite successful.[72]

C. The Conventional Wisdom on Which is Better.

The debate about instrument choice usually assumes a single regulator who rationally chooses a single instrument to comprehensively address one environmental problem.[73] While participants in the instrument choice debate recognize that different instruments might be better for different environmental problems,[74] they typically view the task of instrument choice as one of a single regulator choosing a single tool to address one environmental problem.

In choosing between emissions trading and taxes, economists generally look at the relative efficiency of the two mechanisms.[75] Both are equally efficient under conditions of perfect information.[76] But in practice we always have significant uncertainties about both the costs and benefits of pollution taxes and emissions

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[68] *See* JAN TINBERGEN, ON THE THEORY OF ECONOMIC POLICY (1952); Görlach, *supra* note 17, at 736 (discussing the theory that each policy objective should trigger a separate instrument aimed only at it).

[69] *See generally,* Görlach, *supra* note 17, at 736 (adding that a notion of optimality focused only on cost effectiveness is inadequate).

[70] *See* Reuven S. Avi-Yonah & David M. Uhlmann*, Combating Global Climate Change: Why A Carbon Tax Is a Better Response to Global Warming Than Cap and Trade,* 28 STAN. ENVTL. L. J. 3, 34 (2009) (finding that Quebec, British, Denmark, Finland, Italy, the Netherlands, Norway, and Sweden have implemented carbon taxes); *cf.* Gilbert E. Metcalf & David Weisbach*, The Design of A Carbon Tax,* 33 HARV. ENVTL. L. REV. 499, 508 (2009) (noting that five Scandinavian countries and the United Kingdom employ carbon taxes, but many more employ energy taxes).

[71] *See* David Driesen, *Alternatives to Regulation? Market Mechanisms and the Environment, in* THE OXFORD HANDBOOK OF REGULATION 203, 209 (Robert Baldwin *et al.,* eds. 2010) (noting that exemptions for "high pollution industries" have impaired many taxes' efficacy).

[72] *See, e.g.,* id. (noting the effectiveness of France's tax on water pollution); Hastings, *supra* note 47, at 1036 (explaining that British Columbia's carbon tax has reduced carbon emissions by almost 10% in its first two years).

[73] *See* Wiener, *supra* note 23, at 701-03.

[74] *See* id. at 681-82 (characterizing the idea that no instrument is best for all purposes as a "first principle" of instrument choice).

[75] *See* id. at 703 (noting that the typical analysis aims to achieve Kaldor-Hicks efficiency); Martin L. Weitzman, *Prices v. Quantities,* 41 REV. ECON. STUD. 477, 478-481 (1974) (analyzing the relative merits of price and quantity instruments by reference to their allocative efficiency).

[76] *See* Wiener, *supra* note 23, at 728 (pointing out that under conditions of perfect information a regulator can establish an optimal tax or an optimal cap with equal ease).

trading. These uncertainties lead to differing predictions about the efficiency of trading and taxes.[77]

These predictions flow from the differing roles that governments and private actors play under different mechanisms. A government establishing a pollution tax must establish a tax rate, which determines the maximum cost polluters must pay.[78] A pollution tax, however, does not directly control emissions, leaving the amount of abatement to private choices in response to the cost imposed by the tax and therefore producing uncertainty about the amount of environmental benefits the tax will generate.[79] By contrast, a government creating an emissions trading program establishes a cap that limits emissions.[80] But the price of that abatement remains uncertain, as it depends on private actions to comply with the cap.[81] Although recently the instrument choice literature has treated emissions trading as "putting a price on carbon," the government does not directly establish a carbon price when it creates a trading program.[82] Accordingly, a tax may produce more emissions than the government planned when it establishes a carbon price and trading may produce more costs than the government planned when it limits total emissions.[83]

Thus, a regulator seeking optimal pollution reduction risks failing to achieve that goal either due to greater emissions than anticipated under a tax or greater costs than anticipated under a trading program. The amount of the deviation from optimality depends on the shape of the cost and benefit curves. If costs rise more steeply than benefits, then the risk of cost overruns is greater (in terms of allocative efficiency) than the risk of rising emissions, and the tax instrument will most likely prove optimal.[84] Conversely, if benefits rise more steeply than costs, then the risk of unanticipated pollution increases is greater, and the trading program will most likely prove optimal.[85]

These statements, however, do not speak to the type of efficiency usually discussed with respect to market-based mechanisms, cost effectiveness. Both remain equally cost effective. Rather, these findings speak to the relative allocative efficiency of the mechanisms.

This allocative efficiency finding, while an intriguing bit of economic theory, has little practical utility in choosing between taxes and trading. The theory assumes

[77] *See* id. (noting a divergence between these instruments' efficiency under uncertainty).
[78] *See* id. (explaining that setting a tax rate constrains sources' maximum marginal cost).
[79] *See* id. (stating that pollution taxes yield uncertain pollution levels).
[80] *See* id. (pointing out that trading programs constrain the maximum quantity of emissions).
[81] *See* id. (stating that trading yields uncertain costs).
[82] *See* Driesen, *supra* note 54, at 701 (noting that government does not establish a price on carbon under a trading approach).
[83] *See* Wiener, *supra* note 23, at 728.
[84] *See id*. at 729 (noting that when the cost curve is steeper than the benefits curve the "price rule" is preferred); Weitzman, *supra* note 75, at 485 (noting that a price instrument is indicated "when the benefit function is closer [than the cost function] to being linear").
[85] *See* Wiener, *supra* note 23, at 729 (noting that when the benefits curve is stepper than the cost curve the "quantity rule" is preferred); Weitzman, *supra* note 75, at 485 (stating that a quantity instrument is preferred "if and only if benefits have more curvature than costs"); *cf.* Lawrence Kaplow & Steve Shavell, *On the Superiority of Corrective Taxes to Quantity Regulation,* 4 AM. L. ECON. REV. 1 (2002).

a regulator who wishes to design an allocatively efficient market mechanism—i.e. a tax or cap that generates benefits equal to costs. The finding about the relative efficiency of the two mechanisms rests on an insight about the relative significance of estimation errors in designing these instruments to achieve economists' preferred goal of allocative efficiency.

No regulator, however, has ever established a carbon tax or a cap-and-trade program based on an attempt at achieving optimal pollution control.[86] So, this finding has little, if any, practical significance. Furthermore, perfectly good reasons exist not to attempt to set the cap or tax rate in this way. As a practical matter, analysts usually can quantify only a fraction of the benefits of pollution control decisions (and sometimes none of the benefits of a pollution control decision).[87] Accordingly, establishing an optimal pollution level is not a practical approach to establishing a pollution abatement program.[88] Furthermore, the concept of optimal pollution neglects important equitable and economic considerations, so that it does not offer a compelling basis for policy.[89] This normative point is less controversial than it sounds, as even defenders of cost-benefit analysis often defend it on bases other than an endorsement of allocative efficiency as the product of consumer preferences.[90]

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[86] *See,* David Roberts, *The Political Hurdles Facing a Carbon Tax—and How to Overcome Them* 6 (2016) http://www.vox.com/2016/4/26/11470804/carbon-tax-political-constraints (noting that all carbon taxes, save Sweden's, are below the 50th percentile of estimates of the social cost of carbon, based on very conservative estimates)

[87] *See* David M. Driesen, *Is Cost-Benefit Analysis Neutral?,* 77 U. COLO. L. REV. 335, 341 (2006) (noting that CBA generally includes a long list of non-quantified benefits, often including very significant ones); Amy Sinden, *The Problem of Unquantified Benefits* (2017) (forthcoming) (showing that EPA often could not quantify significant benefits of its rules); *see, e.g.,* Robert Pindyck, *Climate Change Policy: What do the Models Tell Us*?, 51 J. ECON. LIT. 860 (2013) (discussing the severe limits in estimation of benefits from greenhouse gas abatement); Martin L. Weitzman, *On Modeling and Interpreting the Economics of Catastrophic Climate Change,* 91 REV. OF ECON. & STAT. 1 (2009) (suggesting that CBA's inability to quantify the likely cost of catastrophic climate disruption makes it pretty useless); *see generally* Jonathan S. Masur & Eric A. Posner, *Unquantified Benefits and the Problem of Regulation Under Uncertainty*, 102 CORNELL L. REV. 87, 100-01 (2016) (showing that between 2010 and 2013 government agencies fully quantified the costs and benefits of only two rules and could not quantify any benefits in 36 rules).

[88] Spash & Lo, *supra* note 57, at 69 (characterizing calculation of climate disruption's "monetary costs and benefits" as "impossible"); *cf.* Jonathan Masur & Eric A. Posner, *Toward a Pigouvian State,* 164 U. Penn. L. Rev. 93, 138 (2015) (agreeing that "pollution taxes would be difficult to calculate in some cases" and recognizing that this difficulty would arise in efforts to establish allocatively efficient regulation as well).

[89] Driesen, *supra* note 60, at 563-77 (showing that the concept of economic efficiency does not align with many important economic goals); *cf.* David M. Driesen, *Two Cheers for Feasible Regulation: A Modest Response to Masur & Posner,* 35 HARV. ENVTL. L. REV. 313, 321-28 (explaining why the feasibility principle—maximizing reductions without causing widespread plant shutdowns— proves fairer than optimization).

[90] *See* David M. Driesen, *Distributing the Cost of Environmental, Health, and Safety Regulation: The Feasibility Principle, Cost-Benefit Analysis, and Regulatory Reform,* 32 B.C. ENVTL. AFF. REV. 1, 58-66 (2005) (reviewing CBA proponents' arguments, which are not based on a neoclassical approach to economic efficiency); *see, e.g.,* MATTHEW ADLER, WELL-BEING AND FAIR DISTRIBUTION: BEYOND COST-BENEFIT ANALYSIS (2012) (suggesting that CBA can and should be used to consider fairness)*;* MATTHEW D. ADLER & ERIC A. POSNER, NEW FOUNDATIONS OF COST-BENEFIT ANALYSIS 39, 52-56 (2006) (relying on a concept of

Readers interested in understanding the basis for this normative claim can consult the materials cited in the margin. And governments, even when they consider formal cost-benefit analysis seeking to quantify all costs and benefits of a proposed environmental measure do not use the analysis to achieve an allocatively efficient reduction level.[91] So, the relative allocative efficiency of market mechanisms provides a theoretically sound but practically useless way to choose instruments.

By contrast, many analysts support pollution taxes over trading based on the practical claim that a pollution tax proves simpler to establish and implement than an emissions trading scheme.[92] This claim often rests on a comparison between a simple idealized tax and an actual emissions trading proposal that has advanced through a political process, like the Lieberman-Warner Climate Security Act of 2008, which received extensive consideration in Congress.[93] That bill featured complex allocations of allowances to different entities to achieve a variety of equitable and political goals and reflect, no doubt, some special interest influence.[94] By contrast, these analysts point out, to establish a carbon tax a regulator need only set a uniform tax rate for the main sources of greenhouse gases.[95] An analyst, however, cannot make a convincing claim about the relative simplicity of instruments by comparing an idealized instrument of one type to an actual example of another.[96] Instead, one must either advance the theoretical discourse by comparing idealized instruments of both types or advance a practical analysis by comparing actual and likely taxes to real trading programs.[97]

In theory, a regulator could establish an equally simple emissions trading scheme, by auctioning off a fixed supply of allowances to all significant sources of

"overall well-being" to cure problems with relying on cost and benefits defined according to consumer preference).

[91] *See* Driesen, *supra* note 87, at 352-80 (showing that OIRA review serves as a "one-way ratchet" sometimes weakening and almost never strengthening regulation, regardless of CBA's results).

[92] *See, e.g*., Avi-Yonah & Uhlmann, *supra* note 70, at 7 (finding a carbon tax "easier to implement and enforce" than cap and trade); Roberta F. Mann, *The Case for the Carbon Tax: How to Overcome Politics and Find Our Green Destiny*, 39 ENVTL. L. REP. (Envtl. L. Inst.) 10118, 10120 (2009) (characterizing a cap-and-trade program as infinitely more complex than a pollution tax).

[93] *See, e.g.,* Mann, *supra* note 92, at 10122 (justifying statements about cap-and-trade's greater complexity by referring to Lieberman-Warner); Alex Rice Kerr, *Why We Need a Carbon Tax,* 34 FALL ENVIRONS L. & POL'Y J. 69, 95 (2010) (comparing Lieberman-Warner to a far narrower imaginary carbon tax).

[94] *Cf.* Mann, *supra* note 92, at 10123 (suggesting that Lieberman-Warner gave away too many allowances to the fossil fuel industry).

[95] *See e.g., id.* at 10120 (describing a tax as requiring establishment of a tax rate on a particular pollutant).

[96] *See generally* Howard Latin, *Ideal versus Real Regulatory Efficiency: Implementation of Uniform Standards & 'Fine-Tuning' Regulatory Reform,* 37 STAN. L. REV. 1267, 1272 (1985) (stating that assessment of policies cannot rest on comparing flawed actual policies to idealized proposals).

[97] *Cf.* Avi-Yonah & Uhlmann, *supra* note 70, at 37-40 (comparing the Senate bill to a taxation bill that received almost no political attention).

greenhouse emissions and authorizing trading.[98] Indeed, one bill proposed in Congress embodied a scheme almost that simple.[99]

Some analysts suggest that taxes offer a simpler mechanism than trading, because one can tax carbon "at the wellhead," focusing a tax on the producers of fuels.[100] Such an approach has the potential to greatly simplify administration, as the number of fuel producers is much smaller than the number of carbon dioxide emitters.[101] One can, however, design a trading program focusing on the fuel producers as well.[102] And both the Lieberman-Warner bill and California addressed transportation emissions using this approach, focusing its trading regulation of transport primarily on fuel production.[103]

While in theory a tax can be quite simple, in practice a tax probably would embody many of the complexities currently found in the Internal Revenue Code—widely regarded as the most complicated law we have—, as the politicians enacting the tax would pursue various equitable and political goals and respond to special interests, just as they did in crafting leading trading proposals.[104] Moreover, many scholarly proponents of pollution taxes recommend authorizing tax credits for carbon capture and storage and for various kinds of carbon reduction projects outside the taxing jurisdiction.[105] Recently, South Africa and Mexico have both taken up carbon tax proposals that rely heavily allowing polluters to avoid the tax by

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[98] It would require another article to thoroughly prove this point, but it is worth saying a little more about why some of the more fundamental arguments offered on behalf of taxation's simplicity do not appear convincing. Avi-Yonah and Uhlmann suggest that governments must set a baseline for a cap-and-trade program but not for taxes. *Id.* at 38. Governments, however, usually want to know how much revenue a tax will generate and will almost surely wish to project how much pollution reduction their programs will realize (especially when governments pledge a certain quantity of emission reductions in international fora). *See* Metcalf & Weisbach, *supra* note 70, at 511-12 (mentioning the idea of setting a tax rate to achieve a particular emission reduction goal). Doing that requires establishing a baseline. Similarly, they suggest that cap-and-trade requires monitoring and establishment of penalties for non-compliance, but taxation does not. *See id.* But enforcement of pollution taxes also requires monitoring pollution levels to determine whether sufficient taxes have been paid. *See* Mann, *supra* note 92, at 10120 (recognizing that pollution taxes require "measurement standards").

[99] *See* H.R. 1862, 111th Cong. §§ 9902-03, 9907 (2009).

[100] *See* Avi-Yonah & Uhlmann, *supra* note 70, at 31 (suggesting that a carbon tax should focus on fossil fuel production).

[101] *See* Richard L. Ottinger & William B. Moore, 12 PACE ENVTL. L. REV. 109 (1994) (noting that upstream pollution taxes advance administrative ease and enforcement, but may fail to encourage downstream pollution abatement measures).

[102] David M. Driesen & Amy Sinden, *The Missing Instrument: Dirty Input Limits,* 33 HARV. ENVTL. L. REV. 65 (2009); *accord,* Avi-Yonah & Uhlmann, *supra* note 70, at 31-32 (agreeing that either trading or taxation could be implemented upstream or downstream).

[103] *See* Driesen & Sinden, *supra* note 102, at 80-83.

[104] *See* Roberta Mann, *To Tax or not to Tax Carbon—Is that the Question?,* 24 NAT. RES. & ENV'T 44, 45 (2009) (conceding that in light of the tax code's complexity Congress could establish a carbon tax rivaling cap-and-trade's complexity); Janet E. Milne, 10 VT. J. ENVTL. L. 1, 17 (2008) (claiming that issues of economic impact, equity and politics "inevitably" shape an environmental tax proposal).

[105] *See, e.g.,* Avi-Yonah & Uhlmann, *supra* note 70, at 32 (proposing tax credits for carbon capture and storage and to subsidize "alternative energy"); Metcalf & Weisbach, *supra* note 70, at 537-40 (proposing such tax credits).

purchasing offset credits, thereby emulating a key complexity found in the Lieberman-Warner trading bill, as verifying the value of offset projects proves very difficult.[106] Furthermore, politicians would face various equitable claims about why a tax might put some carbon-intensive industries at a competitive disadvantage, bankrupt some firms, or otherwise prove unfair or unwise in particular sectors. Such claims in Europe and Canada, where carbon taxes exist, have generated a number of inefficient exemptions for carbon intensive industries, precisely the industries most in need of a tax.[107] Equitable concerns also usually produce differentiation of tax rates based on fuel type.[108] The list of complications one might introduce to a pollution tax to achieve plausible policy goals and serve special interests is long, so that claims about the relative simplicity of various market mechanisms appear quite unconvincing.

Jonathan Wiener employs a less conventional approach to choosing between taxes and trading in the climate disruption context. He urges a comparison based on "participation efficiency," asking which instrument provides the best tool for bribing developing countries to participate in reducing greenhouse gas emissions.[109] Since emissions trading under the Kyoto Protocol causes developed countries (and their nationals) to pay for reductions in developing countries, he suggests that emissions trading offers better participation efficiency.[110] Yet, a pollution tax implemented in developed countries could provide revenues to pay for carbon abatement in developing countries.[111] Furthermore, under a taxation approach, this "bribe" would add emission reductions to the developed country abatement effort. By contrast, absent a tightening of the cap, the trading approach to enhancing participation efficiency simply moves some of the developed country reductions to developing countries whilst giving up reductions in developed countries in return, thereby losing at least the immediate environmental benefit of enhanced participation.[112] Although

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[106] *See* Climate Action Reserve, *Introduction to Carbon Markets in Mexico*, 3 (2015) (noting that Mexico has imposed a carbon tax on fossil fuels and authorized taxpayers to use offsets to reduce their tax obligation); Republic of South Africa, Draft Carbon Tax Bill, §13 (2015), http://www.treasury.gov.za/public%20comments/CarbonTaxBill2015/Carbon%20Tax%20Bill%20 final%20for%20release%20for%20comment.pdf (authorizing carbon offsets to reduce a proposed carbon tax).

[107] *See* Mark Jaccard, *Carbon Taxes and Caps May be Most Effective in Economic Theory, But Smart Regulation Will Produce Better Climate Policy for Our Political Reality*, POLICY OPTIONS (February 2, 2016), http://policyoptions.irpp.org/magazines/february-2016/want-an-effective-climatepolicy-heed-the-evidence/ (last visited May 9, 2016) (noting that all Canadian carbon taxes include partial exemptions for energy intensive exporting industries).

[108] *See* Samuel Fankhauser*, A Practitioner's Guide to a Low-Carbon Economy: Lessons From the UK,* 13 CLIMATE POL'Y 345, 353 (2013) (discussing variations in carbon and fuel taxes across industries); Metcalf & Weisbach, *supra* note 70, at 508-09 (discussing differing tax rates and exemptions).

[109] *See* Wiener, *supra* note 23, at 750-55.

[110] *See id.* at 763-64.

[111] *See* David M. Driesen, *Choosing Environmental Instruments in a Transnational Context,* 27 ECOLOGY L. Q. 1, 13 (2000).

[112] *See id.* at 42-43 (pointing out that purchasing emission reductions from developing countries "adds nothing to global environmental progress" but instead cost effectively reallocates "reductions that would otherwise occur").

this participation efficiency theory contributes important insights, its results for a choice between taxes and trading depend very heavily on institutional choices and design elements.[113]

So, the general standard theory that has sought to provide advice about choosing instruments by focusing on their merits as stand-alone mechanisms has not produced clear guidance, at least in terms of choosing between pollution taxes and trading. The theory of comparative efficiency provides theoretically sound but practically useless guidance. The theory of the relative complexity of instruments misleads, because instrument complexity depends more heavily upon instrument design than upon instrument choice. Similarly, participation efficiency provides some guidance at least in the climate context, but design variables greatly complicate the process of getting clear guidance from that theory about instrument choice. We shall see, however, that a major systematic difference between the instruments does emerge when considered in light of how well they work with other instruments.

D. The Use of Supplemental Policies Alongside Trading or Taxes.

Every polity that uses emissions trading or a carbon tax to address global climate disruption also employs other policies simultaneously to lower greenhouse gas emissions. For example, in spite of the centrality of trading to the Kyoto Protocol, President Obama's first major federal initiative to address global climate disruption established ambitious Corporate Average Fuel Economy (CAFE) standards for new motor vehicles, which require lower carbon dioxide emissions from vehicles.[114] Only later did the EPA authorize trading to reduce greenhouse gas emissions in its Clean Power Plan for existing electric utilities.[115] And EPA promulgated a traditional regulation for new power plants at the same time, which demanded lower emissions from new and modified plants but did not authorize trading.[116] California's comprehensive climate disruption legislation, Assembly Bill 32, produced not only the well-known California emissions trading scheme, but also a host of other programs, including, ambitious renewable portfolio standards—which demand that a certain percentage of electricity generation come from renewable sources—, a standard for clean fuels, and the low emission vehicle program that served as a model for the federal CAFE standards and has led to the production of hybrid and electric

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[113] *Id.* at 52 (finding design considerations essential to determining which instrument best fosters participation).

[114] *See* Light-Duty Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25324 (May 7, 2010); 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 76 Fed. Reg. 74,854 (December 1, 2011); *see also* Coal. for Responsible Regulation Inc. v. EPA, 684 F. 3d 102, 115 (D.C. Cir. 2012) (mentioning these standards and other regulatory actions addressing climate disruption).

[115] *See* Carbon Pollution Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64662, 64667 (October 23, 2015) (authorizing state emissions trading).

[116] Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 80 Fed Reg. 64510, 64627 (October 23, 2015) (explaining why the new source rules do not rely on emissions trading).

vehicles.[117] Furthermore, 90% of California's projected reductions in greenhouse gas emissions come from these "supplemental" policies.[118] Although the EU ETS blankets Europe, the EU also has policies setting quantitative targets for energy efficiency improvements and deployment of renewable energy—both of which reduce carbon dioxide emissions.[119] The United States and many other countries use traditional standards for the energy efficiency of appliances to advance their design over time.[120] Many countries also fund energy efficiency in buildings and many governments have building codes that include regulations demanding prescribed levels of energy efficiency for new buildings (and sometimes *retrofits*).[121] The Scandinavian countries levying significant carbon taxes employ a rather full panoply of regulatory programs alongside the carbon tax.[122] China, while attracting great attention for its emissions trading program, has more quietly employed renewable energy support, energy efficiency standards, and other measures reducing greenhouse gas emissions.[123]

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[117] *See* Jenkins, *supra* note 20, at 468 (mentioning several of the AB 32 programs).

[118] *See* Ramo, *supra* note 41, at 113 (noting that only 10% of the emission reductions anticipated under AB 32 come from the trading program).

[119] *See, e.g.,* Sarah O. Ladislaw & Ann Hudson, *A Delicate Balance: The EU Climate 2030 Climate Framework* (April 18, 2014), https://www.csis.org/analysis/delicate-balance-eu-2030-climate-framework (noting EU targets of 20% renewable energy, 20% lower primary energy consumption, and 20% emission reductions by 2020); *see also* Görlach, *supra* note 17, at 735-36 (linking these multiple targets to multiple policy objectives, such as energy security, affordability, competitiveness, air quality, and nuclear safety).

[120] *See* Noah Sachs, *Can We Regulate Our Way to Energy Efficiency? Product Standards as Climate Policy,* 65 VAND. L. REV. 1631, 1642-43 (2012) (discussing the regulatory negotiation of federal appliance standards requiring enhanced energy efficiency); *see also* DAVID GOLDSTEIN, SAVING ENERGY GROWING JOBS: HOW ENVIRONMENTAL PROTECTION PROMOTES ECONOMIC GROWTH, PROFITABILITY, INNOVATION AND COMPETITION 88 (2007) (discussing California standards for refrigerators); S. Toshi, *Overview of Japan's Energy Efficiency Policies on Building and Appliances* (2009), http://www.asia-pacificpartnership.org/pdf/BATF/ 8th_meeting/Ministry_of_Economy,_Trade_and_Industry.pdf.

[121] *See, e.g.,* Directive 2010/30/EU of the European Parliament and of the Council (May 19, 2010); Giraudet et. al., *supra* note 19, at 214 (detailing French measures to encourage energy conservation including at least one aimed at encouraging retrofitting of existing buildings).

[122] *See, e.g.,* DANISH MINISTRY CLIMATE, ENERGY AND BUILDING, DENMARK'S SIXTH NATIONAL COMMUNICATION AND FIRST BIENNIAL REPORT UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 26 (2013) (mentioning taxes as part of a large inventory of measures)*;* MINISTRY OF THE ENVIRONMENT SWEDEN, SWEDEN'S SIXTH NATIONAL COMMUNICATION ON CLIMATE CHANGE UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 9 (2014) (noting Sweden's energy and carbon taxes but pointing out that the country supplements these with many other measures); NORWAY'S MINISTRY OF CLIMATE AND ENVIRONMENT, NORWAY'S SIXTH NATIONAL COMMUNICATION ON CLIMATE CHANGE UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 9 (1994) (discussing Norway's carbon tax as part of a "comprehensive approach" to greenhouse gas reduction); LEENA RAITTINEN ET AL.; FINLAND'S SIXTH NATIONAL COMMUNICATION ON CLIMATE CHANGE UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 15 (2013) (mentioning energy taxation as one of a number of policies addressing climate disruption).

[123] *See* Olivia T. Boyd, *China's Energy Reform and Climate Policy: The Ideas Motivating Change,* 6-7, 15-16 (CCEP Working Paper No. 1205, 2012) (discussing various energy efficiency and renewable energy policies in China, including the feed-in tariff).

The supplemental policies governments employ to address climate disruption perform a variety of functions.[124] First of all, they sometimes address risk/risk problems—the problem that measures reducing a greenhouse gas often cause other risks. A good example involves the extensive traditional regulation that Japan has put in place to prevent nuclear accidents in the wake of the Fukushima disaster.[125] Without these regulations, the Japanese public would never stand for the restarting of nuclear facilities, even though nuclear power plants provide base load power with no direct carbon dioxide emissions.[126] The United States has achieved reductions in carbon dioxide emissions because of switching from coal to natural gas, which has become cheaper than coal thanks to hydraulic fracturing (hydrofracking)—a technique involving fracturing underground rock formations with a mixture of water and chemical solvents to permit lateral subsurface drilling.[127] Hydrofracking, however, generates a number of ancillary risks that require traditional regulation.[128] It has reportedly produced water quality problems in Pennsylvania.[129] The public in New York addressed this ancillary risk by successfully demanding a ban on hydrofracking, a drastic form of traditional regulation.[130] While switching from coal to natural gas reduces power plant carbon dioxide emissions, some experts have estimated that methane emissions generated in extracting the gas outweigh these

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[124] *See* Driesen, *supra* note 24, at 418-421 (discussing a variety of functions that traditional regulation performs alongside market-based instruments).

[125] *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-14-109, NUCLEAR SAFETY: COUNTRIES' REGULATORY BODIES HAVE MADE CHANGES IN RESPONSE TO THE FUKUSHIMA DAIICHI ACCIDENT 18 (2014) (discussing Japanese regulation of nuclear power after Fukushima)

[126] *See generally* ID. at 17 (characterizing the need to "regain the public trust" as the biggest challenge facing Japan's nuclear regulatory authority).

[127] John M. Golden & Hannah J. Wiseman, *The Fracking Revolution: Shale Gas as a Case Study in Innovation Policy,* 64 EMORY L. J. 955, 966 (2015) (discussing the effects of low natural gas prices caused by fracking); Thomas W. Merrill, *Four Questions About Fracking*, 63 CASE W. RES. L. REV. 971, 991 (2013) (identifying fracking and the resulting displacement of coal by cheap natural gas as the "most important contributor" to declining CO_2 emissions in the US).

[128] *See* Merrill, *supra* note 127, at 980-85 (discussing the environmental risks from fracking).

[129] U.S. EPA, HYDRAULIC FRACTURING FOR OIL AND GAS: IMPACTS FROM THE HYDRAULIC FRACTURING WATER CYCLE ON DRINKING WATER RESOURCES IN THE UNITED STATES EXECUTIVE SUMMARY (FINAL REPORT) 20 (2016) (discussing spills that have contaminated surface water in Pennsylvania and elsewhere); Thomas W. Merrill & David M. Schizer, *The Shale Oil and Gas Revolution, Hydraulic Fracturing, and Water Contamination: A Regulatory Strategy*, 98 MINN. L. REV. 145, 181-192 (2013) (discussing various incidents in Pennsylvania and other alleged water quality problems); David K. String, *A Fracking Good Solution to the Hydraulic Fracturing Regulation Conundrum,* 48 VAL. U. L. REV. 417, 423 (2013) (discussing residents' complaints about water quality and the discovery of methane leaking into local water supplies).

[130] *See* Jonathan A. Binder & Patrick E. Foster, *Comparing Ambitious Energy Reforms: The German Energiewende and New York State REV,* NAT. RES. & ENVT. 1, 5 (Spring, 2016) (mentioning New York's ban on hydrofracking).

benefits, as methane is a potent greenhouse gas.[131] EPA has accordingly developed traditional regulations regulating methane from natural gas extraction.[132]

Traditional regulation sometimes addresses pollutants that cannot be adequately monitored and therefore resist reliable regulation through emissions trading or taxation. The methane problem illustrates that role as well. Methane from natural gas extraction cannot be reliably measured, because it stems from random leaks, which can take place at different points in the process.[133] For that reason, the EPA regulation of methane from gas extraction includes a leak detection and repair program.[134] Many countries, however, do allow methane reductions to generate credits for their trading programs.[135] But doing that contradicts the teachings of most responsible emissions trading advocates, for they recognize that trading only works properly with well-monitored pollutants.[136] Trading depends upon reliable measurement of emissions, since it involves giving up a specific quantity of emission reductions in one place in exchange for an equivalent amount of reductions elsewhere. Taxation likewise relies on accurate measurement of emissions, and therefore will not work well if applied to pollutants that we cannot monitor well.[137]

Traditional regulation, as Ann Carlson has pointed out, sometimes addresses market failures that prevent realization of least cost abatement opportunities even when the cap (or tax) does correct for the market failure involved in not pricing damage from pollution.[138] The principal example of this type of market failure involves energy efficiency improvements.[139]

Finally, some government programs running alongside a trading program aim to catalyze innovation.[140] Since trading proponents claim catalyzing innovation as an

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[131] *See* Merrill & Schizer, *supra* note 129, at 166 (noting that methane traps heat at twenty times the rate of carbon dioxide and mentioning but doubting a study finding that the methane emission cancel out the carbon reduction benefits of substituting gas for coal).

[132] *See* Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources; Final Rule, 81 Fed. Reg. 35824 (June 3, 2016), *to be codified at* 40 C.F.R. part 60 [hereinafter Methane Rule].

[133] *See* Myriah Jaworski*, LDAR: A Problem and a Solution for Hydraulic Fracturing,* 44 ENVTL. L. REP. (Envt. L. Inst.) 10345, 10346 (2014) (noting that unintentional methane releases can occur "throughout the hydraulic fracturing process").

[134] *See* Methane Rule, 81 Fed. Reg. at 35846.

[135] *See* Eric Shaffner, *Repudiation and Regret: Is the United States Sitting out the Kyoto Protocol to its Detriment,* 37 ENVTL. L. 441, 459 (2007) (discussing the prevalence of methane reduction projects in the Clean Development Mechanism, which generates credits for many trading schemes).

[136] *See also* Görlach, *supra* note 17, at 740 (noting that trading only works where monitoring is possible with "some degree of accuracy").

[137] *See* David M. Driesen, *Why Pollution Taxes Cannot Replace Command and Control Regulation (But Should Have a Bright Future Nonetheless), in* I CRITICAL ISSUES IN INTERNATIONAL ENVIRONMENTAL TAXATION – INTERNATIONAL AND COMPARATIVE PERSPECTIVES (2003).

[138] *See* Carlson, *supra* note 16, at 216 (discussing market failures limiting the price signal's strength and therefore interfering with least cost abatement).

[139] *See generally id.* (discussing this example).

[140] *See, e.g., Federal Republic of Germany, Progress Report under Article 22 of Directive 2009/28/EC on the Promotion of the Use of Energy from Renewable Sources* 6 (2016), http://biofuelstp.eu/country/progress-reports/article_22_germany.pdf (claiming that German energy policy can act as a "catalyst for innovation")

advantage of that mechanism,[141] part III will discuss whether the innovation rationale provides a sound justification for "complimentary policy" later. But it does seem to constitute a motivation for some programs used in conjunction with trading (or taxes).[142]

II. Playing Nice: A Comparison Between Tax's and Trading's Effects on the Adoption and Successful Implementation of Supplementary Policies.

We have seen that conventional stand-alone comparisons of taxes and trading provide little useful advice to governments. But stand-alone comparisons may have limited value anyway, because real governments usually use a pollution tax or an emissions trading program in conjunction with other instruments. It turns out that these two instruments function very differently in their interactions with other mechanisms.

A. Taxes and the Evolution of Additional Programs.

Pollution taxes do not trade away the environmental benefit associated with additional programs. Thus, when a government supplements a pollution tax with a new environmental program addressing the same pollution, it usually adds pollution reductions, which may be needed to effectively address an environmental problem.

Furthermore, a pollution tax may encourage the adoption of additional programs. When a supplemental program reduces emissions, it reduces the polluters tax bill.[143] A polluter has less reason to oppose a new program if the emissions involved are taxed than she would if the emissions are untaxed, because tax relief will offset some of a new program's cost.

Imagine, for example, that the Dutch electric utilities mentioned at the outset produce 50 million tons of carbon dioxide emissions per year, but must pay a $20 per ton tax on each ton of carbon dioxide released into the atmosphere. If the Dutch utilities remain open, they would have to pay $1 billion a year in pollution taxes. If they shutdown half of their generation in favor of zero emission renewables, however, they would avoid $500 million a year in taxes. To be sure, the shutdown will generate some costs. Presumably the Dutch electric utilities would have to build cleaner energy facilities to substitute for the closed coal-fired power plants, and those facilities would have some cost associated with them. But the tax savings would offset

[141] *See e.g.,* Wiener, *supra* note 23, at 717-18 (claiming that "tradable allowances promote dynamic innovation").

[142] *See, e.g.,* R. Denniss, M. Grudnoff, & A Macintosh, *supra* note 63, at 38 (quoting Australia's Treasury Secretary as recognizing the need to supplement carbon pricing with measures supporting "the development of new low-emissions energy technology").

[143] *See* Thomas F. Persen & Stewart Elgie, *A Template for the World: British Columbia's Carbon Tax Shift, in* CARBON PRICING: DESIGN, EXPERIENCE AND ISSUES 3, 11 (Larry Kreiser *et al.* eds. 2015) (pointing out that a carbon tax makes improvements in building codes, insulation standards, and government rebates supporting building retrofits "more attractive").

some of that cost, making the reduction obligation more palatable than it would be if no carbon tax existed.

From the standpoint of society as a whole, pollution taxes do not make new programs more attractive than they would be on a stand-alone basis. For the public as a whole, the tax relief flowing from a new program may have no value. A tax represents a transfer payment.[144] In the Dutch example, the utility paying the tax will likely pass the cost on to ratepayers, so it increases their electricity costs. But the tax generates revenue for the government, which may spend the money to serve the public. So, on balance it does not add significant costs or benefits to a cost-benefit calculation. If the plants shut down the government foregoes the revenue flowing from the pollution tax, but the ratepayers get to keep the money they would have to otherwise spend paying the carbon tax. So, the tax has no effect on the costs or benefits of shutting down coal-fired power plants.

It follows that a shutdown would produce costs approximately equal to the costs of providing the cleaner energy needed to serve the needs formally met by generation of coal-fired power. The public, however, retains the environmental benefits derived from the shutdown, which the public does not lose through the emissions trading mechanism.

Furthermore, once a government has adopted a program intersecting with a tax, the tax may catalyze better policy implementation, increasing the reductions from the supplementary policy. For example, while CAFE standards have encouraged hybrid vehicle adoption throughout Canada, British Columbia has experienced the highest rate of growth in consumer purchases of hybrid vehicles, likely because of its carbon tax.[145]

B. Trading and the Evolution of Additional Programs.

Under trading, however, a supplemental program will frequently not add emission reductions. Phasing out coal-fired power would not, according to the Dutch competition authority and at least one academic, produce additional net carbon dioxide reductions in Europe, because under the EU ETS the owners of the phased-out plants would be able to sell allowances for those plants after they shut down.[146] Polluters elsewhere in Europe would presumably purchase these allowances in lieu

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[144] *See generally* Eric A. Posner, *Transfer Regulations and Cost-Effectiveness Analysis,* 53 DUKE L.J. 1067, 1068 (2003) (explaining transfer payments and why they do not generate net costs or benefits apart from administrative cost).

[145] *See* Werner Antweiler & Sumeet Gulati, *Frugal Cars or Frugal Drivers: How Carbon and Fuel Taxes Influence the Choice and Use of Cars,* http://ssrn.com/abstract=2778868 1 (2016) (finding " conclusive evidence" that carbon and fuel taxes are causing consumers to purchase high efficiency vehicles); Pedersen & Elgie, *supra* note 143, at 10 (stating that the carbon tax "may . . . have stimulated" BC's high adoption rate for hybrid vehicles).

[146] *See ACM Analysis*, *supra* note 10, at 4, 7 (indicating that the agreement provides no net carbon dioxide reductions); Kloosterhuis & Mulder, *supra* note 1, at 870 (pointing out that because electricity producers can sell the permits they do not need after shutdown, the closure has "no net effect" on CO_2 emissions).

of making reductions otherwise required by the EU ETS. Hence, the new program shifts the location of emissions and probably raises the cost of Dutch power production, but may not reduce net emissions.

This conclusion can be generalized. Anytime that a new program regulates a source that has the legal right to sell allowances in a trading program, the new program may not produce a net emissions decrease.[147] A new program will only reliably generate additional progress if those realizing the reductions generated under that new program cannot sell credits.

Governments may sometimes anticipate the loss of benefits from a trading program and forego adoption of a promising emission reduction program, as the Dutch example illustrates.[148] Because under trading additional programs only add costs without necessarily adding environmental benefits, emissions trading may discourage the creation or continuation of additional programs addressing the same problem that the trading program addresses.

On the other hand, trading does offer polluters an opportunity cost advantage that appears similar to that offered by a tax, which might encourage additional programs. Returning to our Dutch example, notice that the owners of coal-fired power plants could make some money by shutting down, for they could sell their allowances and pocket the proceeds. Hence, trading offers an opportunity cost advantage facilitating the sort of private agreement to additional measures that in fact occurred.

The opportunity cost advantages of taxes and trading would be the same under conditions of perfect information. Taxation, however, may offer a stronger incentive for polluters to agree to pollution control measures than trading, because of imperfect information. A polluter agreeing to a pollution abatement measure under taxation knows that she will realize cost savings equal to the amount of abatement multiplied by the tax rate. Under trading, the cost savings depends on the price of allowances after the polluter has carried out the abatement measure, as the cost savings occur through the sale of allowances in the future. Because that price is unpredictable, the polluter may discount the opportunity cost savings associated with agreeing to a new pollution control measure under trading.

Trading's propensity to dissipate emission reductions from supplemental programs suggests that an economically rational government that bases its decisions on the near term costs and benefits of pollution control programs would rarely adopt additional regulation in conjunction with a trading program, except when addressing sources that cannot or will not sell credits into the emissions trading program. Indeed, policymakers and scholars have questioned previously enacted programs that have produced progress on the ground that they will not produce environmental progress after a trading program is put in place, but only increase cost.[149]

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[147] *See, e.g.,* R. Denniss, M. Grudnoff, & A Macintosh, *supra* note 63, at 41 (characterizing subsidies for solar energy as likely to lead to credit sales excusing emission reductions elsewhere under Australia's trading scheme).

[148] *Cf.* Twomey, *supra* note 16, at 18 (discussing the tendency of cap-and-trade programs to discourage "ethically motivated mitigation").

[149] *See infra,* notes 158-159 and accompanying text.

Even when a legal prohibition on the sale of legally required credits exists, this legal prohibition may itself discourage further policy development. Such a prohibition does not usually exist in a pure cap-and-trade program, like the acid rain program, but it does exist with respect to offset programs and therefore applies to the sale of offset credits under the Kyoto Protocol. More specifically, the global climate regime prohibits the sale of "non-additional" offset credits, credits reflecting reductions from uncapped sources that would have occurred anyway without the incentive provided by trading.[150] Legally required reductions therefore should not generate saleable offset credits under the Kyoto Protocol (even though legally required reductions can generate saleable credits from capped sources like the Dutch electric utilities).[151] This rule has a straightforward rationale. If regulators accept credits for non-additional offset credits, they give up a planned emission reduction in exchange for something that would have occurred anyway. That is not a good trade, because absent acceptance of that trade the non-additional reduction will still occur and so will the planned emission reduction from the capped source seeking to purchase the non-additional credit.

A project developer hoping to sell offset credits may oppose a new mandatory pollution abatement program, because enactment of the new program would cut off a potential sale by making reductions realized non-additional.[152] A mandatory program has more environmental value than a set of voluntary efforts to develop offset credits for a trading market, because the reductions realized through new programs generate fresh emission reductions, rather than just provide offsets lowering the cost of planned abatement. In other words, trading in the offset context may add an opportunity cost to the compliance costs generated by a new program and intensify resistance to new programs for that reason.

Hence, trading can discourage additional regulation of the pollution it addresses either by trading away crucial environmental benefits justifying a program or by increasing the cost of a new program to pollution sources hoping to sell offset credits. Under the hybrid trading programs enacted under the Kyoto Protocol, both of these disincentives are relevant in one context or another.

This analysis establishes that taxes will usually make additional programs more attractive to the public than the trading program will. Both taxes and trading provide opportunity cost advantages to polluters that may make additional programs more attractive to polluters than they would be without a market mechanism in place, but polluters may value the cost savings under taxes more than under trading because of increased price certainty. It seems that taxes will encourage more polluter cooperation than trading. Once a government does enact a supplemental program, it usually adds environmental benefits in the context of pollution taxes, but not in the case of trading.

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[150] Axel Michaelowa & Sandra Greiner, *Defining Investment Additionality for CDM Projects - Practical Approaches*, 31 ENERGY POL'Y 1007 (2003) (discussing the prohibition and its ambiguities).
[151] Steven Ferrey, *Environmental Regulation of Independent Power, in* 1 LAW OF INDEPENDENT POWER § 6:7.10 (2016) (explaining that "a project must provide GHG emissions reduction beyond that required by law" to generate additional credits).
[152] *Cf. id.* (noting that China has refrained from regulating carbon emissions in order to obtain tax revenue from the sale of emission reduction credits).

C. The Strength of Trading's Discouragement of New Policies.

The Dutch example of the problem of losing reductions through trading discouraging a new program does not stand alone. In the case of acid rain, EPA issued a rule (the Clean Air Interstate Rule) demanding that States retire sulfur dioxide allowances in order to address particulate pollution problems, which sulfur dioxide emissions contribute to.[153] The United States Court of Appeals for the District of Columbia Circuit reversed this part of EPA's Clean Air Interstate Rule to avoid interfering with the acid rain program.[154]

The problem of trading negating the gains of ancillary programs has occasioned some debates on policies and modifications not just for individual countries and States, but also for the entire EU. EU policies enacted in 2007 called not only for 20% reductions in greenhouse gas emissions, but also for 20% increases in renewable energy, and a 20% increase in energy efficiency by the year 2020.[155] In revising these targets for 2030, however, the European Commission initially put forth a proposal that defers action on an energy efficiency target and proposes only a 27% renewables target without national subtargets to make the target effective.[156] Some observers suggest that economist Robert Stavins' criticisms of renewables targets for their interference with trading played a role in turning the EU away from stricter and more effective renewables policy.[157]

And sometimes concerns about trading's interaction with supplemental policies can lead to attacks on successful programs predating the trading program. In Australia, several high-level policy reports attacked successful renewable energy programs in part because of their interference with least cost abatement possible

[153] *See* North Carolina v. EPA, 531 F.3d 896, 921 (D.C. Cir. 2008) (describing EPA's plan to retire allowances in order to reduce particulate emissions).

[154] *See id.* (holding that EPA lacks authority to terminate allowances provided under the acid rain program). The *North Carolina* Court did not cite any policy reason to avoid confiscating allowances *See id.* The legal basis for the court's decision was thin and highly formalist. *See id.* at 921-22 (apparently holding that EPA may reduce the same sulfur dioxide emissions, but may not terminate allowances without citing any specific language protecting allowances). Sulfur dioxide causes particulate pollution. *Id.* at 903 (pointing out that SO_2 is a precursor to $PM_{2.5}$).

[155] *See* Ladislaw & Hudson, *supra* note 119 (discussing these targets).

[156] *See id.; A Policy Framework for Climate and Energy in the Period from 2020 to 2030,* at 6, COM (2014) 15 final (Jan. 22, 2014) (proposing a 27% EU-wide target for renewable energy predicted to flow directly from the target of a 40% reduction in greenhouse gas emissions without establishing binding targets for member states); *cf. Energy Efficiency and its Contribution to Energy Security and the 2030 Framework for Climate and Energy Policy*, at 17, COM(2014) 520 final (July 23, 2014) (revising the EU Commission's 25% energy savings target to 30% in light of its "economic and energy security benefits").

[157] *See* Ladislaw & Hudson, *supra* note 119 (citing a debate between Stavins and others on supplemental policies, along with other factors).

under a trading scheme.[158] These reports led to an extensive debate about discontinuing these policies.[159]

But the practical effect of this discouragement has proven less powerful than economic theory might predict. Even in the Dutch case, the failure to phase out the 1980s-era plants by 2017 does not tell the entire story. A large group of academics has petitioned the government to phase out all coal-fired power plants, and the government is studying the proposal.[160] So, the Dutch government may yet phase-out coal-fired power in spite of the interaction with trading. If it does, that will not completely eliminate the force of the Dutch example. Carbon dioxide remains in the atmosphere more than a century.[161] And the severity of climate disruption depends on the total amount of accumulated greenhouse gas emissions, not the emissions in one year. So, even if the Dutch government ultimately phases out coal-fired power, the world will have permanently lost the reductions an earlier phase-out might have provided in the years prior to the implementation of the later phase-out. Hence, delaying adoption of a program constitutes an important effect of trading's discouragement of additional measures, at least in the context of accumulating pollutants.

In addition, the most recent analysis of the Dutch phase-out proposal argues that the "market stability reserve" may dampen the "waterbed effect"—the dissipation of supplemental policy's gains through trading.[162] The market stability reserve provisions recently added to the EU ETS provide that the EU will auction fewer allowances than planned if current surpluses in allowances (created mostly by the financial crisis) persist.[163] The withheld allowances, however, get added to a reserve fund for release if the supply of allowances becomes too low.[164] Thus, the market stability reserve, one study argues, may delay the increase of emissions triggered by the decrease from the shutdown.[165]

This study suggests a larger point: a trading program's design may dampen the waterbed effect.[166] But the dampening effects the literature finds so far are linked

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[158] *See* Twomey, *supra* note 16, at 10 (discussing the 2008 Strategic Review of Australian Government Climate Change Programs and reports by the Productivity Commission).

[159] *See id.* at 10 (explaining that concerns about the relative inefficiency of renewable energy programs "fed into the political debate"),

[160] *Shut All Dutch Coal-Fired Power Stations, Say Professors,* DUTCHNEWS.NL (November 23, 2015), http://www.dutchnews.nl/news/archives/2015/11/shut-all-dutch-coal-fired-power-stations-say-professors/ (noting that 64 professors signed this letter).

[161] *See* BURTON RICHTER, BEYOND SMOKE AND MIRRORS: CLIMATE CHANGE AND ENERGY IN THE 21ST CENTURY 21 (2010) (noting that carbon dioxide has a removal time of more than 100 years).

[162] ECOFYS, *supra* note 13 (predicting that the market stability reserve will dampen the waterbed effect).

[163] *See id*. at 3-4 (discussing the allowance surplus created by the financial crisis and explaining the remedy of auctioning fewer than the planned number of allowances to bring down the surplus).

[164] *See id*. at 4 (explaining that when total allowances exceed 400 Mt additional allowances are released from the reserve).

[165] *See id*. at 6 (arguing that the market stability mechanism spreads out "the waterbed effect over time")

[166] *See, e.g.,* ECOLOGIC INSTITUTE, SMART CASH FOR THE CLIMATE: MAXIMISING AUCTIONING REVENUES FROM THE EU EMISSIONS TRADING SYSTEM, 52 (2016), http://ecologic.eu/sites/files/publication/2016/2584-maximiseretsfulltechnicalreport_final.pdf (proposing cancellation of allowances created by new

to overallocation of allowances. So, the lesson may be that an ineffective trading program may dampen the waterbed effect, but an effective trading program almost surely weakens supplementary policies. It also remains an open question whether the prediction of a dampening effect from design features will significantly ameliorate whatever discouragement of supplemental policies may flow from predicted waterbed effects.

We certainly could use more empirical study of the question of whether this trading effect has impeded program development. This question can prove difficult to research because this would be, in part, a story of the dog that did not bark.[167] Research can reveal a proposal abandoned because of trading, but it may be more difficult to find cases when regulators or environmentalists failed to even propose a program out of fear that it would produce few benefits when interacting with trading. Yet, we know that governments often enact policies supplementing trading in spite of this effect.

Enacted supplemental programs, however, clearly become less effective in conjunction with a trading program than they would be if enacted in conjunction with a pollution tax. Hence trading clearly impedes realization of environmental benefits through supplemental programs, even when it does not impede their enactment.

III. Should We Want Market-Based Instruments to Play Nice With Others?

The analysis above showing that taxes likely do a better job of encouraging additional programs than trading raises a question: should we want additional programs?

Some policymakers and analysts have offered a somewhat negative answer to this question, at least in the context of emissions trading, because additional programs tend to interfere with the trading program's cost effectiveness.[168] They envision a world where the government selects one market-based mechanism for

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programs to avoid the waterbed effect); Whitmore, *supra* note 19, at 1 (noting that decisions to limit the use of the market stability reserve under the EU ETS in order to meet international obligations would lessen or delay the emission increases that might otherwise cancel the benefits of supplemental measures).

[167] *See generally* WILLIAM N. ESKRIDGE, JR., DYNAMICS STATUTORY INTERPRETATION 220 (1994) (discussing Sherlock Holmes's use of inferences from a dog not barking in the "Silver Blaze" story).

[168] *See* Bennear & Stavins, *supra* note 16, at 112 (commenting that to economists use of multiple instruments appears ad hoc and unrelated to economic efficiency); Samuel Fankhauser, Cameron Hepburn, & Jisung Park, *Combining Multiple Climate Policy Instruments: How Not to Do it,* 1 CLIMATE CHANGE ECON. 209 (2010) (finding that multiple policies can raise costs without reducing emissions); *cf.* Oren Ahoobim, Clean Power in Imperfect Markets: The Economics of Renewable Energy Markets 57-58 (March, 2009) (unpublished Ph.D. dissertation, Stanford University) (concluding that because electricity markets are not characterized by perfect competition renewables policies can produce more efficient electricity generation than a pollution tax).

each problem and then leaves it alone to work its magic.[169] This vision, as we shall see, appears attractive from the standpoint of static cost effectiveness.

This part presents the rationale behind the cost effectiveness case for relying on a pollution tax or trading program exclusively. It then asks whether we might reach different conclusions if we broadened the lens to look at allocative efficiency, the theory of the second best (what to do when we cannot be efficient), and the climate regime's goal of avoiding dangerous pollution levels. It then presents an analysis focused on evolution of policy and technology over time and across jurisdictions. It concludes that pollution taxes' advantage over trading in playing nice with other mechanisms constitutes an important virtue even in theory. Since governments, regardless of theory, employ multiple measures, this advantage obviously matters in practice.

A. Cost Effectiveness and the Case for Single Market-Based Instruments.

Pairing an emissions trading program with a traditional regulation usually interferes with the trading approach's cost effectiveness by raising costs.[170] The Dutch example illustrates this. Emissions trading generally encourages cost effective abatement, while not encouraging relatively expensive abatement options. The climate regime offers a wide variety of cost effective abatement possibilities, because it provides for trading among all of the principal greenhouse gases and allows for credits from projects in just about any country in the world.[171] Trading, however, probably would not encourage the closure of Dutch coal-fired power plants, because that would probably not constitute the cheapest abatement possibility. Shutting down the Dutch power plant substitutes a relatively expensive government chosen abatement option for cheaper reductions that participants in the emissions trading market would likely select. Often, a specific abatement program will interfere with the static cost effectiveness of an emissions trading program and therefore raise net costs.

Critics of supplementing trading programs also make a somewhat different argument about conventional instruments' interference with emissions trading. They claim that supplemental measures reduce the price of allowances thereby discouraging innovation and harming the emissions trading program.[172] While this argument about lowering cost appears to contradict the argument that supplemental

[169] *See* Oscar Lekuyer & Phillippe Quirion, *Can Uncertainty Justify Overlapping Policy Instruments to Reduce Emissions,* 93 ECOLOGICAL ECON. 177, 177 (2013) (noting the "Tinbergen Rule" seeking to match one policy instrument with each regulatory target).

[170] *See* Görlach, *supra* note 17, at 734-35 (pointing out that if emissions trading alone achieves optimal policy than adding policy instruments "can only lead to a suboptimal, i.e. unnecessarily expensive outcome").

[171] *See generally* Driesen, *supra* note 40, at 30-35 (discussing provisions authorizing international trading of credits).

[172] *See* Görlach, *supra* note 17, at 741-42; Laidislaw & Hudson, *supra* note 119 (summarizing Robert Stavins' argument that a renewables mandate would be "counterproductive" because it would lower allowance prices and stymie innovation).

measures tend to raise abatement costs, analysis shows that the two arguments coexist peacefully.[173] Additional measures presumably raise the total costs of the combined programs by interfering with cost effective abatement. At the same time, after the relevant companies have spent the money required to implement required supplemental measures, the mandatory supplemental measures generate additional reductions. Those reductions, assuming they take place in a sector eligible to generate credits, can be sold. Additional measures, therefore, increase the supply of credits and lower the cost of allowances in the market going forward. The argument that mandatory measures lower allowance prices therefore focuses only on the costs of the trading program, while the claim that supplemental measures raise costs focuses on the total net expenditures of the combined programs. Hence, both arguments are correct; the supplemental measure raises net costs while lowering allowance prices.

Any suggestion that this combination reduces innovation, however, proves misleading.[174] Lowering allowance prices does lessen incentives for those who might sell credits on the market to innovate. But the requirement to make expensive reductions may conversely enhance incentives to innovate. The induced innovation hypothesis in economics teaches that high costs can create incentives to innovate.[175] Hence, the net effect may enhance innovation. The innovation argument seems to conflate reducing the innovation stimulus in the allowance market with reducing net incentives for innovation from the combined programs.

The observation that trading interferes with the cost effectiveness of trading sparks another question: Do competing mechanisms interfere with a *pollution tax's* cost effectiveness? The answer in a strict sense is no, even though a cause for concern does arise (from a cost effectiveness perspective). At first glance, it would appear that a traditional regulation would obviously interfere with a pollution tax's cost effectiveness. After all, if market actors take cost effective measures in response to pollution taxes, then additional measures would likely cost more than the measures market actors subject to a pollution tax would choose.[176] So additional measures raise the cost of pollution control beyond that which a pollution tax would generate on its own.

But, as the analysis above showed, an additional measure would not only add cost, it would also provide additional emission reductions going beyond what the tax would generate. Hence, strictly speaking it is not logically possible to specify a relationship between stand-alone tax and a tax paired with additional measures in terms of cost effectiveness. The cost effectiveness concept presumes a single agreed

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[173] *See* Görlach, *supra* note 17, at 741-42; David Landis & Peter Heindl, *Renewable Energy Targets in the Context of the EU ETS: Whom do They Benefit Exactly?* 3 (ZEW Discussion Paper No. 16-026, 2016) (noting that renewable energy targets both increase net costs for countries implementing them and lower the price of allowances on the trading market).

[174] *Cf.* Laidislaw & Hudson, *supra* note 119 (linking lower allowances priced to stymied innovation).

[175] *See* Richard G. Newell, Adam B. Jaffe, & Robert N. Stavins, *The Induced Innovation Hypothesis and Energy-Saving Technological Change,* 114 Q. J. ECON. 941 (1999); David Popp, *Induced Innovation and Energy Prices,* 92 AM. ECON. REV. 160, 178 (2002) (finding that high prices cause technological change).

[176] *See* Twomey, *supra* note 19, at 9 (pointing out that the first pass at analyzing supplemental policies' influence on abatement "once a carbon pricing scheme is in place" indicates displacement of "cheaper abatement options").

upon goal and focuses on the least cost means of meeting that specified goal. The concept does not provide a means of comparing two types of programs that achieve different goals. It does not address or answer the question of whether additional benefits at higher cost prove worthwhile. That question implicates allocative efficiency, not cost effectiveness in a strict sense.

So, additional measures impede the cost effectiveness of trading. They do not affect the cost effectiveness of a tax, because they change the combined program's overall goal, thereby making cost effectiveness impossible to assess.

B. Imperfect Information, Bounded Rationality, and the Theory of the Second Best.

Market mechanisms may fail to achieve cost effectiveness when real markets prove less than ideal. Economists typically predict that market mechanisms achieve efficiency based on a neoclassical economic model that assumes rational actors making choices based on perfect information. A "rational actor" seeks to maximize his own utility, in this case, by minimizing the cost of a tax or complying with a trading program. But economists recognize that "market failures"—real world deviations from the neoclassical model—may defeat achievement of economic efficiency.

For example, the economics literature recognizes that cost effectiveness may be unobtainable through market-based instruments when it is not possible to monitor relevant pollutants.[177] In such cases, one cannot determine the tax base to which a pollution tax should apply or the quantity of credits or debits for purposes of administering a tradable permits system. The use of multiple instruments in this context can represent a reasonable application of the theory of the second best, since it implies that informational constraints will impede efficient realization of pollution reduction goals.[178] Monitoring weaknesses imply a deviation from the perfect information assumption forming the basis for the prediction that market mechanisms cost effectively achieve policy goals.

Imperfect information may also impede realization of energy efficiency improvements under market mechanisms, even though they often offer the least cost abatement opportunities. Some consumers and business may simply not know about opportunities to employ energy efficiency improvements.[179] Neoclassical economists sometimes treat the assumptions of perfect information used in their models as actual truth and find it hard to believe that rational actors in a market would not know about economically worthwhile opportunities to enhance energy efficiency.[180] But robust

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[177] *See*, *e.g.,* Bennear & Stavins, *supra* note 16, at 120-21 (illustrating this point with the example of unmeasurable mobile source emissions).

[178] *See* id.

[179] *See* Twomey, *supra* note 16, at 15 (discussing the problem of "poorly informed" firms and consumers).

[180] *See* Kenneth Gillingham, Richard G. Newell, & Karen Palmer, *Energy Efficiency Econ. & Pol'y,* 1 ANN. REV. RESOURCE ECON. 597, 602 (2009) (discussing some economists' claim "that the energy efficiency gap must not exist" because "rational consumers" would not just leave $20 bills sitting on the sidewalk).

empirical evidence shows that ignorance has proven quite widespread, and that a model of bounded rationality, where market actors have limited information, better describes markets for energy efficiency improvements than a perfect information model.[181] Governments have sometimes helped businesses and consumers realize cost savings (while reducing greenhouse gas emissions from power plants) by simply making information available about those opportunities.[182] Hence, supplemental programs can address information failures that prevent maximizing a market-based program's cost effectiveness.

Deviations from the rational actor model, like information failures, can also defeat optimal energy efficiency investments. Most experts recognize that consumers often will not pay for energy efficiency improvements, even when these improvements generate cost savings from lowered electricity bills to justify them, which suggests some deviation from the rational actor assumption.[183] Consumers may fail to carefully compare the up-front capital costs involved in making an energy efficiency improvement (such as adding insulation, installing energy efficient windows, and purchasing energy efficient appliances) to the electricity cost savings, which will accrue over time.[184] Although some economists treat this myopia as the rational employment of a high discount rate, a better view might be to treat this as a market failure and accept a government role in correcting it.[185] Thus, energy efficiency programs can make up for failures to take cost effective measures because of behavior that does not fully conform to a rational actor model.

A less controversial market failure may come about because some consumers, such as those with low incomes, lack the capital to invest in energy efficiency.[186] While in principle a trading market might generate capital for that purpose, transaction costs may make that too difficult without government coordination. An even clearer example of the need to overcome private transaction cost market barriers to energy efficiency improvements involves mass transit. A mass transit system may provide for much more energy efficient transportation than private vehicles, but such a system requires public funding to overcome the hidden market barriers to making these improvements through emissions trading or pollution taxes alone.

Also, as Carlson and many others point out, sometimes the person in a position to make a capital investment in energy efficiency will not realize the cost savings from reduced future electricity bills, and therefore will not carry out economically efficient

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[181] Pedro Linares & Xavier Labandeira, *Energy Efficiency: Economics and Policy,* 24 J. ECON. SURV. 573, 578 (2010) (characterizing the idea that consumers do not have perfect information on energy efficiency investments as "generally understood" and explaining that consumers respond to the information they do have through a lens of bounded rationality).

[182] *See* Bennear & Stavins, *supra* note 16, at 113-14 (briefly surveying major US informational programs promoting energy efficiency).

[183] *See* Gillingham *et al., supra* note 183, at 602 (discussing an "energy efficiency gap" defined as a significant difference between observed levels of energy efficiency and optimal energy use).

[184] *See id.* at 605 (describing information problems, including consumers' lack of information about cost savings as "the primary explanation for the energy efficiency gap").

[185] *See id.* at 602 (describing "implicit discount rates" ranging from 25% to over 100%).

[186] Linares & Labandeira, *supra* note 181, at 579 (citing the poor's difficulty in accessing capital markets as a barrier to energy efficiency investments).

measures.[187] A good example comes from rental housing. Often only the landlord has the legal right to add insulation or install energy efficient windows and appliances.[188] But when the tenant pays the utility bills, the cost savings from those actions will go to the tenant, not the landlord.[189] In those cases, the landlord may lack adequate incentives to improve energy efficiency, even though doing so is economically worthwhile for society as a whole (even without considering pollution reduction benefits).[190] While putting a price on carbon may provide some impetus to take some of these actions, it is not likely to completely overcome the problem of split incentives.[191] Hence, market failures may justify energy efficiency measures even when a market-based mechanism would provide adequate incentives to adopt such measures in a world of rational actors, perfect information, and zero transaction costs.

C. Allocative Efficiency and Addressing Ancillary Risks.

Governments may target sources of a pollutant being regulated through a market-based instrument in order to realize reductions of *another pollutant* not subject to the trading program. These measures, even though aimed at other pollutants, can impair the cost effectiveness a tax or trading scheme addressing pollutants that the ancillary regulation does not target. For example, a country might shutdown coal-fired power plants to address local air pollution. If an emissions trading scheme capping carbon dioxide levels applies to the same plant, then this shutdown order would incidentally constrain the plant's option for meeting its carbon dioxide limits. It would comply with those limits by shutting down, instead of purchasing perhaps less costly allowances available on the market. Accordingly, regulation of pollutants not targeted by an emissions trading scheme can sometimes impair the cost effectiveness of the trading scheme nonetheless.

Impairment of trading's flexibility and thus cost effectiveness can also arise from limits on emissions of *the same pollutant* targeted by a trading program to address a different risk than the trading program addresses. For example, the acid rain trading program regulates sulfur dioxide to address acid rain.[192] EPA also regulates sulfur dioxide to limit particulate matter, because sulfur dioxide is a

[187] *See* Carlson, *supra* note 16, at 216 (discussing this problem of "split incentives").
[188] *See generally* Twomey, *supra* note 16, at 15 (pointing out that landlords usually make decisions about energy efficiency investments while tenants enjoy the savings in energy bills).
[189] Linares & Labandeira, *supra* note 181, at 579 (explaining that in the landlord-tenant situation the "agent who pays for the investment [the landlord] is not the one who receives the benefits from it").
[190] *See* Gillingham, Newell, & Palmer, *supra* note 183, at 606 (describing the landlord/tenant problem and similar "principal-agent" or split incentive problems impeding optimal energy efficiency investment).
[191] *See id.* at 599 (noting that an emissions price may not induce adequate energy efficiency investment because of "behavioral failures").
[192] *See* North Carolina v. EPA, 531 F.3d 896, 902 (D.C. Cir. 2008) (noting that the Title IV cap and trade program used a "cap-and-trade program for sulfur dioxide" to reduce "acid rain").

particulate precursor.[193] Limiting particulate matter to reduce particulate levels, however, can interfere with the acid rain program's cost effectiveness.[194]

In spite of the loss of cost effectiveness when supplemental measures address the same activities as a market mechanism, the economics literature does not condemn additional measures regulating ancillary pollutants on this ground. It would not be appropriate or even possible to evaluate a suite of environmental regulations addressing multiple related environmental problems according to a cost effectiveness criterion, because one cannot identify a single goal in order to measure the cost effectiveness of achieving a goal. Instead, these measures would require economic evaluation on the basis of allocative efficiency.

The economics literature recognizes that in the presence of multiple externalities instrument choice should not necessarily focus only on the first-best policy (trading or taxes) for a single externality.[195] Robert Stavins, a leading economic expert on environmental instrument choice, identifies this point with the economic theory of the second best. He defines this theory as one that recognizes that when some constraint prevents obtaining Pareto optimality (a type of allocative efficiency) for the economy as a whole, obtaining Pareto optimality for a subsystem will not necessarily enhance welfare.[196] Hence, the economics literature generally recognizes the appropriateness of using supplemental policies to reduce collateral risks.

D. Allocative Efficiency and Suboptimal Market Mechanisms.

Putting a price on carbon, either through pollution taxes or trading, does not necessarily produce allocatively efficient carbon reductions. Putting a price on carbon would only do that if the price reflected the full social cost of climate disruption, as we have seen.

If a carbon tax is suboptimal (too low), then adding reductions through new programs at a higher cost than the tax would likely move the overall carbon abatement level closer to optimality.[197] Conversely, if the carbon tax were too high, then adding new programs would likely lead to allocative inefficiency, producing costs exceeding benefits. Therefore, pollution taxes' encouragement of new programs tends to enhance allocative efficiency when taxes are suboptimal.

The point that in the face of a suboptimal price on carbon supplementary measures would enhance allocative efficiency implies that effective additional programs would be economically desirable when the cap underlying a trading

[193] *See id.* at 903 (noting that EPA regulated sulfur dioxide as a particulate precursor).
[194] *See generally, id.* at 921 (holding that EPA lacks authority to cancel acid rain allowances in order to address particulate pollution).
[195] *See* Bennear & Stavins, *supra* note 16, at 121.
[196] *See* id. at 112 (defining the "second-best problem" as constraints preventing Pareto optimality "within the general equilibrium system" and stating that "attainment of other Pareto optimal conditions" does not necessarily improve welfare when such constraints exist).
[197] *See* Jenkins, *supra* note 20, at 474 (noting that supplemental policies should not be dismissed as "not economically optimal" since political constraints prevent pricing policies from achieving optimality).

program is suboptimal.[198] But, as we have seen, trading impedes the effectiveness of supplemental programs in adding needed reductions, by allowing these reductions to generate credits excusing compliance elsewhere in the system. Hence, in the face of a suboptimal cap, a trading program's tendency to interfere with the adoption and environmental achievements of supplemental measures constitutes an economic disadvantage, as the supplemental measure can enhance the allocative efficiency of the environmental effort.

Estimates of the social cost of carbon vary and have endured sharp criticism based on their incompleteness and dependency on quite debatable assumptions.[199] The carbon prices generated by market mechanisms, however, almost always fall far below the US government's estimates of the social cost of carbon, which may be thought of as lower bound estimates.[200] Accordingly, additional programs reducing greenhouse gas emissions generally aid the overall allocative efficiency of national and international greenhouse gas abatement.

As noted earlier, the core technological change reducing greenhouse gas emissions, reducing fossil fuel use, also generates co-benefits from the reduction of smog. William Nordhaus and two other economists have concluded that once these co-benefits are considered, a cost-benefit analysis shows that shutting down all coal-fired power plants in the United States would improve economic efficiency.[201] So, the

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[198] *See* Lecuyer & Quirion, *supra* note 169, at 177-78 (noting that some economists believe that too low a carbon price justifies the use of multiple instruments); Linares & Labandeira, *supra* note 181, at 582 (finding adequate carbon prices "difficult to imagine" and therefore arguing for energy efficiency programs).

[199] *See, e.g.,* Frank Ackerman*, Cost-Benefit Analysis of Climate Change: Where It Goes Wrong, in* ECONOMIC THOUGHT AND U.S. CLIMATE CHANGE POLICY 61, 61-67 (David M. Driesen ed. 2010) (criticizing a leading model for estimating climate's social cost); Frank Ackerman & Elizabeth A. Stanton, *Climate Risks and Carbon Prices: Revising the Social Cost of Carbon*, 6 ECON.: THE OPEN-ACCESS, OPEN-ASSESSMENT EJOURNAL 1 (2012) (suggesting that existing model probably greatly underestimate carbon's social cost); David M. Driesen, *Cost-Benefit Analysis and the Precautionary Principle: Can They be Reconciled?,* 2013 MICH. ST. L. REV. 771, 803-811 (examining problems in the federal government's estimate of the social cost of carbon); Jonathan S. Masur & Eric A. Posner, *Climate Regulation and the Limits of Cost-Benefit Analysis*, 99 CALIF. L. REV. 1557, 1577 (2011) (characterizing the U.S. government's estimate of carbon's social cost as suffering "from a variety of problems that render its conclusions unconvincing"); Weitzman, *supra* note 87, at 10 (faulting estimates of the social cost of carbon for failing to adequately address the potential for catastrophic climate disruption).

[200] *See* Jesse D. Jenkins & Valerie J. Karplus, *Carbon Pricing Under Binding Political Restraints,* 4-5 (Wider Working Paper 2016/44) (noting that taxes reflecting the social cost of carbon are "few and far between"); OECD, *Effective Carbon Rates: Pricing Carbon Through Taxes and Emissions Trading Systems* 15 (2016) (discussing low carbon prices); Roberts, *supra* note 86 (showing that carbon prices in places with carbon taxes or trading are low compared to the social cost of carbon and that this is especially true of trading programs); World Bank & Ecofys, *States and Trends in Carbon Pricing* 13 (2015), http://documents.worldbank.org/curated/en/636161467995665933/pdf/99533-REVISED-PUB-P153405-Box393205B.pdf (noting that 85% of the world's emissions are priced at levels far below the social cost of carbon); *see also* Jenkins, *supra* note 20, at 471 (noting that willingness to pay for carbon reductions is far below the social cost of carbon in the United States).

[201] Nicholas Z. Muller, Robert Mendelsohn, & William Nordhaus, *Environmental Accounting for Pollution in the United States Economy,* 101 AM. ECON. REV. 1649, 1649 (2011) (finding that coal-fired

likelihood that additional measures would advance allocative efficiency would be even greater if one expands the lens to consider co-benefits.

E. Avoiding Dangerous Climate Disruption and Supplemental Measures.

The international community, including the United States, has made avoiding dangerous climate disruption the goal of the climate change regime, not the balancing of costs and benefits at the margin.[202] At present, all of the measures planned in the world do not suffice to meet this goal, so additional measures would bring us closer to this goal.[203] From this perspective, trading's interference with realizing additional emission reductions constitutes a serious issue.

Economic studies show that supplementary policies make it easier to achieve the 2ºC goal when combined with the suboptimal pricing that we have now.[204] Supplementary policies enacted in conjunction with a tax lower barriers to an ambitious target more than supplementary policies enacted with trading.[205]

F. Why not Strengthen the Market Mechanisms? An Evolutionary and Dynamic Perspective.

Regulators, in principle, can respond to an inadequate cap or pollution tax by raising the tax or lowering the cap.[206] And indeed, we have seen that that regulators have lowered caps in response to low allowance prices, albeit slowly. This response preserves market mechanism' cost effectiveness, while potentially solving the problem of an inadequate price on carbon failing to avoid dangerous climate disruption or achieve allocative efficiency. This response, however, does not remedy risk/risk problems or market failures muting the response to a price.

An adequate cap may not sufficiently remedy the problem of inadequate caps for the hybrid trading programs currently employed or the taxes often recommended to address global climate disruption, because of their inclusion of offsets and pollutants that cannot be reliably monitored as possible credit sources. But in principle, design improvements could resolve that problem as well.

As long as we use market mechanisms, strengthening them to better meet environmental goals certainly makes sense. But there may be dynamic and evolutionary reasons to worry about trading's tendency to discourage supplemental

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power plants and several other types of facilities generate damages from pollution exceeding the value they add to the economy).

[202] Driesen, *supra* note 40, at 10 (mentioning the Framework Convention on Climate Change's goal of avoiding dangerous levels of climate disruption).

[203] *See* Jones, *supra* note 9, at 1.

[204] *See* Betram *et al., supra* note 19, at 237 (noting that complementary policies lowers "the socio-economic challenges" to achieving a 2ºC target after a period with a suboptimal carbon price).

[205] *See id.* at 238 (finding complimentary policies 20% more effective in conjunction with a carbon tax than with trading in narrowing the gap between weak carbon pricing and a 2ºC goal).

[206] *See generally* Bennear & Stavins, *supra* note 16, at 118 (noting that multiple market failures do not necessarily justify "multiple policy instruments" because governments can sometimes manipulate the market instruments to address the market failures).

measures or to cancel some of the reductions realized through supplemental programs adopted in spite of the disincentives that trading creates. In addition, some commentators have argued that political limitations make it especially hard to strengthen pricing mechanisms.[207]

1. Technological Innovation

So far, emissions trading has sparked little or no strategically important technological innovation in the climate disruption context (defined as non-obvious departures from prior art).[208] On the other hand, traditional regulation of new cars has spurred radical innovation, creating a market for hybrid vehicles and electric cars.[209]

As mentioned previously, regulators may justify measures supplementing trading and taxes as catalyzing innovation. The economics literature recognizes that markets usually fail to stimulate optimal innovation.[210] Those considering investing in innovation face uncertain prospects of success and likely an inability to capture all of the benefits of successes when they occur (since competitors can often copy or build upon their innovations).[211] And the environmental economics literature recognizes that emissions trading and taxes, even if they price pollution externalities accurately, do not necessarily correct for inadequate incentives for innovation.[212] Accordingly, environmental economists recognize that technological market failures can justify some supplemental measures.[213]

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[207] *See* Görlach, *supra* note 17, at 743 (conceding that a very high carbon price would reduce the need for renewables support but arguing that a high carbon price is not politically sustainable); Jenkins, *supra* note 20, at 474-75 (suggesting that the choice of policy mechanism influences consumer willingness to pay, citing greater support for relatively expensive CAFE standards even while consumers resist modest increases in the gasoline tax).

[208] *See* CORPORATE RESPONSES TO EU EMISSIONS TRADING 10-11 (Jon Birger Skjærseth & Per Ove Eikeland eds., 2013) (summarizing the literature on the effects of the EU ETS on firm innovation as showing very "limited" impact); *cf.* Calel & Deschezplepretre, *supra* note 50, at 174 (attributing 2% of a low carbon patent surge in the EU to the EU ETS).

[209] *See* Driesen, *supra* note 39, at 43 (pointing out that California's Low Emission Vehicle standards spurred the development and sale of hybrid vehicles); Bradley W. Lane et al., *Government Promotion of the Electric Car: Risk Management or Industrial Policy*?, 4 EUR. J. RISK REG. 227, 230-31 (2013) (explaining how California Zero Emissions Vehicle requirements have spurred development of electric cars).

[210] *See* Nic Rivers & Mark Jaccard, *Choice of Environmental Policy in the Presence of Learning by Doing,* 28 ENERGY ECON. 223, 226 (2006) (arguing that investments in learning-by-doing may be suboptimal).

[211] *See* Bennear & Stavins, *supra* note 16, at 119 (noting that uncertainties and the difficulties of obtaining a high payoff on investments can lead to "underinvestment" in innovation).

[212] *Id.* (noting that "environmental policy alone" does not completely overcome "technological market failures"); Gregory N. Mandel, *Innovation Rewards: Towards Solving the Twin Market Failures of Public Goods*, 18 VAND. J. ENVT. & TECH. L. 303, 321 (2016) (noting that neither "cap-and-trade" nor taxes address the market failure in innovation); Rivers & Jaccard, *supra* note 210, at 226 (stating that in the presence of learning-by-doing taxes and other market-based instruments may provide inadequate incentives for clean energy); Twomey, *supra* note 16, at 15.

[213] *See* Lecuyer & Quirion, *supra* note 169, at 177 (stating that some economists endorse multiple instruments based on the need to stimulate innovation); *see, e.g.* Bennear & Stavins, *supra* note 16, at

A quick glance at the environmental economics literature, however, would leave the impression that innovation needs would never justify supplemental traditional regulation to catalyze innovation, as much of it suggests that market-based mechanisms stimulate innovation and traditional regulation does not.[214] A close reading of the economics literature, however, shows more of a division among economists on market-based mechanisms' propensity to spur innovation than one might suppose.[215]

Some scholars have argued that trading does less than a performance standard of comparable stringency to catalyze high cost innovation.[216] By lowering the cost of deploying routine environmental technologies, trading can reduce pressures on high cost sources to innovate to escape high abatement costs.[217] Furthermore, the small empirical literature comparing traditional regulation to emissions trading addressing the same pollutants finds more innovation under traditional regulation.[218] In

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119 (commending combination of environmental policies with measures to stimulate technological innovation and diffusion); Bertram *et al., supra* note 19, at 237 (finding that "additional technology policies. . . lower socio-economic challenges" in meeting a 2ºC target and "partially compensate for a lower than optimal carbon price"). It is not clear that Bennear and Stavins would endorse California vehicle emission regulation or other types of environmental policies as innovation enhancing measures. They try to neatly divide the world into "environmental policies" on the one hand and measures promoting technological innovation and diffusion on the other. Beenear & Stavins, *supra,* at 119. A zero emissions requirement for part of the vehicle fleet, however, constitutes an environmental policy that promotes technological innovation and diffusion. Although they endorse subsidies, they only do so when the subsidies change the costs of research and development, not explicitly when they provide returns on use of technologies that might encourage firms to incur unchanged R & D costs. *Id.* But the existence of a market failure in innovation could justify environmental measures aiming at overcoming that failure, at least in some cases. *See* Bertram et al., *supra* at 236-37 (finding that renewable support and coal moratorium policies make up for deficiencies in suboptimal carbon pricing schemes).

[214] *See, e.g.,* Rivers & Jaccard, *supra* note 210, at 226, 235-38 (noting the standard assumption about market-based instruments' superiority in stimulating new technology and concluding that even when technologies evolve over time, market-based instruments are likely to prove more cost effective than traditional regulation).

[215] *See* David M. Driesen*, Design, Trading, and Innovation*, in MOVING TO MARKETS IN ENVIRONMENTAL PROTECTION: LESSONS FROM 20 YEARS OF EXPERIENCE 436, 441-42 (Jody Freeman & Charles Kolstad eds. 2006) (explaining that economists divide on this question depending on whether or not they focus on the Malueg model); *Görlach, supra* note 17, at 735 (defining dynamic efficiency as about "ensuring that low-cost abatement options become available in the future.").

[216] *See* Driesen*, supra* note 215, at 443 (explaining that trading reduces incentives for costly innovation by allowing polluters with high marginal abatement costs to escape by paying for allowances instead of innovating); David M. Driesen, *Does Emissions Trading Encourage Innovation*?, 33 ENVTL. L. REP. (Envtl. L. Inst.) 10094 (2003) (hereinafter ELR).

[217] *See* Driesen, ELR, *supra* note 216, at 10096 (explaining that emissions trading lessens incentives for high cost sources to innovate); *accord* David A. Malueg, *Emissions Credit Trading and the Incentive to Adopt New Pollution Abatement Technology,* 16 J ENVT. ECON. & MGMT. 52, 54-56 (1987) (explaining that under a trading program some polluters make fewer reductions than under a traditional regulation and some make more).

[218] David Popp, *Pollution Control Innovation and the Clean Air Act of 1990,* 22 J. POL'Y ANALYSIS & MGMT. 641 (2003) (finding less innovation in technologies reducing sulfur dioxide under trading than occurred under command and control, but finding a boost in innovations enhancing control efficiencies under trading); Margaret Taylor, *Innovation Under Cap-and -Trade Programs*, 109 PROC. OF THE Nat'l

addition, since emissions trading does encourage new investments in refining existing technologies, it may facilitate technological lock-in, thereby raising the opportunity cost of abandoning dirty old technologies for much cleaner alternatives.[219]

High cost innovation may prove very important to addressing long-term environmental problems like climate disruption, because it lays a foundation for dynamically lowering the cost of core technologies over time, as the clean car example illustrates.[220] In other words, a tension exists between maximizing near term cost effectiveness and long-term technological development.[221] This argument suggests a justification for supplementing trading with additional measures catalyzing important innovations.[222]

This argument also would suggest that one might fruitfully supplement taxes with supplemental measures to catalyze needed innovation as well. Taxes also encourage least cost changes, and may not catalyze significant innovations that require great initial expense. The literature suggests that innovation-promoting policies prove more effective at closing the gap between suboptimal pricing and ultimate climate goals than trading.[223]

2. Policy Evolution and Additional Measures.

Environmental policy tends to evolve over time. This evolution matters a lot when governments confront a long-term challenge of broad dimensions, such as global climate disruption.

Furthermore, no single government controls this evolution. Most environmental law scholars endorse a model of multilevel governance, which focuses on complex interactions between different levels of government and private actors.[224]

ACAD. of SCI. 4804 (2012) (finding less innovation under the acid rain trading program than under prior command and control regulation); *see also* Calel & Deschezplepêtre, *supra* note 50, at 188-90 (finding, as other emissions trading studies have, a relatively small positive effect on innovation from trading).

[219] *See* Görlach, *supra* note 17, at 743 (pointing out that relying solely on all of the cheapest options "until their potential is exhausted" encourages "lock-in," making significant changes more expensive, time consuming, and less politically feasible); *see also* Spash & Lo, *supra* note 57, at 71 (suggesting that the radical innovations needed to address global climate disruption respond less readily to price signals than incremental innovation).

[220] *See* Driesen, *supra* note 39, at 25.

[221] *See id.* at 59 (arguing that environmental law must address the tension between "short-term cost effectiveness and long-term sustainable development").

[222] *Cf.* Jonas Meckling et al., *Winning Coalitions for Climate Policy: Green Industrial Policy Builds Support for Climate Regulation,* 11 SCIENCE 1170 (2015) (suggesting that targeted measures are important to build political support for effective pricing policies).

[223] *See* Bertram *et al., supra* note 19, at 238 (finding technology policies about 20% more effective when enacted in conjunction with a carbon tax than when enacted with trading in "closing the climate action gap").

[224] *See, e.g.,* Sarah E. Light & Eric W. Orts, *Parallels in Public and Private Environmental Governance*, 5 MICH. J. ENVTL. & ADMIN. L. 1, 4 (2015) (stating that today's environmental problems require "multi-faceted legal approaches that combine local, regional, national, and international public law" with private participation); Michael P. Vandenbergh & Jonathan A. Gilligan*, Beyond Gridlock,* 40 COLUM. J.

Whether or not multilevel governance seems desirable, climate policy offers a case study in multilevel governance. The global climate regime includes global agreements among nations, broad policy goals and specific policies for the entire European Union, numerous programs adopted by individual countries, an emissions trading program forged by a group of U.S. States, globally important law emanating from a single U.S. State (California), and numerous initiatives by local and state governments around the world.[225] This regime also engages private parties in a variety of ways, as brokers, technological innovators, policy entrepreneurs, and third party verifiers of compliance.[226]

Furthermore, the law in this area features transnational learning. The European Commission, an organ of the EU, consulted with leading U.S. experts before construction the EU ETS.[227] German success with the feed-in tariff (a program offering an above-market price for deployment of renewable energy) seems to have stimulated similar programs in China and the Chinese solar industry.[228]

While thinking about instrument choice from the standpoint of a single ideal regulator achieving a single goal in one stage has some advantages for clarifying theory, climate policy depends on the evolution of policy across multiple jurisdictions over time. In such a context, the ability of leading jurisdictions to establish ambitious programs going beyond what their neighbors appear willing to do may matter a great deal, as the introduction suggested.[229] California policymakers have long viewed themselves as playing that role, and we have already seen that California low emission vehicle standards have served as a model for U.S. CAFE standards. Many countries have adopted similar standards that seem to follow the California model.[230] Germany's feed-in tariff program establishes a model that many other countries have

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ENVTL. L. 217, 302-03 (2015) (advocating private initiatives pending government action on climate disruption).

[225] *See* David M. Driesen, *Linkage and Multilevel Governance*, 19 DUKE J. COMP. & INT'L L. 389, 390-96 (2009) (explaining that the international, national, and regional governments play a role in implementing emissions trading under the Kyoto Protocol); Heike Schroeder & Harriet Bulkeley, *Global Cities and the Governance of Climate Change: What Is the Role of Law in Cities*?, 36 FORDHAM URB. L.J. 313, 316 (2009) (explaining that cities have adopted greenhouse gas emission reduction targets).

[226] *See, e.g.,* Driesen, *supra* note 225, at 393-94 (discussing private actor's enforcement role in emissions trading under the Kyoto Protocol); *see generally* Harro van Asselt, *The Role of Non-State Actors in Reviewing Ambition, Implementation, and Compliance under the Paris Agreement,* 6 CLIMATE L. 91, 94-99 (2016) (reviewing the role of non-state actors in the climate regime, with some emphasis on agenda setting and compliance monitoring).

[227] *See* JONAS DREGER, THE EUROPEAN COMMISSION'S ENERGY AND CLIMATE POLICY: A CLIMATE OF EXPERTISE 37 (2014) (stating that an EPA official explained to the European Commission that allocation proves controversial and that industry prefers grandfathering to auctioning).

[228] *See* IPCC, CLIMATE CHANGE 2007: MITIGATION OF CLIMATE 762 (2007) (finding price supports for renewable energy very effective in reducing greenhouse gas emissions); Eric R. Carlson, *Chinese Companies had been Dumping Under Market Price Solar Panels and Parts on European Consumers at a Loss Backed by Significant Financial Support from the Government,* 032213 ABI-CLE 141 (2013) (mentioning allegations that China has dumped solar panels and parts on European markets).

[229] *See generally* Twomey, *supra* note 16, at 19-20 (associating institutional and evolutionary economics with the idea that we need a diversity of "technology platforms").

[230] *See* International Council on Clean Transportation, *The State of Clean Transportation Policy* (2016), http://www.theicct.org/sctp-ldv-e (comparing CAFE standards around the world).

used. Hence, taxes' propensity to allow and even reinforce tendencies of leading jurisdictions to enact ambitious programs and trading's propensity to lessen the effectiveness of ambitious models and sometimes discourage their adoption matters.[231]

Almost any polity can enact some sort of leading program. But, at least when a national or regional government enacts a trading system, evolution and improvement of trading becomes something that only a few governments can manage. For example, the European Union as a whole can improve, and has improved, the EU ETS, but member states cannot do that on their own. In principle, however, countries or states subject to a regional or national tax could adopt stricter taxes on their own, without losing the environmental benefits. Hence, the need to accommodate and make effective programs enacted in leading polities, in order to establish models for the rest of the world, strongly argues for choosing an instrument that plays nice with other instruments.

Furthermore, evolution of a single instrument at a national or regional level requires a consensus among the polities making up the national government or region. The EU cannot craft an emissions trading scheme based on the policy preferences of a leading environmental polity like Sweden. It must take into account the views of governments in southern and Eastern Europe and more heavily industrialized countries, which may constrain the effective evolution of policy. But an additional measure demonstrating the efficacy of vehicles not relying on gasoline, nuclear power, or solar energy can occur at a lower level of governance, at least if higher level law permits it.[232] Such demonstrations can in turn convince a higher level of government of the feasibility of stricter caps and higher tax rates.[233] Hence, a single market-based instrument adopted by a broad polity will not likely prove sufficient on its own to address a challenge like global climate disruption. Playing nice with other instruments matters in theory if one believes that jurisdictional diversity offers important potential for demonstrating the feasibility of high ambition.[234]

Thus, a strong case exists for giving weight to a pollution tax's ability to play nice with other instruments in theory. Such an approach can address risk/risk problems, market failures, and inadequacies in market-based mechanisms, whilst facilitating the evolution of policy across time and multiple jurisdictions. Since governments, at any rate, almost always combine market-based mechanisms with other policies, the playing nice advantage obviously matters a lot in practice.

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[231] *Cf.* R. Denniss, M. Grudnoff, & A Macintosh, *supra* note 63, at 43 (arguing against the Australian Capital Territory's target of a 40% greenhouse gas reduction by 2020 because it will simply "free up additional pollution permits in other states").

[232] *See generally* Kirsten H. Engel & Scott R. Saleska, *Subglobal Regulation of the Global Commons: The Case of Climate Change*, 32 ECOLOGY L.Q. 183, 184-186 (2005) (discussing bottom-up climate policy with emphasis on U.S. States and municipalities).

[233] *See* Eric Biber, Nina Kelsey, & Jonas Meckling, *The Political Economy of Decarbonization: A Research Agenda,* 82 BROOKLYN L. REV. 1, 12-13 (2017) (suggesting that targeted programs may be needed to make a reasonably high carbon price politically feasible)*; see generally* Kirsten H. Engel*, Harnessing the Benefits of Dynamic Federalism in Environmental Law,* 56 EMORY L.J. 159, 170-72 (2006) (discussing dynamic federalism in which State policies change federal policies).

[234] *Cf.* Twomey, *supra* note 16, at 20-22 (suggesting that we may need a diversity of policy approaches to climate disruption because of uncertainty about how various approaches will perform in practice).

G. Implications, Additional Research, and a Caveat.

This article has made the case for an evolutionary multiple jurisdictional view of environmental policy, the improved allocative efficiency through supplemental measures, and the need for them to avoid serious dangers based primarily on the climate example. Doing that leaves open the question of whether the case for preferring a pollution tax based on its capacity to play more nicely with other programs than emissions trading applies outside that context.

A number of other environmental problems have multiple causes, require actions from multiple jurisdictions, and depend on multijurisdictional policy evolution and technological innovation in a variety of sectors. These problems include the problems of ground level ozone and particulate matter pollution.[235] In such cases the arguments based on policy and technological evolution apply fully. Also, these particular cases involve problems that often suffer from insufficiently ambitious programs, just as climate disruption does, at least in many places.[236] So, in many contexts, the capacity of a market-based mechanism to play nice with other instruments matters.

Yet the case made above does not completely rule out the possibility that we can sometimes tackle a relatively simple environmental problem with a single instrument adjusted over time. For example, the problem of lead in gasoline involved a single substance in a single industry. We began the phase-out of lead with traditional regulation. But we completed it with a trading program.[237] Federal law largely preempts State capacity to regulate lead in gasoline, so the idea of a leading polity advancing matters through some sort of innovative approach did not apply.[238] For a relatively simple pollution problem like abatement of lead in gasoline, the capacity of a chosen market-based instrument to play nice with other instruments does not seem to matter a whole lot.

One might also ask whether governments can design around the waterbed effect when enacting new programs. The most straightforward design fix would involve prohibiting the sale of allowances made from a capped source under a new mandatory program. Sometimes free trade law or the law establishing a trading program may not allow this particular fix, and even when it does allow, taking away a quasi-property right in allowances may prove politically difficult as it violates

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[235] *See, e.g.,* EPA v. EME Homer City Generation, 134 S. Ct. 1584, 1593-1598 (2014) (discussing State and federal roles in managing particulate and ozone pollution that crosses State boundaries).

[236] *See id.* at 1595-96 (discussing a rule seeking to remedy continuing failure to attain air quality standards); Michael Livermore & Richard Revesz, *Rethinking Health-Based Environmental Standards,* 89 N.Y.U L. REV. 1184, 1189 (2014) (showing that for these pollutants and others, existing standards are suboptimal).

[237] *See* Driesen ELR, *supra* note 216, at 10105 (discussing the trading rule); Small Refiner Lead Phase-down Task Force v. U.S.E.P.A., 705 F.2d 506, 512-14 (D.C. Cir. 1983) (discussing the course of early lead regulation).

[238] *See* Oxygenated Fuels Ass'n, Inc. v. Davis, 331 F.3d 665, 668 (9th Cir. 2003) (explaining that the Clean Air Act preempts state fuel additive regulation except in California).

settled expectations.[239] In general, design fixes may cause delay, legal difficulties, further political problems, and added complexity. But certainly the question of whether design fixes can address the waterbed effect merits more research.

This article's insights regarding the relative merits of taxing and trading in a world of multiple instruments matter a great deal globally, because many countries will be choosing whether to use taxes or trading to price carbon in the coming years. The recently concluded Paris Agreement rests on new pledges by developing countries to limit carbon emissions, and some of them have carbon taxes under active consideration. Canada has quite recently signed the Paris accord and Prime Minister Trudeau has announced that Canadian provinces must impose a carbon price, either through taxation or a cap-and-trade program.[240] Some countries and jurisdictions have already chosen pollution taxes and polities (including Canadian provinces) should take this article's lessons into account as they choose and design new instruments to meet Paris pledges.[241]

Furthermore, if countries that have relied on trading programs experience too many difficulties with the weak trading design that have become common, even these countries may, at some point, change course. In Europe, an oversupply of allowances

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[239] *See, e.g.,* Clean Air Markets Group v. Pataki, 194 F. Supp. 2d 147, 157–61 (N.D.N.Y. 2002), *aff'd*, 338 F.3d 82 (2d Cir. 2003) (finding that a state law restricting allowance sales violates the dormant Commerce Clause and is preempted by the Clean Air Act); James Munro, *Trade in Carbon Units As A Financial Service Under International Trade Law: Recent Developments, Future Challenges*, 8 CARBON & CLIMATE L. REV. 106, 113 (2014) (suggesting that tradable allowances constitute a financial asset regulated by the WTO Annex on Financial Services); Elias Leake Quinn, Comment, *The Solitary Attempt: International Trade Law and the Insulation of Domestic Greenhouse Gas Trading Schemes from Foreign Emissions Credit Markets*, 80 U. COLO. L. REV. 201, 203, 210 (2009) (suggesting that international trade law may demand free trade in emission allowances); Glenn M. Wiser, *The Clean Development Mechanism Versus the World Trade Organization: Can Free-Market Greenhouse Gas Emissions Abatement Survive Free Trade?*, 11 GEO. INTL. ENVTL. L. REV. 531, 594 (1999) (suggesting that sales of emission reduction credits might be subject to trade disciplines under the General Agreement on Trade in Services).

[240] Kathleen Harris, *Justin Trudeau Gives Provinces until 2018 to Adopt Carbon Price Plan,* CBA News (October 3, 2016), http://www.cbc.ca/news/politics/canada-trudeau-climate-change-1.3788825.

[241] Republic of South Africa, Draft Carbon Tax Bill, §13 (2015), http://www.treasury.gov.za/public%20comments/CarbonTaxBill2015/Carbon%20Tax%20Bill%20final%20for%20release%20for%20comment.pdf (proposing a new carbon tax); World Bank & Ecofys, Carbon Pricing Watch 2016 6 (2016), http://documents.worldbank.org/curated/en/418161467996715909/pdf/105749-REVISED-PUBLIC-New-CPW-05-25-16.pdf (showing carbon taxes introduced in Mexico, Chile, Portugal, and France since 2014); *see also* Ipshita Chaturvedi, *The 'Carbon Tax Package': An Appraisal of its Efficiency in India's Clean Energy Future,* 4 CARBON & CLIMATE L. REV. 494 (2016) (evaluating India's carbon related taxes); INDIA, INDIA'S INTENDED NATIONALLY DETERMINED CONTRIBUTION: WORKING TOWARDS CLIMATE JUSTICE 27 (2015), http://www4.unfccc.int/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf (last visited Oct. 13, 2016) (indicating that India is creating an "implicit" carbon tax by raising taxes on petrol and diesel); Ed King, *India to Double Coal Tax under 2016-17 Budget*, Climate Home, Feb. 29, 2016, http://www.climatechangenews.com/2016/02/29/india-to-double-coal-tax-under-2016-17-budget/ (last visited Oct. 12, 2016) (indicating that India has taxed coal at increased rates); *Excise Tax for New Car 2016*, THAILAND AUTOMOTIVE INSTITUTE, http://www.thaiauto.or.th/2012/news/news-detail.asp?news_id=3198 (last visited Oct. 12, 2016) (indicating that Thailand has adopted an excise tax, which taxes new high carbon vehicles at a greater rate than low carbon vehicles).

(stemming mostly from the financial crisis) threatens to make the EU ETS irrelevant to carbon reduction efforts for some time.[242] If the EU ETS becomes a significant barrier to meeting climate goals through supplemental programs while accomplishing very little itself, the EU may eventually abandon it.[243] Already, the United Kingdom has felt obliged to supplement the EU ETS with a carbon tax in order to make up for the low prices of allowances.[244] And the United Kingdom has voted to leave the EU, so it no longer has to participate in the EU emissions trading scheme.[245] This paper suggests that the EU may be wise to substitute a higher carbon tax for participation in the EU ETS. Even in the United States, while prospects for a federal carbon tax appear very bleak, legislators have introduced carbon tax proposals in several states.[246] While a federal carbon tax looks unlikely in a Trump Administration, the deficits created by his proposals to cut taxes and fund infrastructure together with the deficit in carbon reductions might create some impetus to consider a carbon tax more seriously than in the past if the politics shift drastically.[247] Any polity choosing between taxes and trading should consider the opportunity pollution taxes offer as a useful framework around which to construct complementary instruments.

CONCLUSION

[242] Stephen Sewalk, *Europe Should Dump Cap-and-Trade in Favor of Carbon Tax with Reinvestment to Reduce Global Emissions*, 5 WASH. & LEE J. ENERGY, CLIMATE & ENV'T 355, 371-74 (2014) (claiming that the EU ETS is failing because of oversupply of allowances stemming from inadequate caps and the recession).

[243] *See id.* (advocating such an abandonment).

[244] ENERGY AND CLIMATE CHANGE COMMITTEE, THE ENERGY REVOLUTION AND THE FUTURE CHALLENGES FOR UK ENERGY AND CLIMATE CHANGE POLICY: THIRD REPORT OF SESSION, 2016-2017 28 (2016) (noting that the UK has established a "carbon price floor" of £18 per tonne of carbon, even though the EU ETS price is around £6 per tonne of carbon).

[245] ID. (noting that the future of the UK's role in the EU ETS sparked considerable debate among witnesses appearing before the House of Common's Energy and Climate Change Committee); COMMITTEE ON CLIMATE CHANGE, MEETING CARBON BUDGETS: IMPLICATIONS OF BREXIT FOR UK CLIMATE POLICY 6 (October, 2016) (discussing the implications of leaving the EU ETS for UK carbon budgets); SELECT COMMITTEE ON THE EUROPEAN UNION, ENERGY AND ENVIRONMENT SUBCOMMITTEE, UNCORRECTED ORAL EVIDENCE: BREXIT: ENVIRONMENT AND CLIMATE CHANGE 8-13 (November 23, 2016), http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/eu-energy-and-environment-subcommittee/brexit-environment-and-climate-change/oral/43853.pdf (testimony regarding the desirability of leaving the EU ETS as part of Brexit); SELECT COMMITTEE ON THE EUROPEAN UNION, ENERGY AND ENVIRONMENT SUBCOMMITTEE, UNCORRECTED ORAL EVIDENCE: BREXIT: ENVIRONMENT AND CLIMATE CHANGE 27-31 (November 2, 2016), http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/eu-energy-and-environment-subcommittee/brexit-environment-and-climate-change/oral/42724.pdf (same).

[246] Janet Milne, A *Tale of Four States* (2016) (forthcoming).

[247] *See* Melanie Zanona, *Five Things to Know About Trump's Infrastructure Plan,* THE HILL, (November 20, 2016) (noting that Trump has called for $1 trillion of infrastructure investment over ten years, but proposes to finance it with $137 billion of tax credits, while declaring himself open to other ideas); James R. Nunns *et al., Analysis of Trump's Tax Plan,* Tax Policy Center: Urban Institute and Brookings Institution 1 (December 22, 2015) (noting that Trump's tax cut proposal would reduce federal revenue by $9.5 trillion over a decade).

A pollution tax plays much more nicely with other instruments than emissions trading. For this reason, governments should prefer taxation to trading when dealing with a complex problem requiring substantial policy evolution over time at a variety of governmental levels, in other words, for most environmental problems. When polities, inside or outside the climate context, consider economic incentive mechanisms, they should generally prefer taxes over trading on the basis of taxes' superiority in working with, rather than against, other mechanisms likely to play a role in combating complex environmental problems.