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Unilateral Climate Regulation

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UNILATERAL CLIMATE REGULATION

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It is now plain that decades of negotiation toward a binding global climate treaty have failed. Yet, at the same time, many nations are adopting a range of unilateral policies to address climate change. The existing literature on climate policy neglects these unilateral climate regulations because it focuses on the necessity and possible design of a multilateral climate treaty. But these domestic regulations present a unique puzzle: Given that climate outcomes are determined by global emissions, and that unilateral regulations inevitably influence incentives to regulate elsewhere, how can domestic action achieve the greatest marginal reduction in global emissions? In other words, how can regulators encourage, rather than discourage, action in other countries?

This Article answers this question by describing three ways that unilateral regulation influences incentives to regulate in other countries. First, domestic regulations can interact with other nations' regulations in a way that increases those countries' incentives to regulate. Second, unilateral regulation can support incentives to regulate elsewhere by limiting the incentive for polluters to move, or "leak," to countries with weaker regulation. Third, unilateral regulations that are modular and simple will serve as potential model rules in a wider swath of countries. These considerations have important implications for regulators looking to maximize the global impact of their unilateral actions. They suggest that, contrary to the received wisdom in climate policy, regulators should prefer regulation with publicly transparent costs. They also suggest that, contrary to the current state and federal preference for cap-and-trade systems and energy-efficiency standards, unilateral regulators should prefer carbon taxes and funding for green technology.

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INTRODUCTION

Many of today's pressing environmental problems are global "public bads" that no one country can solve. Climate change is the prime example.[2] Characteristic activities of human civilization in every country — heat, electricity, transportation, and farming — emit greenhouse gases that warm the whole earth.[3] Given the global nature of the problem, the literature on climate change has focused on the need for an international treaty specifying what each country should do. But there is no such treaty, and there is no prospect of such a treaty.[4] At the same time, many individual nations are adopting domestic

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[2] Rachel Brewster, *Stepping Stone or Stumbling Block: Incrementalism and National Climate Change Legislation*, 28 YALE L. & POL'Y REV. 245, 268 (2010) ("The planet's atmosphere is a public good, and climate change constitutes a public bad.").

[3] NAT'L RESEARCH COUNCIL, CLIMATE CHANGE SCIENCE: AN ANALYSIS OF SOME KEY QUESTIONS 10–11 (2001) [hereinafter CLIMATE CHANGE SCIENCE]; Endangerment Finding, 73 Fed. Reg. 44354, 44402–03 (July 30, 2008) (describing greenhouse gases attributable to diverse human activities such as electricity, heating, cooking, transportation, landfills, mining, industry, soil management, land use change, and raising domesticated animals); Jonathan Baert Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L.J. 677, 692 (1999) ("[I]n every country, virtually every human activity directly or indirectly emits GHGs . . . ."). In 2005, 66.5% of the world's greenhouse gas emissions were from energy use, 13.8% were from agriculture, and 12.2% were from changing land use. Tim Herzog, *World Greenhouse Gas Emissions in 2005* 2 (World Res. Inst. Working Paper, 2009), *available at* http://perma.law.harvard.edu/0Lp6U6bBPX9.

These gases stay in the atmosphere for centuries. *See, e.g.*, Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153, 1159–61, 1165 (2009). And the earth's temperature can take further centuries to adjust. *See id.* at 1164–68 (describing stock/flow relationship between greenhouse gas emissions and resulting warming).

[4] Multilateral negotiations are challenging in any context, but climate change treaty negotiations are particularly difficult given the distributional issues, high stakes, and long-term commitments involved. Current negotiations remain deadlocked by a disagreement between developed nations and developing nations regarding the amount of emissions that should be allocated to developing countries. Brewster, *supra* note 2, at 300 & n.176. *See infra* note 72 for a fuller discussion of this deadlock.

Although the 1997 Kyoto Protocol committed thirty-seven industrialized countries and the EU to reduce their emissions, it was far from a global, enforceable treaty, and is now expiring. Kyoto Protocol to the United Nations Framework Convention on Climate Change art. 3(1), Dec. 10, 1997, U.N. Doc FCCC/CP/1997/7/Add.1, 37 I.L.M. 22 (1998). The United States rejected it from the start, *see* S. Res. 98, 105th Cong. (1997), because it did not provide for reductions from major emitters like China, India, Indonesia, and Brazil, Brewster, *supra* note 2, at 273 n.80 (2010), and even some of the countries that adopted the Protocol did not meet their commitments, Jonathan H. Adler, *Eyes on a Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization*, 35 HARV. ENVTL. L. REV. 1, 9 nn.50–53 (2011). Japan recently dropped its Kyoto commitment to cut its emissions by twenty-five percent, and will now promise only that its emissions will rise no more than three percent above 1990 levels. Hiroko Tabuchi & David Jolly, *Japan Backs Off From Emissions Targets, Citing Fukushima Disaster*, N.Y. TIMES (Nov. 15, 2013), http://perma.cc/

greenhouse gas regulations.[5] These regulations are puzzling: Most of the benefit of limiting greenhouse gas emissions in one country accrues to other countries and if unilateral climate regulation encourages increased greenhouse gas emissions in other countries, it could do more harm than good. Scholarship on the design of climate policy has generally assumed that these domestic regulations are principally a first step toward a global treaty, so it has focused on what domestic regulations would be good models for multilateral regulation. But the quest for a binding global treaty has proven to be a non-starter. So this Article takes a different approach, asking how domestic regulation can marginally mitigate environmental harm even without a treaty — that is, it studies the optimal design of *unilateral climate regulation*. It describes how, holding regulatory stringency constant, careful instrument choice can maximize the chance that other countries will strengthen their own domestic greenhouse gas regulations.

Part I briefly describes the problem of unilateral climate regulation, the gap in the literature concerning it, and the stakes of improved regulatory design. Many countries are adopting unilateral climate regulations, but existing scholarship focuses on proper choice of multilateral climate regulation. There has also been little attention to the ways that unilateral regulation might affect incentives to regulate in other countries, which is particularly important because, as Part I argues, even marginal changes in the stringency of foreign domestic climate regulations would have important effects.

Parts II–IV examine three ways that unilateral climate regulation influences incentives to regulate in other countries. *First*, as Part II explores, certain regulatory interactions can increase other nations' incentives to regulate. One way to do this is with conditional regulation, in which unilateral regulators precommit to adopt more stringent controls if other countries increase their commitments. For example, the European Union could commit to increase the stringency of its climate regulation on the condition that the United States or China adopt somewhat more stringent regulation. On the other hand, linkages proposed in the existing literature would seriously undercut domestic incentives to regulate. For instance, given the focus on a global deal prescribing connected national cap-and-trade regulations, many have advocated adopting and then connecting domestic cap-and-trade systems in different countries as a first step toward a treaty. But, if there is no treaty, connecting domestic cap-and-trade regulations would actually exacerbate incentives to free-ride in connected re-

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VL4W-P2DM. And Canada announced that it would withdraw from the Protocol, because it considered the targets impossible to meet. Ian Austen, *Canada Announces Exit From Kyoto Climate Treaty*, N.Y. TIMES (Dec. 12, 2011), http://perma.cc/0ZouMDmXEad. A 2009 meeting in Copenhagen was supposed to produce a more comprehensive and effective successor, but failed to produce any new agreement, or even any extension of the Protocol. Later meetings in Cancun, Durban, and Doha only resulted in agreements to agree in the future, rather than commitments to binding reductions. John M. Broder, *Climate Talks Yield Commitment to Ambitious, but Unclear, Actions*, N.Y. TIMES (Dec. 19, 2012), http://perma.law.harvard.edu/0vspgbciCqN.

[5] *See generally* Roger Martella, Jr., James Coleman & Jeffrey Gracer, *North American and Global Integration of Carbon Control Markets*, *in* THE LAW OF CLIMATE CHANGE IN CANADA 19-1 (Dennis Mahony ed., 2d ed. 2012); Daniel A. Farber, *Carbon Leakage Versus Policy Diffusion: The Perils and Promise of Subglobal Climate Action* 5–10 (UC Berkeley Public Law, Research Paper No. 2102060, 2012), *available at* http://perma.law.harvard.edu/0MKMecKwtcv.

gimes. In linked cap-and-trade schemes, polluters purchase permits from countries where permits are abundant and consequently cheap. This money transfer creates a powerful incentive for countries to issue more permits, which undercuts regulation.

Second, as Part III explores, when polluters flee jurisdictions that pursue unilateral regulation — moving, or "leaking," to countries with less stringent climate regulation — it weakens incentives to regulate in other countries for two reasons. For one thing, it economically punishes countries that regulate and rewards those that do not. Even worse, the politics of countries that do not regulate will increasingly be dominated by burgeoning polluting industries. So greenhouse gas emissions will be increasingly concentrated in countries that become less and less likely to regulate. To the extent that unilateral regulation can limit leakage, either through subsidies or tariffs, it will mitigate this problem. Thus, unilateral regulation inevitably has an effect on incentives to regulate elsewhere; leakage weakens incentives to regulate in other countries and the better it is controlled, the less harm unilateral regulation will cause.[6]

Third, as Part IV argues, all other things equal, unilateral regulations will be more likely to encourage action elsewhere if they are clear, modular, and simple. Although the primary obstacle to regulation of global problems is incentives, not regulatory knowledge, the cost of designing effective regulation is also a barrier to action. Providing examples of successful regulations reduces this barrier. Thus, ideal regulations would be modular so that countries could adopt them without also borrowing a background legal regime — for instance, addressing global problems through the tort system might not provide a useful model because, even if it proved effective, other countries would be unlikely to adopt the tort system of a first-mover country. Ideal regulations would also be simple so that they could serve as a model to the widest possible range of countries, including countries without the capacity to adopt very complex regulations.

Finally, as Part V argues, these three considerations should alter our view of proposed alternative domestic climate policies. The conventional wisdom has long been that climate regulation will be most politically successful if its economic costs are not fully transparent to the public, which is one common argument against a carbon tax.[7] But, this Article argues, each of the three fac-

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[6] Thus, although leakage is sometimes thought of as a reason not to regulate at all, leakage is also an important consideration for countries that *do* choose to regulate. *Cf.* Cary Coglianese & Jocelyn D'Ambrosio, *Policymaking Under Pressure: The Perils of Incremental Responses to Climate Change*, 40 U. CONN. L. REV. 1413, 1429 (2008) (arguing that it is "better to wait to develop a comprehensive and effective climate change policy rather than to . . . adopt incremental options" because "leakage from unregulated areas can undermine the reductions made in more policy active states.").

[7] *See, e.g.*, Joseph E. Aldy, Richard Baron & Laurence Tubiana, *Addressing Cost: The Political Economy of Climate Change*, *in* BEYOND KYOTO: ADVANCING THE INTERNATIONAL EFFORT AGAINST CLIMATE CHANGE 85, 100–01 (2003) (arguing that carbon tax "has never been seriously pursued in the climate negotiations" because it "makes the costs of climate policy more transparent than a quantitative approach," thus "presenting an easier target for opponents of climate action"); Robert N. Stavins, *Policy Instruments for Climate Change: How Can National Governments Address a Global Problem?*, 1997 U. CHI. LEGAL F. 293, 320–21 (1997) (arguing

tors here suggests that transparent climate regulation is most compatible with encouraging other countries to strengthen their climate regulations: Matching commitments require credible and transparent measurements of stringency; limiting leakage through subsidies that compensate for regulatory burdens will lead to trade disputes that can only be mitigated by more transparent regulation; and transparent regulatory mechanisms will be easier for other countries to copy.

As a result, state and federal regulators attuned to the external effects of their unilateral climate policies should shift from their current focus on cap-and-trade and energy-efficiency standards, and focus on more transparent policies such as carbon taxes or funding for greenhouse gas reducing technology. Admittedly, these regulators — legislatures, executive agencies, and the courts — face important political, practical, and legal constraints that limit their freedom to adopt regulations that are optimized for encouraging action overseas. Legislation often requires supermajority support, and agencies and courts can act only within the authority given to them by statutes, constitutions, or other sources of law. Further, these regulators will naturally continue to consider more traditional domestic efficiency and equity issues. Thus, the factors identified here for encouraging action overseas are not determinative in all cases. But the net impact of unilateral climate regulation depends on whether it marginally encourages or discourages unilateral regulation in other countries. Accordingly, it is crucial that regulators consider these factors when they have some freedom of action in designing domestic greenhouse gas policy.

I. The Neglected Stakes of Unilateral Climate Regulation

Despite the failure of efforts to secure a binding climate treaty, countries have adopted a wide range of domestic policy instruments to control greenhouse gases. The European Union, along with other jurisdictions,[8] uses a cap-and-trade system, in which polluters are required to hold a permit to emit greenhouse gases.[9] A cap-and-trade system limits emissions by capping the number of available permits, and keeps costs low by allowing emitters to purchase more permits from other polluters that can reduce their emissions

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that carbon tax is less feasible than cap-and-trade and efficiency standards because it will "make the costs of climate-change protection more visible to private industry and thus to the general public"). For reasons to be skeptical of this conventional wisdom, see *infra* note 131.

[8] New Zealand uses such a system, Emissions Trading Scheme Review Panel, Government of New Zealand, Doing New Zealand's Fair Share: Emissions Trading Scheme Review 2011 6 (2011), *available at* http://perma.law.harvard.edu/0hnmaAXY4eV [hereinafter Emissions Trading Scheme], as do several U.S. states, Martella et al., *supra* note 5, at 19-30. New Zealand, however, currently allows covered entities to purchase unlimited allowances at a price of $12.50 NZ per ton, Emissions Trading Scheme, *supra* at 29, which means that it does not absolutely cap emissions — indeed if there were widespread purchase of allowances at this price, the scheme would be closer to a carbon tax. *See also* Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 Harv. Envtl. L. Rev. 293, 367–71 (2008) (describing cap-and-trade systems of EU and U.S. states).

[9] European Comm'n, EU Action Against Climate Change: The EU Emissions Trading Scheme 9 (2008), *available at* http://perma.law.harvard.edu/0NS9wXM5fpA.

cheaply.[10] Several other countries have adopted carbon taxes, in which polluters pay a fixed fee to the government for each ton of greenhouse gas that they emit.[11] The United States has employed a third option: greenhouse gas performance standards for new automobiles[12] and for industrial sources of emissions.[13] The world's largest emitter, China, has adopted regulations that encourage energy efficiency and renewable power, which will prevent some greenhouse gas emissions.[14]

Thus, although an international treaty remains unlikely, many countries, including crucial greenhouse gas emitters, are willing to adopt some level of domestic climate regulation, because there are motives to regulate that at least partially counterbalance the strong incentives to free-ride on the efforts of other nations. For example, large countries do receive some of the benefit of controlling their greenhouse gas emissions; if a giant economy like the United States or China internalizes one-twentieth of the benefit from greenhouse gas con-

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[10] *See, e.g.*, Stavins, *Policy Instruments*, *supra* note 7, at 305–07 (1997). The administrator of such a regime may distribute allowances to emitters based on their past emissions, simply auction them to the highest bidder, or adopt a more complex distribution system. *Id.* (describing each system and noting that auctioning these permits makes a cap-and-trade system more like a carbon tax).

[11] Carbon taxes have been adopted in Costa Rica, Switzerland, and the Canadian province of British Columbia. PETER J. MEYER, CONG. RESEARCH SERV., R40593, COSTA RICA: BACKGROUND AND U.S. RELATIONS 6 (2010), *available at* http://perma.law.harvard.edu/0z2Md6m7qGw; Romina Schürch, CO_2 Taxation versus Emissions Trading – An Analytical Representation for Switzerland 15–20 (Jan. 2011) (unpublished Master's thesis, University of Bern), *available at* http://perma.law.harvard.edu/02jj8BHQwi4; Yoram Bauman & Shi-Ling Hsu, *The Most Sensible Tax of All*, N.Y. TIMES (July 5, 2012), http://perma.cc/0t2CkjkyQBw (describing British Columbia's tax). Although Australia adopted a carbon tax in 2011, it is likely to be repealed by the incoming Liberal/National government. Lenore Taylor, *Australia Could Be Left With No Policy on Climate Change,* THE GUARDIAN (Sept. 25, 2013), http://perma.law.harvard.edu/0hKUWytAaTD.

[12] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25,324, 25,330 (May 7, 2010).

[13] Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010) (requiring new sources to keep greenhouse gas emissions below a level set by local permitting authorities). The EPA also proposed new standards for greenhouse gas emissions from fossil-fired utilities. Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 1430 (Jan. 8, 2013). Finally, EPA is due to release greenhouse gas standards for existing fossil fuel plants, Presidential Memorandum, Power Sector Carbon Pollution Standards (Jun. 25, 2013), http://perma.cc/M22K-2A3X, and new and modified refineries in the near future, Proposed Settlement Agreement, 75 Fed. Reg. 82,390 (Dec. 30, 2010) (announcing proposed settlement agreement, addressing greenhouse gas emissions standards for certain refineries).

[14] These regulations commit China to increase its energy efficiency by twenty percent between 2005 and 2010, and mandate that sixteen percent of its energy come from renewable sources like wind, biomass, solar, and hydropower by the year 2020. JANE A. LEGGETT, CONG. RESEARCH SERV., RL34659, CHINA'S GREENHOUSE GAS EMISSIONS AND MITIGATION POLICIES 19–21 (2008), *available at* http://perma.cc/ED5A-KWKD. China has also committed to improving the efficiency of the power sector by shutting down old, inefficient coal plants and building efficient new plants. *Id.* at 21. Most recently, China has announced plans to launch pilot greenhouse gas emissions trading programs in six provinces before 2013, with a possible national scheme by 2015. *China Planning Emissions Trading in 6 Regions*, REUTERS (Apr. 11, 2011), http://perma.law.harvard.edu/0UiP41NJAQJ. Finally, China is also pursuing miscellaneous measures such as promoting nuclear power. LEGGETT, *supra* at 21.

trols,[15] then it should adopt greenhouse gas regulations as long as their worldwide benefits are twenty times greater than their cost.[16] Finally, there are political forces in each country that may reward politicians for adopting regulations even if the cost of regulation exceeds the domestic benefit.[17] Countries may also believe, rightly or wrongly, that if they regulate greenhouse gases, other countries will necessarily follow suit.[18] Whatever the precise balance of these motives, the question for domestic regulators who would like to encourage more action elsewhere is how their choice of regulations can limit other nations' incentives to free-ride and strengthen their incentives to regulate.

This question is critical because even if optimal regulation of climate change is impossible, marginal reductions in greenhouse gas emissions can have significant benefits. First, the projected costs due to climate change are very large: Seas will rise, inundating coast lands and displacing hundreds of millions of people, and weather patterns will change, forcing billions more to move or adapt their agriculture, housing, water, and energy sources.[19] Climate change may also lead to extreme weather such as droughts, heat waves, and storms, and could even lead to catastrophic shifts in global weather.[20] Second, these costs increase smoothly with increasing emissions. Although the catastrophic results may kick in only above threshold levels of warming, no one

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[15] Such estimates, while merely for purposes of argument, are not implausible given the likely economic spillover effects of climate change in a global economy. *See* Jody Freeman & Andrew Guzman, *Climate Change and U.S. Interests*, 109 COLUM. L. REV. 1531, 1596 (2009). The United States economy comprises over a fifth of the world's GDP. WORLD BANK, GROSS DOMESTIC PRODUCT 2011, http://perma.law.harvard.edu/06a2fkM3yUM. China's GDP is roughly half as big, *id.*, and rising. So if climate change does serious damage to the world economy, these major economies will likely experience a significant fraction of this harm even if the economic costs are unevenly distributed. Each country also comprises about a sixteenth of the world's land area. WORLD BY MAP, LAND AREA OF THE WORLD, http://perma.law.harvard.edu/0VVrPiTewYt.

[16] There is a wide range of possible measures to address climate change that have costs ranging from very high to non-existent (i.e., the regulation is economically justified apart from the greenhouse gas reduction benefits); as a result, countries may, if they choose, adopt only those measures where the local benefit exceeds the local cost. Per-Anders Enkvist, Tomas Naucler & Jerker Rosander, *A Cost Curve for Greenhouse Gas Reduction*, MCKINSEY Q. 38 Exh.1 (2007) (assessing abatement measures with dollar-per-ton-of-abatement costs ranging from -150 to nearly 50 Euros per ton, including measures such as avoided deforestation, shifting from coal to natural gas, shifting to biofuels, carbon capture at utilities and other industries, wind power, biomass power, control of livestock emissions, nuclear power, reducing standby power losses, use of sugarcane biofuels, building insulation, increased efficiency in vehicles, heating and air conditioning, and water heating).

[17] *See* William Magnuson, *The Domestic Politics of International Extradition*, 52 VA. J. INT'L L. 839, 862–63 (2012); Kal Raustiala, *Form and Substance in International Agreements*, 99 AM. J. INT'L L. 581, 595 (2005).

[18] Brewster, *supra* note 2, at 278 ("The conventional wisdom among interest groups, policymakers, popular commentators, and academics is that national climate change legislation is useful not because of its direct environmental effects but because it puts the nation on a path to achieving a comprehensive climate change solution.").

[19] CLIMATE CHANGE SCIENCE, *supra* note 3, at 4; Richard B. Alley et al., *Summary for Policymakers*, *in* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 1, 13–17 (Susan Solomon et al. eds., 2007); *see also* Freeman & Guzman, *supra* note 15, at 1596 (estimating costs for the United States).

[20] CLIMATE CHANGE SCIENCE, *supra* note 3, at 4.

knows what these thresholds are, so the *risk* of catastrophic results increases smoothly.[21] Thus, every small step to lower greenhouse gas emissions mitigates the certain results of global warming and makes the catastrophic risks less likely. So if an international treaty optimally regulating climate change would be worthwhile — i.e., if the massive benefits of avoiding climate change are worth the very large costs of such a solution — then, from a global perspective, more modest efforts are also worth the cost. Indeed, the usual assumption is that initial efforts have the largest benefits, because nations will start by mandating the cheapest controls that make the biggest difference; even if optimal regulation will ultimately require adopting more expensive controls, countries will start with the easiest fixes. Thus, we should expect that marginally stricter controls on greenhouse gas emissions are particularly valuable *because* the world is so far from achieving optimal control of greenhouse gas emissions.[22] Therefore, marginally increasing the chance of more stringent regulation in other countries would have significant benefits.

Despite its importance, the unique puzzle of unilateral climate regulation has been neglected because of the focus on an international treaty. Most scholarship on climate change regulation has focused on what kind of treaty should be adopted — which countries should be required to do the most, how aggressive reductions should be, and what environmental policy instruments the treaty should prescribe.[23] Scholarship on domestic regulation has focused on *whether* nations should adopt regulation in the absence of an international agreement and how stringent it should be — in other words, is first-mover regulation a poor use of resources because most of the benefits of regulation would accrue to other countries,[24] or is it justified as a matter of fairness,[25] to signal coopera-

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[21] David A. Weisbach, *Instrument Choice Is Instrument Design, in* U.S. ENERGY TAX POLICY 129–30 (Gilbert E. Metcalf ed., 2011).

[22] For a contrary view, see Eric A. Posner & Cass R. Sunstein, *Climate Change Justice*, 96 GEO. L.J. 1565, 1600–01 (2008) (arguing that, even without leakage, the effect of unilateral regulation "even if aggressive and effective" would be "not so far from zero," so "it is not easy to say that the [global] benefits of significant unilateral reductions would clearly exceed the costs").

[23] *See* Stavins, *A Meaningful U.S. Cap-and-Trade System*, *supra* note 8, at 294 (stating need for "global policy architecture"); *see generally* Joseph E. Aldy, Scott Barrett & Robert N. Stavins, *Thirteen Plus One: A Comparison of Global Climate Policy Architectures* (Kennedy Sch. of Gov't, Harvard Univ., Working Paper No. RWP03-012, 2003) (evaluating thirteen alternative global policies); Wiener, *Global Environmental Regulation*, *supra* note 3 (systematically evaluating possible international policies).

There is another debate concerning the relative merits of achieving a global but inadequate agreement versus an adequate agreement between fewer nations. *Compare* Stavins, *Policy Instruments*, *supra* note 7, at 324–26 (arguing that focus should be on achieving global consensus first and then ratcheting up regulation) *with* Valentina Bosetti & David G. Victor, *Politics and Economics of Second-Best Regulation of Greenhouse Gases: The Importance of Regulatory Credibility*, 32 ENERGY J. 1, 19 (2011) (suggesting smaller-scale cooperation based on more credible domestic regimes).

[24] *See, e.g.*, Posner & Sunstein, *supra* note 22, at 1576 ("For greenhouse gases, by contrast, it is plain that unilateral action by the United States would not be in the domestic interest of that nation, simply because the cost would be significant and the benefits necessarily small."); Robert N. Stavins, *National Climate Change Policy: A Quick Look Back at Waxman-Markey and the Road Ahead*, AN ECONOMIC VIEW OF THE ENVIRONMENT (June 29, 2009), http://perma.law.

tion,[26] or because certain political units are big enough to capture a significant portion of the benefits of mitigation?[27] Even scholarship that has focused on design of domestic policy has often proceeded on the assumption that the policy chosen will encourage a treaty adopting the same design.[28] As a result, it has rarely addressed the possibility that unilateral regulation might decrease incentives to regulate overseas, or considered ways that climate regulation could encourage action overseas even if it does not result in a treaty.[29]

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harvard.edu/0VkKkU9qiQ3 ("[F]or any single country, the costs of action will inevitably exceed its direct benefits.").

[25] *See, e.g.*, Joakim Sandberg, "My *Emissions Make No Difference": Climate Change and the Argument from Inconsequentialism*, 33 ENVTL. ETHICS 229, 241–42 (2011) (advocating for a collective duty to limit greenhouse gas emissions); Cass R. Sunstein, *The World vs. the United States and China? The Complex Climate Change Incentives of the Leading Greenhouse Gas Emitters*, 55 UCLA L. REV. 1675, 1697–98 (2008); *see also* NICHOLAS STERN, THE ECONOMICS OF CLIMATE CHANGE: THE STERN REVIEW 47 (2007); Matthew D. Adler, *Corrective Justice and Liability for Global Warming*, 155 U. PA. L. REV. 1859, 1865–67 (2007).

[26] *Compare* Stavins, *A Meaningful U.S. Cap-and-Trade System*, *supra* note 8, at 304 ("Negotiations with key developing countries, including China and India, are more likely to succeed if the United States is perceived to be prepared to adopt a meaningful domestic program, because these countries have emphasized the importance of the industrialized world acting first.") *and* Farber, *supra* note 5, at 21 ("[Subglobal] efforts communicate a willingness to negotiate.") *with* Brewster, *supra* note 2, at 249, 282–83 (arguing that "we should not conclude that all national climate change legislative proposals are worth substantial political investment" because some might undercut support for a treaty) *and* Coglianese & D'Ambrosio, *supra* note 6, at 1420, 1423–25 (2008) (arguing that transfer of industry to uncooperative nations will strengthen their resistance and that incremental responses to climate change may lock in an inadequate level of regulation).

[27] Freeman & Guzman, *supra* note 15, at 1542 ("[T]he United States internalizes a significant fraction of the global gains of climate change abatement, making it worthwhile to bear at least some costs."); *see also* Kirsten H. Engel & Scott R. Saleska, *Subglobal Regulation of the Global Commons: The Case of Climate Change*, 32 ECOLOGY L. Q. 183, 196–97 (2005) (modeling a game with two actors, each internalizing only half the global benefit, which results in significant, though not optimal, controls).

A related but slightly more abstract debate concerns the benefits and drawbacks of comprehensive versus incremental solutions to climate change. *See* Coglianese & D'Ambrosio, *supra* note 6, at 1415–25 (2008) (describing the promises and perils of incremental solutions, and arguing against incremental solutions to climate change).

Of course, many have also suggested that regulations that control greenhouse gases could be useful for other reasons, such as job creation and reducing dependence on oil. *See, e.g.*, Mary D. Nichols, *California's Climate Change Program: Lessons for the Nation*, 27 UCLA J. ENVTL. L. & POL'Y 185, 189 (2009) (arguing that greenhouse gas regulations can "reduce our dependence on oil, diversify our energy sources, save energy, [and] create new jobs"); *see also* Michael E. Porter & Claas van der Linde, *Toward a New Conception of the Environment-Competitiveness Relationship*, 9 J. ECON. PERSP. 97, 98 (1995). This Article, however, addresses greenhouse gas reduction for its own sake.

[28] On this assumption, the best domestic instrument is likely whatever would work best internationally, collapsing the two inquiries. *See, e.g.*, Stavins, *A Meaningful U.S. Cap-and-Trade System*, *supra* note 8, at 303 n.54 (2008) ("[T]he cap-and-trade system, like any meaningful domestic climate policy, may best be viewed as a step toward establishing U.S. credibility for negotiations on post-Kyoto international climate agreements."); Stavins, *Policy Instruments*, *supra* note 7, at 323–24 (arguing that to determine the best domestic instrument, we should determine the best international instrument "[b]ecause unilateral action will invariably be highly inefficient, any domestic program requires an effective international agreement").

[29] Even those who have considered the design of tariffs on countries that do not have climate regulation — a specific policy that could be used to encourage action overseas — have focused on narrower questions of tariff design, rather than on the broader questions of what types of policies could enhance incentives to regulate in other countries. *See generally* Carolyn Fischer, Eric

This Article squarely addresses the question that currently faces domestic actors: *What kind* of unilateral climate instruments should they choose to maximize the chance that other countries will adopt stringent greenhouse gas regulations? After all, no matter whether one views the initial domestic efforts to address climate change as a cautious and inadequate first step or as an idealistic and naïve waste of resources, one point of commonality is that, from any country's perspective, it would be better if *other* countries reduced their greenhouse gas emissions.[30]

II. Forming Beneficial Connections: Using Conditional Regulation to Encourage Action in Other Countries

Unilateral domestic regulation should interact with other nations' regulations in a way that increases those nations' incentive to regulate. Possible interactions include: (1) simple regulatory cooperation, in which countries seek to harmonize their regulations, (2) matching commitments, in which domestic regulations ratchet up in response to action elsewhere, and (3) formally linked domestic regulations, such as multi-jurisdiction cap-and-trade systems. These proposed interactions are sometimes championed as a kind of bottom-up approximation of a global treaty: If the world cannot agree on a treaty that prescribes what each country should do, then perhaps individual countries can form links that eventually cover most of the world's emissions.[31] But there has been insufficient attention to how these connections would affect domestic incentives to regulate. In the case of greenhouse gases, some of the most frequently proposed connections, such as links between national cap-and-trade systems, would actually discourage control of emissions. By contrast, some more promising modes of connection, like matching commitments, have been comparatively neglected.

Moore, Richard Morgenstern & Toshi Arimura, *Carbon Policies, Competitiveness, and Emissions Leakage: An International Perspective* (Res. for the Future, Conference Summary, 2010), *available at* http://perma.law.harvard.edu/0EvS5xkzofE; Brewster, *supra* note 2, at 292–96; Joseph E. Stiglitz, *A New Agenda for Global Warming*, 3 Economists' Voice 1, 1–4 (2006) (advocating trade sanctions to encourage action by recalcitrant countries like United States); Joshua Elliott et al., *Trade and Carbon Taxes*, 100 Am. Econ. Rev.: Papers & Proc. 465 (2010) (studying leakage and use of border adjustments to prevent leakage); Howard F. Chang, *An Economic Analysis of Trade Measures to Protect the Global Environment*, 83 Geo. L.J. 2131 (1995).

[30] *See, e.g.*, Lazarus, *supra* note 3, at 1164 ("[A]ny effective climate change legislation must include, of course, domestic controls, but no domestic legislation is enough standing alone."); Freeman & Guzman, *supra* note 15, at 1542 (taking as given that while unilateral action could "be significant and meaningful" it "might result in a less than optimal amount of mitigation").

[31] Matthew Ranson & Robert N. Stavins, *Post-Durban Climate Policy Architecture Based on Linkage of Cap-and-Trade Systems*, 13 Chi. J. Int'l L. 403, 406 (2013) (discussing "linkage between tradable permit systems" and arguing that "the outline of a decentralized system of direct and indirect linkages is already emerging" so "it is possible that in the absence of a top-down international agreement, such a collection of linkages will become the de facto near-term architecture for post-Durban international climate policy.").

A. Simple Regulatory Cooperation

At the simplest level, a relatively low-stakes regulatory connection could commit countries to maintaining regulations of comparable stringency. Domestic regulators are already seeking to connect greenhouse gas performance standards in this fashion — the United States collaborated with Canada on its most recent auto emission standards,[32] and with several other countries on standards for appliances and consumer electronics.[33] President Obama has recently stepped up these coordination efforts by issuing an Executive Order prescribing efforts to "reduce, eliminate, or prevent unnecessary differences in regulatory requirements" between countries through "[i]nternational regulatory cooperation."[34] This type of international regulatory harmonization is one important goal of the current EU-U.S. Transatlantic Trade and Investment Partnership negotiations.[35] These connections can lower the cost of command-and-control regulations by allowing industry to exploit economies of scale in meeting a uniform standard across several countries.[36] But there is little reason to think that these methods would significantly alter incentives to regulate, or alternatively free-ride, in connected countries.

B. Matching Commitments

A more promising form of connection is conditional regulation, in which regulation automatically becomes more stringent if other countries adopt controls. Pre-commitment to matching efforts may be most familiar from charitable appeals where a first-moving donor may be able to induce further donations by promising to match future donations.[37] But matching efforts have been used and proposed in a variety of contexts to achieve a cooperative result in situations where that result cannot be externally imposed.[38] The idea is that actors

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[32] Max Paris, *Kent Unveils New Rules to Cut Heavy-Duty Vehicle Emissions*, CBC NEWS (Apr. 13, 2012), http://perma.law.harvard.edu/0jw8hDCDrBH (also noting that the Canadian government prefers a sector-by-sector approach to economy-wide market-based controls because this approach "makes it easier to align Canada's policies with those of the U.S.").

[33] Clean Energy Ministerial, *Fact Sheet: Super-Efficient Equipment and Appliance Deployment Initiative* (Apr. 25, 2012), http://perma.law.harvard.edu/0sSutXhEA7t (showing that sixteen countries agreed to coordinate on appliance and electronics standards).

[34] Exec. Order No. 13,609, 77 Fed. Reg. 26,413 (May 1, 2012).

[35] *See* CTR. FOR ECON. POLICY RESEARCH, REDUCING TRANSATLANTIC BARRIERS TO TRADE AND INVESTMENT: AN ECONOMIC ASSESSMENT 1–3 (2013), *available at* http://perma.law.harvard.edu/0MspEDcNgCo (arguing that "domestic rules and regulations . . . can place a cost on trade and investment" but that "the costs involved may . . . be mitigated or reduced through partial regulatory convergence and cross-recognition of standards").

[36] *See id.* at 1; *cf.* E. Donald Elliott, Bruce A. Ackerman & John C. Millian, *Toward a Theory of Statutory Evolution: The Federalization of Environmental Law*, 1 J.L. ECON. & ORG. 313, 326–33 (1985) (describing how U.S. industry came to favor national environmental standards due to difficulty of complying with diverse state standards).

[37] Dean Karlan & John A. List, *Does Price Matter in Charitable Giving? Evidence from a Large-Scale Natural Field Experiment*, 97 AM. ECON. REV. 1774, 1774 (2007) (finding that pre-commitment to matching increases future donations).

[38] *See* Joel M. Guttman, *Understanding Collective Action: Matching Behavior*, 68 AM. ECON. ASS'N 251 (1978) (summarizing theoretical and empirical evidence).

are willing to pay for a more significant portion of a common pool resource if they know that their efforts will cause others to contribute more.[39]

This matching technique is simplest with two actors, as in federal matching grants for state provision of goods like Medicaid,[40] but it also can be expanded to encompass more actors. For instance, the National Popular Vote Interstate Compact addresses such a cooperation problem with multiple actors.[41] Each state has the power to award its Electoral College votes however it chooses, and strong majorities prefer that the presidential candidate that wins the most votes nationwide should win the election.[42] So, by hypothesis, each state might prefer that all states awarded their votes to the nationwide popular vote winner, but any one state that decided to do so would be sacrificing its voters' influence in the presidential election.[43] To address this problem, the National Popular Vote Interstate Compact asks states to commit to award their votes to the nationwide popular vote winner, but only conditional on a sufficient number of states enacting the compact to ensure that the popular vote winner would then necessarily be elected.[44] Eight states and the District of Columbia, with 132 electoral votes, have already enacted the compact; it is possible that it will hit 270 electoral votes, and thus enter into force, in time for the 2016 election.[45]

Constructing a matching technique for climate change regulation is even more complicated because regulation is not a binary choice — each country that chooses to regulate must choose how much to regulate — but there are matching strategies that, in theory, would lead to a cooperative outcome. For instance, under strong assumptions of transparency, credibility, and rationality it can be shown that, if each country simultaneously sets, first, a rate at which it would match emission reductions from other countries, and then, second, its own baseline level of reduction, the resulting rates would optimally control climate change even if countries chose rates entirely for selfish reasons.[46] Matching drives this result because each country would know that if it adopted even slightly more stringent regulation, preexisting matching commitments in other countries would induce stronger regulation around the world; so even

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[39] *Id.*

[40] GLORIA N. ELDRIDGE, THE MEDICAID EVOLUTION: THE POLITICAL ECONOMY OF MEDICAID FEDERALISM 46 (2007) (stating that a benefit of open matching grants is that "[s]tates contribute more to Medicaid than they would without this structure because with every dollar spent, they receive federal funds in return").

[41] Derek T. Muller, *The Compact Clause and the National Popular Vote Interstate Compact*, 6 ELECTION L.J. 372, 375 (2007).

[42] Lydia Saad, *Americans Would Swap Electoral College for Popular Vote*, GALLUP (Oct. 24, 2011), http://perma.law.harvard.edu/0SfmbtCH3Se.

[43] *See* Muller, *Compact Clause*, *supra* note 41, at 375.

[44] That is, states comprising 270 electoral votes. *Id.*

[45] Derek T. Muller, *Invisible Federalism and the Electoral College*, 44 ARIZ. ST. L.J. 1237, 1238–39 (2012). Of course, even if the compact came into force, it might still be subject to legal challenge. *See, e.g.*, Muller, *Compact Clause*, *supra* note 41, at 390.

[46] Robin Boadway, Zhen Song & Jean-François Tremblay, *The Efficiency of Voluntary Pollution Abatement when Countries Can Commit* (Queen's Univ., Dep't of Econ., Working Paper No. 1205, 2009), *available at* http://perma.law.harvard.edu/0AEt1kSYGHA.

though each country could not capture the full benefit of its own increased regulation, it would benefit from the resulting regulation by other countries.[47]

Of course, the strong assumptions of credibility, rationality, and transparency that such mechanisms require to reach an optimal solution do not align with the current state of climate change regulation. Nevertheless, these mechanisms do suggest possible connections that could help encourage more stringent regulation of greenhouse gases by other countries. For instance, even if we cannot expect fully credible and transparent matching commitments from all countries, it may be that large jurisdictions, like the United States and European Union, could make relatively credible and transparent commitments. Such commitments would mean that regulators in other nations would know that for each additional increment of stringency, they would receive an extra environmental benefit as countries with conditional commitments ratcheted up their regulation. This consideration would provide an incentive for these regulators to adopt marginally more stringent regulations. In other words, although it might take worldwide credible matching commitments to induce optimal controls from other countries, even less perfect matching commitments could shift the balance of political forces toward regulation in other countries, by promising that their efforts would be matched by some other nations, increasing the environmental benefits of regulation.

A few nations have made haphazard attempts at employing matching commitments. For example, the European Union's Emissions Trading System ("EU ETS") commits it to reducing greenhouse gas emissions by twenty percent by the year 2020, but promises to reduce emissions by thirty percent if other developed nations adopt "comparable" reductions through a "global agreement."[48] Similarly, in 2010 Australia committed to a five percent reduction by 2020, but promised a fifteen percent reduction if a "global agreement" commits developing countries to "substantially restrain" emissions and advanced economies to "comparable" reductions, and further promised to reduce emissions by twenty-five percent if an "ambitious global deal" ensures stabilization of atmospheric greenhouse gas levels.[49] Given the lack of a binding treaty, and continuing domestic efforts, international negotiations have increasingly focused on these types of unilateral pledges.[50]

These pledges, however, are not well calculated to affect foreign climate policy. For one thing, a global deal is unlikely, so these commitments would be better aimed at achieving greenhouse gas reductions in key countries. A margi-

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[47] *See also* Peter John Wood, *Climate Change and Game Theory: A Mathematical Survey* (Australian Nat'l Univ., Crawford Sch. of Econ. & Gov't, Working Paper No. 2.10, 2010), *available at* http://perma.law.harvard.edu/0S5aJDRZ7Lm (surveying other game theoretic solutions to climate change).

[48] EUROPEAN COMM'N, EU ACTION AGAINST CLIMATE CHANGE: LEADING GLOBAL ACTION TO 2020 AND BEYOND 9 (2008), *available at* http://perma.law.harvard.edu/063yZgnfRmJ.

[49] Letter from Penny Wong, Australian Minister for Climate Change and Water, to Yvo de Boer, Executive Secretary, United Nations Framework Convention on Climate Change (2010), *available at* http://perma.law.harvard.edu/0GbZMDZrGiV.

[50] *See* David Hunter, *Implications of the Copenhagen Accord for Global Climate Governance*, 10 SUSTAINABLE DEV. L. & POL'Y 4, 4 (2010) (describing pledge and review process).

nal nudge is unlikely to produce the long-sought binding global deal — but many countries are already adopting and calibrating unilateral climate regulation, so a nudge toward stringent regulation could be effective. So, for instance, the European Union could agree to increase its reductions by two percent if the United States adopted a similar level of reduction. The same process would work with a carbon tax. For example, the United States could announce that it would impose a carbon tax of $25 per ton, but would raise it if China adopted a carbon tax.

Such matching commitments could be made even more responsive by stating that whatever tax China adopted, the United States would increase its tax by one quarter of that amount. So if China adopted an $8 per ton tax, the United States would raise its $25 per ton tax by $2 (to $27 per ton), and if China adopted a $12 per ton tax, the U.S. tax would rise $3 to $28 per ton. This type of continuously variable commitment would be superior because it would consistently reward more stringent regulation — providing partial credit for less-than-comparable stringency and extra credit for more-than-comparable stringency. It would also avoid putting too much stress on contentious debates regarding what type of regulation is "comparable" in the first place. If major players like the United States and European Union adopted continuous matching commitments, it could have a significant impact on subsequent countries setting the stringency of their climate regulation, which would only be amplified if other countries also adopted matching commitments.

Of course, just as domestic political constraints prevent regulators from adopting globally optimal levels of regulation, so too would they prevent regulators from committing to overambitious matching commitments. In fact, regulators using matching may want to start with a lower baseline of regulation. For example, if the United States was considering a tax on carbon dioxide of somewhere between $25 and $35 per ton, and it was not concerned about regulation overseas, it could just take the midpoint and adopt a $30 per ton tax. But with matching commitments, the United States might want to adopt a $25 per ton baseline, with the understanding that its matching commitments would encourage regulation overseas, and that would push the tax up to around $30 per ton. Sometimes this would result in a tax that was less than $30 per ton, sometimes it would end up with a tax of over $30 per ton, but at every point the matching commitment would be encouraging action overseas.

A related benefit of such continuous matching commitments is that they would not require bilateral, much less multilateral, agreement.[51] This is important because of the persistent distributional disagreements that have deadlocked

[51] In the wake of failed multilateral negotiations, scholars have proposed increased reliance on bilateral agreements. *See* Robert O. Keohane & David G. Victor, *The Transnational Politics of Energy*, 142 DÆDALUS 97, 97 (2013) (arguing for making negotiation "problems more manageable by working in small groups of relevant countries"); *see also* DAVID G. VICTOR, GLOBAL WARMING GRIDLOCK: CREATING MORE EFFECTIVE STRATEGIES FOR PROTECTING THE PLANET (2011). But bilateral negotiations are often difficult as well, particularly between developed and developing countries, which is why this Article examines the potential of unilateral measures.

climate negotiations.[52] The countries that are currently adopting unilateral climate regulations do not receive any matching benefits from other countries if they make those regulations stricter. If matching commitments were in place, they would be rewarded for each additional increment of stringency. In the previous example, China would know that a somewhat higher carbon tax would cause carbon tax increases in the United States as well as in other countries that had implemented matching commitments. Notably, China would not have to approve or accept the level of U.S. regulation to receive this benefit — it might still think that U.S. policy was unfairly lax for such a rich country. The benefits of matching commitments exist independent of any distributional negotiation or agreement.[53]

For matching commitments to be effective, regulators would need to ensure that those commitments were transparent and credible. One premise of matching mechanisms is that commitments by both first-movers and follow-on countries are observable. Indeed, experimental evidence suggests that a primary reason that real-life matching games do not always produce the cooperative outcome is because of the difficulty of calculating and monitoring matching rates, a problem that grows with an increasing number of players.[54] This suggests that whatever commitments are made, it would be better if they did not, like the commitments of the European Union and Australia, rely on imprecise terms like "comparable" and "aggressive."[55] Commitments should be more precise in terms of the specific countries targeted and the regulations required to win matching commitments.[56]

For similar reasons, the need for credible commitments may also militate in favor of a carbon tax over cap-and-trade to address greenhouse gas emissions, because a carbon tax makes it easier to signal and observe the current and future stringency of climate regulation. Although carbon taxes and cap-and-trade systems may be designed so that, in theory, they will have similar long-term consequences, they have different signaling properties because an optimal carbon tax is far simpler than an optimal cap-and-trade system for greenhouse gases.[57] An optimal cap-and-trade system requires adjustments that make it difficult to assess the system's stringency in any given year. This, in

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[52] *See infra* note 72 (describing disagreement between developed and developing countries on appropriate distributional baselines for cuts in emissions).

[53] China would almost certainly be willing to do more if the United States agreed to adopt the level of regulation that China thought correct. This Article, however, examines what is possible without such an agreement.

[54] Guttman, *supra* note 38, at 255 ("[C]omputation and observation of matching rates is costly, and these costs may increase with group size, diminishing the returns to matching behavior.").

[55] Admittedly, there are many reasons that nations may want to preserve flexibility in defining such terms; the point is that if the goal is to induce follow-on action, the more transparent the better.

[56] Although one can imagine theoretical situations in which one nation may want to hide its commitment to providing a public good, there is no reason to think that these apply to greenhouse gas regulation. Briefly, if nations believe that other countries will not provide greenhouse gas regulation, they are likely to substitute for it by increasing efforts to adapt rather than through overmitigation. *See infra* notes 137–38 and accompanying text.

[57] Weisbach, *supra* note 21, at 136–38.

turn, would undercut matching commitments by making it impossible to send credible signals of regime stringency.

An optimal per-ton carbon tax is very simple because it should simply be set equal to the marginal benefit from reducing pollution by one ton.[58] As a result, a flat per-ton tax will be nearly optimal as long as the marginal benefit from reducing pollution is nearly flat — that is, when every additional ton of reduction provides an almost equivalent amount of benefit.[59] In the case of climate change, every additional ton of reduction provides almost the same benefit. Admittedly, if emissions were drastically reduced *on a global scale*, and stayed low for decades, there would eventually be some diminishing returns to increased reductions — at some point greenhouse gases would be at a safe level, where further reductions did little good.[60] But no individual country can cut global emissions to a safe level. And even if global emissions were cut drastically, historical emissions ensure that greenhouse gas emissions will continue warming the planet for decades.[61] This means that, when adopting a national policy, the benefit of reducing emissions stays relatively constant with increasing stringency. So a simple per-ton carbon tax would be efficient.[62]

By the same token, a simple cap-and-trade system would not be efficient, which is why cap-and-trade proposals have more complex provisions, designed to provide a stable permit price, imitating the effect of a tax. But these complex provisions undercut the transparency necessary for matching commitments. For example, the number of permits available could be continuously adjusted to provide a more stable carbon price.[63] Or the price of permits in a cap-and-trade system could be circumscribed by a maximum price and a minimum price, which would result in a flatter and more nearly optimal carbon price.[64] Or polluters could be allowed to borrow permits from future years' allocations to

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[58] *Id.* at 115 ("If marginal harm is not flat — a fixed $x per unit of pollution — the tax should vary with marginal harm.").

[59] Zvi Adar & James M. Griffin, *Uncertainty and the Choice of Pollution Control Instruments*, 3 J. ENVTL. ECON. & MGMT. 178, 182, 188 (1976) (demonstrating that a tax is more efficient if the marginal environmental benefit from each additional ton of pollutant abatement decreases less rapidly than the marginal cost of pollution controls to achieve each extra ton of abatement increases). This would not be the case for a pollutant that (1) only became dangerous above a certain threshold, and (2) was likely to be reduced below that threshold by regulation — in such cases, a simple quantitative cap below that threshold would be more nearly optimal. *See* Wiener, *Global Environmental Regulation*, *supra* note 3, at 728–29 ("In such cases of relatively steep benefits compared to costs, the quantity rule is the preferable choice.").

[60] Stavins, *Policy Instruments*, *supra* note 7, at 314 ("In the case of global climate change, the available evidence seems to indicate that marginal abatement costs will be relatively flat over some range, then steep once some abatement level is exceeded.") (citing William D. Nordhaus, *The Cost of Slowing Climate Changes: A Survey*, 12 ENERGY J. 37, 61–63 (1991)).

[61] *See* William A. Pizer, *Prices Versus Quantities Revisited, The Case of Climate Change*, 10–13, 29 (Res. for the Future, Discussion Paper No. 98-02, 1997) (showing that these historical emissions may mean that the benefits from an optimal carbon tax would be five times those from an optimal cap-and-trade system).

[62] *Id.*

[63] Weisbach, *supra* note 21, at 123–27.

[64] *Id.* at 128–30.

smooth prices.[65] But these steps would be difficult to square with matching commitments. Adjustments to the number of permits would be inconsistent with the necessary credible commitments to particular stringencies. The complexities of systems using a quantitative cap, price floor, and price ceiling would substantially complicate the task of calibrating matching commitments. And borrowing permits from the future would make current regime stringency depend on the future cap stringency, requiring other countries to trust that future governments would never loosen climate regulations. As a result, a carbon tax would be more compatible with efforts to encourage regulation overseas by connecting regime stringencies.

C. Linked Cap-and-Trade Systems

A more significant connection that is often advocated is linked cap-and-trade systems,[66] but in a world without a global treaty, such a connection may discourage regulation in connected countries. Admittedly, if there were an international treaty that set out how much carbon each country could emit, linked cap-and-trade systems would have considerable advantages. In a cap-and-trade system, emitters that wish to emit more may purchase permits from other emitters, so if several countries had linked cap-and-trade systems, then industries in countries where permits were expensive could purchase more from industries in countries where permits were cheap, lowering the cost of regulation.[67] As a result, many have suggested that individual countries should approximate the effect of an international treaty by adopting domestic cap-and-trade systems and then connecting them.[68]

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[65] *Id.* at 137–38; *see also* Jonathan B. Wiener, *Property and Price to Protect the Planet*, 19 DUKE J. COMP. & INT'L L. 515, 519–21 (2009) (discussing these methods of creating price certainty along with others such as a limited reserve of permits to be sold during periods of high permit pricing).

[66] JUDSON JAFFE & ROBERT N. STAVINS, LINKING TRADABLE PERMIT SYSTEMS FOR GREENHOUSE GAS EMISSIONS: OPPORTUNITIES, IMPLICATIONS, AND CHALLENGES (2007); NICHOLAS STERN, KEY ELEMENTS OF A GLOBAL DEAL ON CLIMATE CHANGE 19–20, 23 (2008), *available at* http://perma.law.harvard.edu/0ZLmr78m5Ax; Stavins, *Policy Instruments*, *supra* note 7, at 309; Wiener, *Global Environmental Regulation*, *supra* note 3, at 798–99; *see also* Alice Kaswan, *Decentralizing Cap-and-Trade? The Question of State Stringency*, 1 SAN DIEGO J. CLIMATE & ENERGY L. 103, 128 n.97 (2009) ("Trading advocates generally prefer large trading markets in order to maximize the number of sources and opportunities for low-cost reductions, to send widespread market signals for technology innovation, and to reduce competitive pressures between jurisdictions.").

[67] STERN, KEY ELEMENTS, *supra* note 66, at 20 (estimating savings from a global market at twenty to eighty percent). Furthermore, a larger linked market should even out local cap miscalculations, achieving price stability and resulting in a more liquid market for allowances. Martella et al., *supra* note 5, at 19-49. But many have noted that linking these systems is much easier in theory than in practice because seemingly similar cap-and-trade systems may be very different in subtle ways that prevent one-for-one trading of allowances, such as types of greenhouse gases or emitters covered. *Id.* at 19-15–19-31; Wiener, *Global Environmental Regulation*, *supra* note 3, at 790–91.

[68] *See supra* note 66; *see also* Stavins, *A Meaningful U.S. Cap-and-Trade System*, *supra* note 8, at 324 ("In the long run, linking the U.S. cap-and-trade system to cap-and-trade systems in other countries or regions, such as the EU Emissions Trading System, will clearly be desirable to reduce the overall cost of reducing GHG [greenhouse gas] emissions and achieving any global GHG concentration targets."); Gilbert E. Metcalf & David Weisbach, *Linking Policies When Tastes*

The problem with this approach is that allowances are expensive when caps are tight and cheap when they are loose, so international trade in permits sends wealth directly from countries with tight caps to countries with loose caps.[69] This would create a powerful incentive for countries to adopt a less stringent cap or under-enforce its cap, which would, in effect, subsidize its own industries under the guise of cap-and-trade greenhouse gas regulation.[70] This incentive could be resisted if there were (1) a treaty defining how tight each country's cap should be and (2) tough international enforcement of national caps. But there is no such consensus and no such enforcement. Countries have radically divergent ideas of the appropriate standard for a cap, and this is one of the reasons that an international treaty has proven so elusive: Developed nations have largely embraced the principle that each nation should cut its emissions from the baseline of its current emissions,[71] while developing nations argue that each nation should be held to the same *per capita* emissions, which would require radical cuts in developed world emissions.[72] Furthermore, there is no international mechanism to enforce domestic caps. So each country in connected cap-and-trade systems has motive and opportunity to weaken its regulation.[73]

Differ: Global Climate Policy in a Heterogeneous World, 6 REV. ENVTL. ECON. POL'Y 110, 113–14 (2012) (noting that linkage can "narrow or eliminate differences in the marginal cost of abatement between different regions or countries" and therefore "reduce" the "inefficiencies" created by diverse national systems); Felicity Carus, *EU Plans to Link Emissions Trading Scheme with California*, THE GUARDIAN (Apr. 7, 2011), http://perma.law.harvard.edu/0vGWaoEDeQg.

[69] And this is not merely a remediable side-effect of linked cap-and-trade systems: The entire point of linking such systems is to lower the cost of permits by allowing purchase of permits from nations where they are cheaper. *See* Stavins, *A Meaningful U.S. Cap-and-Trade System*, *supra* note 7. If regulators prevented one-way flows of permits, they would be removing the point of linking cap-and-trade systems.

[70] *See also* Martella, *supra* note 5, at 19-17 (describing how linked cap-and-trade systems could be used to subsidize domestic industry); Roger R. Martella & James W. Coleman, *Ratifying Kyoto via Local Actors: Accomplishments and Limitations of Local Cap and Trade Programs*, 40 ENVTL. L. POL'Y ANN. REV. 10,780, 10,782 (2010) (noting potential for gaming in linked state cap-and-trade systems).

[71] Kyoto Protocol, *supra* note 4, art. 3.

[72] Brewster, *supra* note 2, at 300 & n.176. Furthermore, developing countries, noting that climate change is being caused by past emissions, also insist that developed countries take responsibility for their historic emissions, which suggests that the developed world should be limited to lower per capita emissions than the developing world. *Id.* at 274 & n.82, 301 (quoting China's lead climate negotiator as saying, "The developed countries, in realizing their industrialization, have discharged a large amount of greenhouse gases in the course of one or two centuries. The cumulative emissions by the developed countries have caused global warming. Who should take the historical responsibilities?") (citing Michael Wines, *China Sees Progress on Climate Accord but Resists an Emissions Ceiling*, N.Y. TIMES (Aug. 6, 2009), http://perma.cc/0YwJhts9JLq). But the developed world has been equally firm in rejecting this view, which would demand more radical emission cuts than most are willing to contemplate. Brewster, *supra* note 2, at 276 & n.92 (citing PETER SINGER, ONE WORLD: THE ETHICS OF GLOBALIZATION 14–43 (2002) and JOSEPH E. STIGLITZ, MAKING GLOBALIZATION WORK 175 (2006)); *see also infra* note 95 (noting that developing world arguments could require developed world to cut emissions *below* zero).

[73] And this is not simply a one-time dilemma to be overcome — instead, caps seem to be subject to constant renegotiation. *See* Alexander Jung, *The EU's Emissions Trading System Isn't Working*, DER SPIEGEL (Feb. 15, 2012), http://perma.law.harvard.edu/0UL4aNqxdph (describing attempts to change cap); Brewster, *supra* note 2, at 273–77. Indeed, many of the supporters of a cap-and-trade bill in the United States founded their support on the notion that the caps could be changed later.

The one set of linked cap-and-trade systems, the European Union's cap-and-trade system, illustrates this dynamic. The EU initially attempted to rely on a nominally decentralized cap setting.[74] The system design and infrastructure were centralized, leaving no technical barriers to connection, only a cooperation problem.[75] The result was predictable: Eleven countries adopted caps so loose that they did not even reach them.[76] As a result, the EU moved to a centralized allocation system.[77] Thus, although cap-and-trade systems might, in theory, work better in concert, there is strong reason to think that, given the incentives that connected systems would create, (1) such connections will be hard to form, and (2) such connections might unravel existing movement toward greenhouse gas controls by providing strong incentives to make regulation less stringent.

A similarly problematic connection is the idea of "offsets," in which emitters in cap-and-trade systems, rather than reduce their emissions, pay companies in other countries to reduce their emissions.[78] The idea is that if a factory in an unregulated country is able to reduce its emissions more cheaply than a factory in a regulated country, then it makes most sense to pay for the reduction in the unregulated country; after all, the location of greenhouse gas emissions has no effect on the global climate. The problem with these offsets is that, in unregulated countries, there is no baseline against which one can unequivocally say that emissions are reduced. So, for instance, many European companies, rather than reduce their emissions to comply with Europe's carbon dioxide cap, have instead paid companies in China and India to destroy certain very potent greenhouse gases.[79] These transactions would benefit the climate if the greenhouse gases would otherwise have been produced and not destroyed. But there are no limits on the production of these gases in China and India, so it can be very profitable to produce these gases solely in order to accept money from European companies to destroy them. And indeed this is what has happened. European companies have been allowed to emit millions of tons of extra greenhouse gases because they have nominally purchased corresponding reductions from Chinese and Indian factories, but those factories have simply ramped up

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See id. at 279–83 (describing support of President Obama, Union of Concerned Scientists, and environmentalist groups). Thus, cap-setting disputes seem likely to be a constant struggle for linked cap-and-trade systems.

[74] Martella et al., *supra* note 5, at 19-37–19-38.

[75] *Id.*

[76] EUROPEAN ENV'T AGENCY, GREENHOUSE GAS EMISSION TRENDS AND PROJECTIONS IN EUROPE 2007: TRACKING PROGRESS TOWARDS KYOTO TARGETS 46 (2007); *see also* Alessio D'Amato & Edilio Valentini, *A Note on International Emissions Trading with Endogenous Allowance Choice*, 31 ECON. BULLETIN 1451 (2011) (demonstrating that decentralized control will lead to over-allocation of allowances and that centralized control is against the interest of over-allocating countries).

[77] Martella et al., *supra* note 5, at 19-38.

[78] These offsets can also be purchased from domestic companies that are not covered by greenhouse gas regulations.

[79] Michael Wara, *Is the Global Carbon Market Working?*, 445 NATURE 595 (2007); *see also* Jason Scott Johnston, *Problems of Equity and Efficiency in the Design of International Greenhouse Gas Cap-and-Trade Schemes*, 33 HARV. ENVTL. L. REV. 405, 427–29 (exploring perverse incentives that make offsets ineffective).

production of greenhouse gases so that they can destroy more, earning more credits.[80] As a result of these offsets, European emissions are much higher than they would otherwise be and worldwide production of damaging greenhouse gases has increased as well.

Some have proposed linked carbon taxes — encouraging countries to join by offering access to a portion of the revenue collected[81] — but such a system would have similar problems. Net wealth transfers to countries that adopted a low rate, or failed to collect it, would have all the destabilizing characteristics of linked cap-and-trade regimes. Each country would have an incentive to under-collect and demand an outsized share of revenues.[82] Given these pressures, it is doubtful that such a program could survive.[83]

III. Stopping Leakage: Avoiding Concentrating Emissions in Recalcitrant Countries

The global effect of domestic regulation will depend crucially on how much pollution simply leaks from regulating jurisdictions to jurisdictions where pollution is uncontrolled. When emitting industries flee regulation, global emissions are merely shuffled rather than reduced, and countries that do not regulate are rewarded, making future regulation unlikely. Scholars and policymakers have explored mechanisms of reducing leakage, such as preferential treatment for trade-exposed industry, or tariffs on imported goods. But there has been comparatively little consideration of how the problem of leakage or these proposed solutions should affect choice of a domestic climate policy instrument. This section fills that gap, arguing that plausible solutions to the leakage problem require a transparent measurement of the economic burden that unilateral regulation places on domestic actors. This requirement militates in favor of carbon pricing measures such as a carbon tax or cap-and-trade, rather than more traditional modes of regulation such as greenhouse gas performance standards.

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[80] Wara, *supra* note 79, at 595 (stating that at the beginning of 2007, companies had already purchased about half a billion tons of greenhouse gas reductions using this process); Elizabeth Rosenthal, *Profits on Carbon Credits Drive Output of a Harmful Gas*, N.Y. Times (Aug. 8, 2012), http://perma.cc/09rg4YjowZH (noting that massive revenue to greenhouse gas producers/destroyers has made them politically influential forces reducing any fixes to this perverse result); *see also* Daniel H. Cole, *From Global to Polycentric Climate Governance*, 2 Climate L. 395, 401–02 (2011) (describing more problems with these efforts to pay other countries for reductions).

[81] Stavins, *Policy Instruments*, *supra* note 7, at 299 ("[A] *uniform international* tax on greenhouse emissions could be imposed, with total tax revenue allocated among participating countries according to a given set of rules."); Wiener, *Global Environmental Regulation*, *supra* note 3, at 707–08, 760 ("This approach would impose a global tax on sources and match the tax with a set of international side payments that would assure individual net benefits to those who would be cooperative losers under the tax.").

[82] *See also* Wiener, *Global Environmental Regulation*, *supra* note 3, at 760–63 (explaining how subsidies necessary to ensure participation would undo environmental benefits of a tax).

[83] *See also* Stavins, *Policy Instruments*, *supra* note 7, at 322 ("Most important, it is difficult to imagine what existing international institution could impose and enforce such as system.").

If unilateral greenhouse gas regulation merely shifts emitting industries to other jurisdictions, the consequences are dire for both the environment and the prospect of widespread regulation of climate change. Industries that emit greenhouse gases will shrink in nations where regulation raises the cost of these emissions and grow in nations where there is no such regulation; or, instead, individual emitters may simply relocate to nations without regulation.[84] This leakage is worse than with other environmental pollutants, because the global distribution of greenhouse gases means that even when the regulating country loses an emitting industry (and its economic benefits) to another country, it still experiences the same environmental harm. And as voters see their industries leaving without any environmental benefit, the political case for greenhouse gas controls becomes more and more difficult. Furthermore, uncooperative countries will not only benefit from an influx of industry seeking an unregulated arena, they will also increasingly be dominated by the interests of the greenhouse gas-emitting industries that will be concentrated in them.[85] These two factors will work in concert to harden the recalcitrance of uncooperative nations.[86]

If leakage is severe enough, greenhouse gas emissions may not be reduced at all and political support for regulation may wane in countries losing industries; at the same time, greenhouse gas emitters will form an increasingly large (and powerful) interest group in uncooperative regimes.[87] This would make unilateral regulation worse than nothing;[88] it will increase emissions in other countries and harden resistance to greenhouse gas limits in the very countries where they are increasingly emitted.[89] There is reason to think that leakage could be a

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[84] *See* Wiener, *Global Environmental Regulation*, *supra* note 3, at 694 (also noting a third mechanism of leakage: As regulating countries use fewer fossil fuels, the price of these fuels will drop, encouraging their use overseas).

[85] *See id.* at 696; Brewster, *supra* note 2, at 286–87.

[86] Brewster, *supra* note 2, at 286–87; *see also* Coglianese & D'Ambrosio, *supra* note 6, at 1420.

[87] Brewster, *supra* note 2, at 270–71; *see also* Stavins, *Policy Instruments*, *supra* note 7, at 318 (describing modes of leakage and noting that so "long as participation in an international greenhouse policy is voluntary, countries will have incentives to free ride, leading to a less than optimal level of aggregate abatement").

[88] Resistance to greenhouse gas cuts from the largest remaining emitters will be exacerbated if some nations, particularly those in cold climates like Russia and Canada, actually benefit from global warming. *See* Stavins, *Policy Instruments*, *supra* note 7, at 298. Some have even argued that the United States could benefit from some climate change in certain scenarios. *See, e.g.*, Cass R. Sunstein, *The World vs. the United States and China? The Complex Climate Change Incentives of the Leading Greenhouse Gas Emitters*, 55 UCLA L. REV. 1675, 1684 (2008).

[89] There may be some positive spillover effects from unilateral climate regulation, if that regulation drives companies to develop new technologies to reduce greenhouse gas emissions — that is, if these regulations are "technology forcing." If new technologies lower the cost of reducing greenhouse gas emissions, that could make other countries more likely to adopt climate regulations. Brewster, *supra* note 2, at 257 (stating that "lowering the cost of emissions reductions makes a global agreement easier to achieve because it lowers the cost of climate change mitigation for everyone" and growing green "industries also would have an interest in lobbying for an international agreement that would raise the global demand for their product"). But these technology-forcing spillovers run both ways — they create a strong incentive for countries to delay action on climate change. The countries that "go first" will incur all the research and development and trial and error costs of finding new technologies, but those technologies will benefit all countries,

very serious problem — a recent study found that the emissions leaked to developing countries in the past two decades outweighed the entirety of emission reductions called for by the Kyoto Protocol in the same period.[90] And leakage may grow worse with increasing globalization.[91]

Thus, although leakage is sometimes thought of as merely a reason not to adopt domestic regulation of global pollutants,[92] it is also important to nations that do choose to regulate. Regulators designing domestic regulation of global problems must limit leakage. In practice, this will likely mean favoring domestic regulation that provides an easy measurement of the burden that it places on domestic industry, because most methods of combating leakage work best if this burden can be accurately measured. To explain why this measurement is crucial, it is helpful to consider the options that have been frequently proposed to limit leakage of greenhouse gas emissions. They are (1) paying countries to adopt similar regulations, (2) paying industry not to flee, and (3) imposing tariffs to account for unregulated greenhouse gases emitted in the production of goods overseas.[93] Each of these options is designed to compensate for the bur-

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especially those that delayed action. *See* Adam Jaffe, Richard G. Newell & Robert N. Stavins, *Environmental Policy and Technological Change*, 22 ENVTL. & RES. ECON. 41, 53 (2002) ("Induced innovation reduces marginal abatement costs, which increases the optimal amount of abatement, but it also increases the cost of abatement today relative to the future."); *see also* Jonathan B. Wiener, *Think Globally, Act Globally: The Limits of Local Climate Policies*, 155 U. PENN. L. REV. 1961, 1973 (2007) (expressing skepticism that green tech diffusion will be able to outrace leakage).

Theoretically, technology-forcing potential could be another important factor in choosing unilateral climate regulation. But currently there is no reason to believe that any particular climate policy instrument — whether cap-and-trade or performance standards — would be particularly effective at technology forcing, either in theory or in practice. Jaffe et al., *supra*, at 53 ("[I]t appears that an unambiguous exhaustive ranking of instruments is not possible on the basis of theory alone"); *id.* at 55 ("There has been exceptionally little empirical analysis directly of the effects of alternative policy instruments on technology innovation in pollution abatement, principally because of the paucity of available data."). More stringent regulation will induce more innovation, but at a given level of stringency, there is no way to distinguish different types of regulation. For instance, a recent empirical study found reduced innovation under a cap-and-trade regime; this result seems to be tied to low stringency, which would reduce innovation under any scheme. Margaret R. Taylor, *Innovation Under Cap-and-Trade Programs*, 109 PROC. NAT'L ACAD. SCI. 4804, 4808 (2012) (noting lack of innovation and attributing it to cap that is too high or easy to evade).

[90] Glen Peters et al., *Growth in Emission Transfers via International Trade from 1990 to 2008*, 108 PROC. NAT'L ACAD. SCI. 8903, 8904 (2011). Although this indicates the size of the phenomenon, it is important to note that much of this leakage was not caused by greenhouse gas emission control. *Id.* at 8908; *see also* Brewster, *supra* note 2, at 287 (noting that "estimates [of leakage from EU emission reductions] range from as low as 5% to as high as 130%"); Wiener, *Global Environmental Regulation*, *supra* note 3, at 695 (noting that estimates of likely leakage from EU range "from 4% to more than 100% of the emission abatement achieved initially").

[91] Jonathan B. Wiener, *Think Globally*, *supra* note 89, at 1970 ("As the world economy becomes increasingly open and integrated, the fluidity and immediacy of the price effect and the longer-term re-location effects will grow, exacerbating leakage.").

[92] *See, e.g.*, Coglianese & D'Ambrosio, *supra* note 6, at 1419 (noting that it is "likely that incremental policies will do little or nothing to affect global warming" and "might also worsen the global climate change problem because of leakage").

[93] There are also some more radical, if less likely, options, including coercive threats to foreign nations or holding foreign polluters liable in U.S. courts. *See* Jonathan Zasloff, *The Judicial Carbon Tax: Reconstructing Public Nuisance and Climate Change*, 55 UCLA L. REV. 1827, 1872–81

den that greenhouse gas regulation imposes on domestic industry. But each option for preventing leakage is problematic, because it could be used in bad faith to hold up a regulator for more money, or to impose a protectionist tariff under the guise of environmental regulation.

Scholars have often suggested that regulating nations could simply pay recalcitrant countries to adopt greenhouse gas controls.[94] To the extent that recalcitrant countries are poorer developing countries, this suggestion could accomplish a kind of rough justice given the historical responsibility of developed countries for greenhouse gas concentrations.[95] But recalcitrant countries could

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(2008) (arguing that nuisance suits could be brought against foreign corporations for their emissions in foreign countries, so long as the corporation itself has some contact with the United States). A court could look to the example of the U.S. Foreign Corrupt Practices Act ("FCPA") of 1977, which prohibits bribery of foreign officials. Under the FCPA the United States claims jurisdiction whenever *any* act in furtherance of the bribery takes place in the United States, including a "telephone call to the United States, a letter mailed to the United States, the use of air or road travel, or the clearing of a check or wire transfer of funds through a financial institution in the United States." H. Lowell Brown, *Extraterritorial Jurisdiction Under the 1998 Amendments to the Foreign Corrupt Practices Act: Does the Government's Reach Now Exceed Its Grasp?*, 26 N.C. J. INT'L L. & COM. REG. 239, 359 (2001). By analogy, if a foreign entity used a U.S. financial institution at any stage of funding for an emitting project or simply discussed a project with personnel or investors in the United States, a court could hold it liable for its emissions. But given the political sensitivity of greenhouse gas controls, and the knotty fairness issues involved, see discussion *supra* note 72 (describing difficulty of deciding on appropriate division of emissions among nations), not to mention the practical difficulty of such a suit, there is little reason to expect that domestic courts would assume the power to resolve such worldwide claims. *See* Douglas A. Kysar, *What Climate Change Can Do About Tort Law*, 41 ENVTL. L. 1, 8–44 (2011) (demonstrating practical difficulty of adjudicating climate change tort claims).

[94] Such payments could be direct payments for participation or could be folded into linked regimes. *See* Wiener, *Global Environmental Regulation*, *supra* note 3, at 763–68 (suggesting cap-and-pay options to compensate countries that would gain less from greenhouse gas controls); Stavins, *Policy Instruments*, *supra* note 7, at 308–10 (describing how poorer countries could be compensated under an international tax system or an international cap-and-trade system); Daniel A. Farber, *Basic Compensation for Victims of Climate Change*, 155 U. PA. L. REV. 1605, 1646 (2007) ("If mitigation is achieved through a cap-and-trade system, we might want to provide compensation by reallocating some emissions allowances from emitters to victims. Victims would receive financial compensation by selling allowances, which emitters would have to acquire for compliance purposes.").

[95] Given that carbon dioxide and other greenhouse gases can last in the atmosphere for centuries, emissions from developed nations account for the vast majority of greenhouse gases currently causing global warming. *See* WORLD RES. INST., CONTRIBUTIONS TO GLOBAL WARMING: HISTORIC CARBON DIOXIDE EMISSIONS FROM FOSSIL FUEL COMBUSTION, 1900–1999 (2007), *available at* http://perma.law.harvard.edu/0DwJQexczjy (showing that United States was responsible for 30.3% of greenhouse emissions from burning of fossil fuels during the twentieth century; Europe (excluding the former Soviet Union) was responsible for 27.7% of emissions; and there was a mere 12.2% contribution by China, India, and other developing parts of Asia combined). Even if one only considers emissions since 1990 — a plausible marker of when the developed world should have realized the climate risks imposed by its emissions — the United States and European Union are each responsible for more than a quarter of greenhouse gases currently in the atmosphere, even though each has less than a tenth of the world's population. PAUL BAER, TOM ATHANASIOU & SIVAN KARTHA, THE GREENHOUSE DEVELOPMENT RIGHTS FRAMEWORK: THE RIGHT TO DEVELOPMENT IN A CLIMATE CONSTRAINED WORLD 19 (2d ed. 2008), *available at* http://perma.law.harvard.edu/0xRBEyei3dB. Consequently, one could justly say that developed countries have already "used up" their share of the global climate commons. Furthermore, developed countries are richer and better able to afford greenhouse gas abatement schemes, so some have argued that the developed world should cut its own greenhouse gas emissions *below* zero through

simply exaggerate the costs of adopting regulation and demand more money from first-mover regulators. More fundamentally, this suggestion probably requires an international treaty — it is implausible that any one first-mover country could pay each of its competitor countries enough to adopt comparably stringent greenhouse gas controls.

More realistically, unilateral regulators can pay domestic industry not to leave through subsidies or "rebates." This is likely the most common method of limiting leakage of greenhouse gas emissions. The EU uses a version of this method,[96] as does the carbon tax recently adopted in Australia;[97] the cap-and-trade bill passed by the United States House in 2009 did so as well.[98] Charging polluters for their emissions and then rebating them the cost of regulation is, of course, problematic — if polluters are paid the full cost of regulation, they have no incentive to cut their emissions. But this policy is not entirely futile: Polluters are usually charged per unit of pollution, and then rebated money per unit of production, so that if they lower their pollution while keeping all their production within the regulating country, they get to keep the difference. However, this method does not provide any incentive to reduce production that is inherently polluting, and gives polluters every incentive to hold up domestic regulators by exaggerating the cost of regulation and threatening to flee if their demands are not met.

Conversely, unilateral regulators may impose a tariff on imported goods produced using unregulated greenhouse gases overseas. This helps level the playing field between domestic producers, who had to pay for their greenhouse gas emissions, and producers in countries without greenhouse gas regulation.[99] Such tariffs have downsides as well because they could be used to adopt pro-

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drastic cuts paired with funding abatements in developing countries. *Id.* at 21–22 (arguing that the United States should cut its emissions below zero by 2025).

Of course, the propriety of making such adjustments for affordability and historical emissions is hotly contested. *See generally* Posner & Sunstein, *supra* note 22 (arguing that such adjustments are inefficient and unjust). And as developed countries continue to struggle economically in comparison with more quickly growing developing countries, there may not be the political will in developed countries to pay the developing world enough to ensure its cooperation. *See* INT'L MONETARY FUND, WORLD ECONOMIC OUTLOOK: TENSIONS FROM THE TWO-SPEED RECOVERY: UNEMPLOYMENT, COMMODITIES, AND CAPITAL FLOWS 2–3 (2011), *available at* http://perma.law.harvard.edu/0eTRZoE4JiM.

[96] *See* EUROPEAN UNION, CLIMATE ACTION: CARBON LEAKAGE, http://perma.law.harvard.edu/0TNaVzrGuqu.

[97] TONY WOOD & TRISTAN EDIS, GRATTAN INST., NEW PROTECTIONISM UNDER CARBON PRICING: CASE STUDIES OF LNG, COAL MINING AND STEEL SECTORS 39–41 (2011), *available at* http://perma.law.harvard.edu/0yrjpCueBVd.

[98] The American Clean Energy and Security Act, H.R. 2454, 111th Cong. §§ 763–64 (2009).

[99] Such a tariff would not remove the entire incentive to flee because a domestic manufacturer's *exports* to other countries would still face a cost disadvantage compared to production from a country where emissions were unregulated, unless the recipient country applied a similar penalty to goods from jurisdictions without regulation. *See* Brewster, *supra* note 2, at 294–95 & n.150. One option for addressing this differential is pairing the tariff with a subsidy for exports to countries without regulation. *See* Farber, *supra* note 5, at 13.

tectionist legislation in the guise of environmental regulation[100] — a nation could exaggerate the burden that its regulations place on domestic industry so that it could adopt high tariffs that would exclude foreign goods. Even tariffs designed in a good-faith effort to prevent leakage might lead to an international trade war,[101] or could violate international trade law.[102] But at least there are some methods of reducing these frictions — one possibility is that the tariff collected on goods from industries in a country without regulation could be rebated to that country so long as it made a verifiable commitment not to simply refund those revenues to its polluting industries.[103] If tariffs were perceived as covert protectionism, however, it seems very likely that they would spark a trade war.

Thus, each option for preventing leakage is prone to manipulation by industries or nations that wish to exaggerate the burden that greenhouse gas regulation places on domestic industry. If a country pays industries to tolerate these regulations, those industries will exaggerate the burden to maximize their payout. If a regulating country adopts a compensating tariff, other nations will suspect that the regulating country has exaggerated the burden to adopt protec-

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[100] Scholars who favor paying developing nations to regulate greenhouse gases also object that penalizing rather than paying such nations is inherently unfair. Robyn Eckersley, *The Politics of Carbon Leakage and Fairness of Border Measures*, 24 ETHICS & INT'L AFF. 367, 382 (2010).

[101] *See* Wiener, *Global Environmental Regulation*, *supra* note 3, at 758–59; *see also* Brewster, *supra* note 2, at 294–95 (arguing that different conceptions of appropriate level of regulation could lead to a patchwork of inconsistent carbon tariffs). Regarding this concern, it is important to distinguish between punitive tariffs, which would be used to force a country to comply, and compensatory adjustments, which would merely put exporters in the same position that they would occupy if the importing state had not adopted greenhouse gas controls. *See id.* at 293–95 (explaining the difference between a sanctioning tariff and compensatory adjustments).

[102] *See* Paul-Erik Veel, *Carbon Tariffs and the WTO: An Evaluation of Feasible Policies*, 12 J. INT'L ECON L. 749, 770–93 (2009); Gary Clyde Hufbauer & Jisun Kim, *The World Trade Organization and Climate Change: Challenges and Options* (Peterson Inst. for Int'l Econ., Working Paper No. 09-9, 2009), *available at* http://perma.law.harvard.edu/0XkshoHJkUV. This formal concern may be somewhat exaggerated; given the political salience of carbon tariffs that would touch a broad swath of the manufacturing economy, political consensus may be more important than WTO rulings. The WTO can only authorize trade sanctions — if the United States and European Union agree on a border adjustment regime, it seems unlikely that a smaller country would risk a trade war with such economically dominant powers, even if it were supported by a WTO decision. *See* Brewster, *supra* note 2, at 294 n.150 (citing WORLD TRADE ORG., INTERNATIONAL TRADE STATISTICS 2008 11 (2008), *available at* http://www.wto.org/english/res_e/statis_e/its2008_e/its2008_e.pdf) (noting that the United States and European Union together import over half of the world's exports). As for larger nations, it is not clear that the WTO would restrain them on an issue of such importance. Instead, they could simply retaliate while the lengthy WTO process was ongoing. Geoff Antell & James Coleman, *An Empirical Analysis of Wealth Disparities in WTO Disputes: Do Poorer Countries Suffer From Strategic Delay During Dispute Litigation?*, 29 B.U. INT'L L.J. 267, 275 (2011) (finding that the average dispute took 1,555 days from filing through the end of compliance). Even though retaliation is technically prohibited, the WTO's remedies are only prospective, *id.*, and the only remedy is to file a counterclaim, so there is little practical incentive not to retaliate.

[103] This would operate as a sort of enforced carbon tax on the country's exports. Of course, money is fungible, so this policy would present difficult accounting issues — a target country might shift resources to polluting industries in many subtle ways. If it proved too difficult, another option would simply be sending the revenues to fund private greenhouse gas reducing projects in such a country.

tionist tariffs. For all these reasons, regulators need a measurement of the burden of greenhouse gas regulations that is as credible as possible.

Market measures like a carbon-tax or cap-and-trade will provide a better measurement of regulatory burden than more traditional modes of regulation like greenhouse gas performance standards because market measures provide a carbon price — a specified cost to emit a ton of greenhouse gases. Under a carbon tax a polluter must pay a fee for each ton of greenhouse gas emitted — e.g., $25 per ton of carbon dioxide equivalent. Under a cap-and-trade system, a polluter must purchase a permit for each ton of greenhouse gas emitted. As a result, both systems make it relatively easy to determine how much a polluter is burdened: one can just look at how much tax it paid or how much it paid to purchase permits. By contrast, when the Environmental Protection Agency ("EPA") issues performance standards, which demand that new sources of pollution achieve specified emission rates, it is very difficult to measure the cost of those standards objectively. Indeed, disparate cost estimates are often a principal focus of political and legal controversy concerning such rules.[104] But if the United States adopted a carbon tax of $25 per ton or adopted a cap-and-trade system in which permits were selling for $25 per ton, there would be a relatively public and relatively uncontroversial measure of the burden imposed by greenhouse gas regulations.[105]

A carbon price is not a silver bullet for disputes about rebates or tariffs, but it could provide a more credible measurement of their appropriate size. Multiplying the greenhouse gases emitted to create a product overseas times the domestic carbon price should provide a reasonable estimate of the advantage that a foreign manufacturer would gain from avoiding regulation.[106] A similar process could be used to calculate the appropriate size of subsidies to domestic industry burdened by greenhouse gas regulation. Of course, it is both theoretically and practically difficult to estimate the amount of greenhouse gases used

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[104] John F. Anderson & Todd Sherwood, EPA, Office of Transp. & Air Quality, Comparison of EPA and Other Estimates of Mobile Source Rule Costs to Actual Price Changes (SAE Technical Paper 2002-01-1980, 2002), *available at* http://perma.law.harvard.edu/0NLmN3DmexS (noting that the central issue in rule adoptions was the differing cost projections of agency and industry and finding that "all ex ante estimates tended to exceed actual price impacts, with the EPA estimates exceeding actual prices by the smallest amount"); *see also* EPA, FINAL REGULATORY IMPACT ANALYSIS (RIA) FOR THE SO_2 NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) 6–20 (2010).

This problem is exacerbated when countries adopt *different* command-and-control standards — how can their stringency be compared? Imagine that as part of its greenhouse gas policy, the United States required that a specified percentage of vehicles be battery-powered vehicles, and that Mexico instead demanded that a specified percentage of vehicles run on natural gas. It would be very difficult for either regulator to quantify how much more or less stringent the other country's regulation was.

[105] These prices are subject to "cushioning" — countries may adopt offsetting tax cuts or subsidies to greenhouse gas emitting industries to counteract the effect of the carbon price. *See* Wiener, *Global Environmental Regulation*, *supra* note 3, at 785–87. For this reason, regulators comparing carbon prices must also monitor tax policy in exporting countries, a daunting task. *Id.*

[106] If the other country also regulated greenhouse gas emissions, one could use a more precise tariff that relied upon the *difference* in carbon prices between the two nations.

to manufacture a product overseas, but state and federal administrative agencies (as well as private industry) are aggressively developing tools to accomplish this task.[107] Thus, market measures would minimize some of the inevitable problems with efforts to stop leakage.

As between a cap-and-trade system and a carbon tax, it seems likely that a carbon tax would provide a somewhat less controversial measurement of the burden imposed by greenhouse gas regulation. Under a cap-and-trade system, the market price of carbon varies significantly over time — under the EU Emission Trading System, prices have varied from € 1 to over € 30.[108] As a result, a comparison of market prices does not provide a *stable* measurement of the difference between two cap-and-trade regimes — a regime that is more stringent using one time baseline may be much less stringent using another baseline. Thus, stringency comparisons would be open to manipulation in a way that would make it difficult for regulators to make border adjustments that

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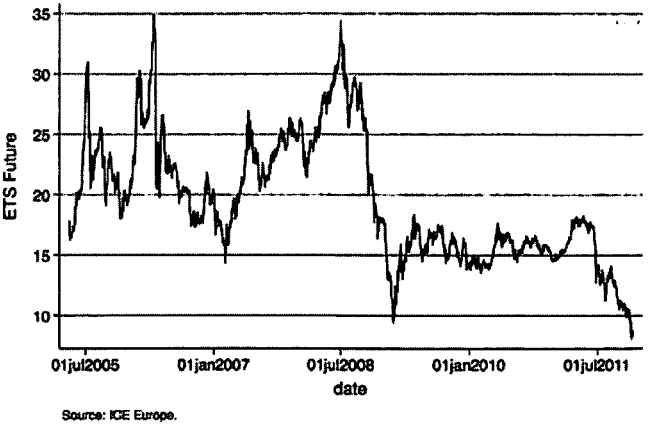
[107] *See generally* Michael P. Vandenbergh & Mark A. Cohen, *Climate Change Governance: Boundaries and Leakage,* 18 N.Y.U. ENVTL. L.J. 221 (2010) (arguing that it is critical to assess emissions from supply chains because they are the principle mechanism for leakage). Assessing the greenhouse gas emissions associated with production of a product is a critical component of EPA's renewable fuel standard program which sets standards for "lifecycle greenhouse gas emissions," 42 U.S.C. § 7545(o)(1)(B) (2012), which includes all the emissions associated with producing and transporting fuel, as well as emissions that result from market changes driven by sale of the fuel, *id.* at § 7545(o)(1)(H) (stating that "lifecycle emissions" include all emissions "related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer"); *see also* EPA, EPA LIFECYCLE ANALYSIS OF GREENHOUSE GAS EMISSIONS FROM RENEWABLE FUELS (2009), *available at* http://perma.law.harvard.edu/07kuCA1LHCz.

[108] *See* Farber, *supra* note 5, at 7; THE INTERCONTINENTAL EXCHANGE, THE EMISSIONS MARKET: ICE FUTURES EUROPE – ECX 10, http://perma.law.harvard.edu/06Fb62Vj52c. This volatility is well represented in a graph by Professor Allan Collard Wexler:



ALLAN COLLARD WEXLER, GRAPHS, PRICE OF CARBON FROM THE EU ETS, http://perma.law.harvard.edu/0ejZbvfMU1q.

are perceived as legitimate. The relatively stable prices provided by a carbon tax make for a simpler and more stable comparison.[109]

IV. Modeling Regulation: Adopting Environmental Policy Instruments That Can Be Used Elsewhere

Finally, first-mover regulation would do more to encourage foreign nations to address global environmental problems if it could provide a model for other countries to use. Thus, first-mover regulation should ideally be (1) transparent, so that other countries can copy it, (2) modular, so that countries can adopt it even if they are unable to make larger changes to their legal systems, and (3) simple, so that a wide range of other countries can adopt it, even if they do not have the capacity to adopt complex regulations.

Designing effective regulation is costly, and reducing this cost can lower one barrier to adoption of regulation. It is true, of course, that the primary obstacles to regulation of global problems concern incentives to free-ride rather than regulatory knowledge — even if they had many excellent and appropriate models to choose from, nations might well choose not to regulate greenhouse gas emissions. Nevertheless, the existence of successful models of regulation can catalyze regulation by lowering the cost of designing regulation for nations that are willing to control greenhouse gas emissions.[110] As noted, this dynamic is already playing out with the United States and Canada, which collaborated on the most recent auto emission standards, and with several countries that are coordinating efficiency standards for appliance and consumer electronics.[111]

This should not be particularly surprising: One premise of the literature on policy diffusion is that when one jurisdiction adopts a rule, other jurisdictions are more likely to follow suit, all other things equal.[112] This catalyzing effect is

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[109] Cap-and-trade systems can be designed so that they provide a more stable carbon price, and carbon taxes can be designed so that they provide a variable price. Weisbach, *supra* note 21, at 133–34 (arguing that caps and taxes can be designed to resemble each other and noting that "[r]ecent proposals . . . seemed designed to make fun of the artificial distinction between taxes and permits"). The point, however, is that a generic flat carbon tax, or a cap-and-trade system designed to operate like such a tax, would work better than a generic variable-price cap-and-trade system or a tax designed to operate like such a cap.

[110] This is to employ a functionalist, rather than expressive approach to comparative environmental law — examining diffusion of policy instruments along regulatory networks to address common problems. *See* Mark Tushnet, *The Possibilities of Comparative Constitutional Law*, 108 Yale L.J. 1225, 1228–29 (1998) (distinguishing between these two types of law in discussing the use of foreign constitutional models); *see also* David Landau, *Political Institutions and Judicial Role in Comparative Constitutional Law*, 51 Harv. Int'l L.J. 319, 333–34 (2010) (same). This functionalist view is well established in environmental law. *See infra* notes 115–118 and accompanying text.

[111] *See* Clean Energy Ministerial, *supra* note 33 and accompanying text.

[112] *See, e.g.*, Charles R. Shipan & Craig Volden, *The Mechanisms of Policy Diffusion*, 52 Am. J. Pol. Sci. 840, 841–43 (2008) (identifying mechanisms of diffusion through learning and imitation); Frances Stokes Berry & William D. Berry, *State Lottery Adoptions as Policy Innovations: An Event History Analysis*, 84 Am. Pol. Sci. Rev. 395, 406 (1990) (reporting empirical finding that "the probability that a state will adopt a lottery increases as the number of its neighbors that have previously adopted it grows, even when [other state] characteristics have been controlled");

also consistent with the explanation of lobbying as a "legislative subsidy" — that is, lobbying expenditures work, in part, by providing model legislation, which lowers a barrier to congressional action.[113] And the diverse organizations and institutes that collect or develop model laws and regulations have a similar motivation.[114]

The catalytic role of first-mover regulation is particularly prominent in the environmental arena. California has a long history of exporting its more stringent environmental regulations to other states,[115] and scholars have documented how national environmental regulations spread across global trade networks.[116] This is one reason that organizations like the Sierra Club collect and publicize collections of state laws on types of pollution that they believe should be better controlled.[117] The International Energy Agency has followed the same strategy on climate change, compiling databases of "policies and measures" in three climate related fields: "Addressing Climate Change," "Global Renewable Energy," and "Energy Efficiency."[118] Therefore, if unilateral climate regulation could be used by other countries as a model, there is reason to think that it might catalyze regulation in other countries.

Of course, unilateral regulation is most likely to be used as a model in other countries if it proves successful — that is, if it reduces net greenhouse gas emissions at a reasonable economic cost and does not simply push emitting industries elsewhere. But that simply underlines the importance of the previously discussed factors and the usual criteria for regulation. The separate consideration here is, assuming that they have proven successful, which unilateral climate regulations could be used as a model by countries that are willing to adopt regulation?

First, domestic regulation can only serve as a model for foreign nations if those nations can determine what that regulation is, so unilateral regulation

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Isaac Martin, *Dawn of the Living Wage: The Diffusion of a Redistributive Municipal Policy*, 36 URB. AFFAIRS REV. 470 (2001) (documenting spread of living wage policies between U.S. cities in the 1990s).

[113] *See generally* Richard Hall & Alan Deardorf, *Lobbying as Legislative Subsidy*, 100 AM. POL. SCI. REV. 69 (2006).

[114] *See, e.g.*, AM. LEGAL INST., MODEL PENAL CODE (1962); AM. LEGAL INST., MODEL CODE OF EVIDENCE (1942); DeKeely Hartsfield, Anthony D. Moulton & Karen L. McKie, *A Review of Model Public Health Laws*, 97 AM. J. PUB. HEALTH s56 (2007) (reviewing 107 model public health laws, including a law from the American Legislative Exchange Council).

[115] David Vogel, TRADING UP: CONSUMER AND ENVIRONMENTAL REGULATION IN A GLOBAL ECONOMY (1995) (using the term "California effect" to describe how California's regulatory innovation has spread to other states through national trade).

[116] *See, e.g.*, Richard Perkins & Eric Neumayer, *Does the 'California Effect' Operate Across Borders? Trading- and Investing-Up in Automobile Emission Standards*, 19 J. EUR. PUB. POL'Y 217 (2012) (documenting spread of stricter auto emissions standards to trading partners of regulating jurisdictions); Anu Bradford, *The Brussels Effect*, 107 NW. UNIV. L. REV. 1, 29–30 (2013) (describing spread of EU measures on hazardous waste); *see also* Richard B. Stewart et al., *Building Blocks for Global Climate Protection*, 32 STAN. ENVTL. L. J. 341, 378–79 (2013) (giving these effects the name "dominant actor strategies").

[117] *FRAC: Fracking Regulatory Action Center*, SIERRA CLUB, http://perma.law.harvard.edu/0W1q EdiLVnK.

[118] *Policies & Measures*, INT'L ENERGY AGENCY, http://perma.law.harvard.edu/0pJ7vRsQSsh.

should be transparent.[119] This could have several implications for environmental policy choice. For one thing, it suggests that simpler numerical performance standards might be preferable to more flexible multi-factor tests. As an example of how this might apply, consider the first two EPA initiatives on controlling greenhouse gases from industrial sources. The first U.S. federal controls on greenhouse gas emissions from stationary sources like refineries, factories, and power plants were "Best Available Control Technology" ("BACT") requirements for new sources.[120] What constitutes the "best available" control is determined in permitting decisions "on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs."[121] Subsequently, EPA has proposed a numerical national performance standard which is only applicable to new power plants; it requires new fossil-fuel plants to emit less than 1,100 pounds of CO_2 per megawatt-hour.[122] From the perspective of a country trying to emulate the United States, the numerical performance standard would be easier to imitate than the nebulous BACT standard. And indeed, Canada has recently finalized power plant regulations closely paralleling the numerical performance standard proposed by EPA.[123] By contrast, emulating the BACT standard would require following the results of numerous case-by-case analyses just to learn what kind of reductions would be required.

By the same token, regulatory bans, although potentially problematic for many reasons, might be even better in the limited sense that they are easy to emulate. For instance, in 2007, as part of greenhouse gas control legislation, the U.S. state of Minnesota placed a moratorium on construction of coal-fired power plants.[124] In the same year, the Canadian province of Ontario went even further, phasing out existing coal-fired power plants.[125] At the other extreme, regulation of global environmental problems through tort law would not be easy to emulate, because unlike statutes and regulations, it is not written down in one place. Because tort law is composed of a body of legal opinions, it

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[119] *See, e.g.*, David Dolowitz & David Marsh, *Who Learns What from Whom: A Review of the Policy Transfer Literature*, 44 POL. STUD. 343, 353 (1996) ("[T]he more information agents have about how a programme operates in another location the easier it is to transfer.").

[120] Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010).

[121] Clean Air Act (CAA) § 165, 42 U.S.C. § 7479(3) (2012). EPA has suggested that it could include energy efficiency measures, or more significant steps such as switching to cleaner fuels or even carbon capture and storage. PSD and Title V Permitting Guidance for Greenhouse Gases, 75 Fed. Reg. 70,254 (Nov. 17, 2010); EPA, EPA-457/B-11-001, PSD AND TITLE V PERMITTING GUIDANCE FOR GREENHOUSE GASES (2011), *available at* http://perma.law.harvard.edu/0QYbSGr FwGN (updated version of guidance).

[122] Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 Fed. Reg. 22,392 (Apr. 13, 2012). At the time of this Article's publication, the regulations had not yet been published in the Federal Register.

[123] Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations, 146 C. Gaz. 2012-1060 (Aug. 30, 2012) (prescribing a standard of 420 tons per Gigawatt hours, which is approximately 926 pounds per megawatt-hour).

[124] MINN. STAT. § 216H.03 (2007).

[125] Cessation of Coal Use – Atikokan, Lambton, Nanticoke and Thunder Bay Generating Stations, O. Reg. 496/07 (Can.).

would be difficult for foreign regulators, whether courts or legislators, to implement — even domestic lawyers often cannot discern a consistent rule from disparate tort decisions.[126]

Domestic regulation of global environmental problems will also be a more useful model if it can be adopted by other countries without requiring wider-scale changes to their regulatory systems — that is, if it is modular. On this front, tort regulation is again problematic. Tort liability seems particularly ill-suited to transfer from country to country because the tort system is designed to remedy a wide range of harms rather than being tailored specifically to global environmental problems; consequently, countries have significant differences between their tort liability systems that they may not wish to sacrifice to address a single problem such as climate change. Indeed, this seems to be one of the principle reasons for the failure of efforts to adopt international liability treaties addressing global environmental harms; countries cite unwillingness to adopt tort principles like joint-and-several liability and environmental damages as an important reason for rejecting such treaties.[127]

Finally, other things equal, first-mover regulation will be a more useful model if it is simple enough that it can be adopted and enforced in a wide range of countries that might not have the institutions to use more complex regulation. Although this concern does not apply to policy diffusion between nations of a similar capacity, nations at all levels of economic and institutional development contribute to global problems like climate change. Indeed, given the costs of regulatory design, developing countries may be particularly likely to look to the developed world for regulatory models. Thus, a first-mover model would find the widest audience if it relied on broadly shared institutions rather than on institutions that are usually limited to developed countries.

For facility-level controls on pollution, this consideration would likely favor simple regulatory bans rather than more complex multi-factor tests that would require sophisticated environmental permitting agencies for adjudication.[128] Among market-based instruments, pollution taxes might be preferable to tradable permit schemes like cap-and-trade because functioning states have at least some existing ability to collect taxes, while states must build a market for cap-and-trade. Even scholars who argue that there is little inherent difference between a well-designed carbon tax and permit system admit that operating a

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[126] *See* Victor E. Schwartz & Christopher E. Appel, *Exporting United States Tort Law: The Importance of Authenticity, Necessity, and Learning from Our Mistakes*, 38 PEPP. L. REV. 551, 553 (2011) (arguing that foreign courts attempting to adopt United States tort law "adopted a distorted, modified, or incomplete approach" because they "failed to obtain and pattern the authentic United States law or failed to incorporate later developments by courts that corrected mistakes or elucidated key legal concepts").

[127] Noah Sachs, *Beyond the Liability Wall: Strengthening Tort Remedies in International Environmental Law*, 55 UCLA L. REV. 837, 888–89 (2008) (documenting that the most common reasons for rejecting these treaties are inconsistency with domestic law and mismatch between complexity of the treaty and the capacity of the domestic law system).

[128] Numerical pollution limits, while transparent, might be hard for developing countries to enforce depending on the difficulty of monitoring compliance.

permit market may well be more complex because of the "costs of operating markets, having price ceilings and floors, and having banking and borrowing provisions."[129] And there is reason to think that some of these costs would be exacerbated in developing countries that might not have expertise in creating permit markets, and might have more need for provisions like ceilings, floors, banking, and borrowing that are particularly necessary when the government does not have the ability to accurately forecast the permit market or credibly commit not to revise the market in the future.[130] So a first-mover carbon tax might be a plausible model for a wider range of countries than a cap-and-trade system.

V. General Implications for Choice of Domestic Greenhouse Gas Policy Instruments

Paying attention to the ways that domestic regulation can marginally increase the incentives to regulate in other countries provides two general lessons that apply to ongoing debates concerning what policy instruments should be used to address climate change. First, to the extent that they have freedom of action, domestic regulators should pay special attention to making regulation transparent along several dimensions; transparent regulatory commitments are better able to induce matching commitments, easier to compensate for, and easier to copy. Although one can imagine situations where opaque regulation would do more to encourage action overseas, climate change is not such a situation. Second, on balance, choosing some combination of a carbon tax and funding for pollution-reducing technology rather than performance standards or a cap-and-trade system would probably do the most to induce other countries to adopt marginally more stringent climate regulations. Finally, these general implications would also apply to U.S. states and other subnational actors seeking to address greenhouse gases, with some modifications because states' abilities to limit leakage may be constrained by the dormant commerce clause.

A. Domestic Regulators Should Pay Special Attention to Choosing Transparent Regulations to Fight Climate Change

If nations tackling climate change want other countries to follow suit, they should pay special attention to making regulation transparent along several dimensions. Perhaps most importantly, the burden imposed by greenhouse gas regulation should be clear. Leakage of emissions from countries that regulate is one of the principal problems of unilateral climate policy design, and to limit leakage regulators must compensate for the burden of regulation using subsidies to domestic industry or carbon tariffs. Those mechanisms, in turn, require a transparent measure of the burden imposed by greenhouse gas regulation. And

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[129] Weisbach, *supra* note 21, at 137–38.
[130] *Id.*

unilateral regulation that promises a matching commitment will also be most effective when its stringency is transparent — that is, when it offers a credible promise about how much it will reduce greenhouse gas emissions.

The importance of adopting regulations with a knowable cost, which might be thought of as an ordinary virtue of regulation, goes against the conventional wisdom in the climate change context. For one thing, the received wisdom in climate change policy is that, given the difficulty of winning support for climate policy, regulators should hide the cost of regulation.[131] Scholars have also reasonably argued that, given the uncertainty surrounding the cost of climate change, the effects of unilateral regulation,[132] and the weight that should be afforded to the interests of future generations,[133] cost-benefit analysis may be uniquely unsuited to decisions about climate change. Rather than choosing climate regulation by reference to supposedly neutral criteria like social welfare maximization, they argue that such choices are necessarily the result of political or ethical decision making.[134] But whatever the difficulty of knowing the *benefit* of climate change regulation, transparent measurements of the *burden* of climate change regulation are crucial because they will enable unilateral regulation that encourages, rather than discourages, action elsewhere.[135]

Finally, although one can imagine theoretical situations in which hiding one's level of commitment to providing a public good might induce more provision by other countries, climate change is not such a scenario. For example, such a scenario could occur if there were an essential public good with a relatively fixed cost with no reasonably close private substitute. Then a first-mover

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[131] *See, e.g.*, Aldy et al., *supra* note 7, at 100–01; Stavins, *Policy Instruments*, *supra* note 7, at 320–21. There is reason, however, to doubt that hiding-the-ball is an effective strategy, even as a matter of politics. Interest groups opposed to regulation have every incentive to point out the presence of hidden costs. *See* John M. Broder, *'Cap and Trade' Loses Its Standing as Energy Policy of Choice*, N.Y. TIMES (Mar. 26, 2010), http://perma.cc/0NEf99uHSe5 (noting that cap-and-trade is now "in wide disrepute, with opponents effectively branding it 'cap and tax'"). And even proponents of regulation must acknowledge its costs, if only to ensure compensation for its regressive impact. *See, e.g.*, EPA, EPA ANALYSIS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009 (2009), *available at* http://perma.law.harvard.edu/0c5LYyMQANn ("Before accounting for the way in which allowances are allocated or revenues are redistributed, lower income households are disproportionally affected by a GHG cap-and-trade policy because they spend a higher fraction of their incomes on energy-intensive goods.").

[132] *See generally* Jonathan S. Masur & Eric A. Posner, *Climate Regulation and the Limits of Cost-Benefit Analysis*, 99 CAL. L. REV. 1557 (2011) (arguing that the benefit of greenhouse gas regulation cannot be specified in cost-benefit terms because it depends on fundamentally political questions such as how we value the welfare of foreigners and how we believe foreigners will react to our regulation).

[133] Richard L. Revesz & Matthew R. Shahabian, *Climate Change and Future Generations*, 84 S. CAL. L. REV. 1097, 1143–45, 1152–56 (2011) (arguing that discount rates typically applied in cost-benefit analysis are inappropriate for climate change, because (1) they are not appropriate for intergenerational comparison, and (2) path dependence means that some mitigation options that are available now may not be available later).

[134] Masur & Posner, *supra* note 132, at 1596–99 (arguing that the social cost of carbon — and, consequently, the benefit of climate regulation — must be set politically); Revesz & Shahabian, *supra* note 133, at 1163 (arguing that discount rate for cost-benefit analysis must be justified in ethical terms).

[135] Domestic regulations may also pave the way for foreign regulation if they are transparent enough that they can serve as a model for other countries. *See supra* Part IV.

country might hide its provision of a public good in the hope that other nations would then provide it because they would be afraid that otherwise no one would provide the public good. For instance, the United States could pretend that it would not use military force to ensure regional stability in Europe, which might encourage its European allies to build their own military forces for this purpose. Or the United States might pretend that it was indifferent to the fate of an endangered species endemic to only the United States and Canada, which might encourage Canada to step up its conservation efforts.

Climate change regulation, however, is not an area where a nation could induce more effort overseas by pretending that it was doing less. First, unlike the hypothetical military force or endangered species, no one country can provide the public good of stabilizing the global climate. So the stringency of unilateral climate regulation would still result from the balance between the normal incentives to regulate and incentives to free-ride. There is no clear mechanism in which a false belief that other countries were doing less would push the balance toward incentives to regulate. For instance, first-mover countries will experience leakage, even if they try to hide the stringency of their unilateral regulation. Leakage is nearly impossible to hide — fossil fuel-dependent industries will shrink in countries with regulation and grow in countries without regulation.[136] So if foreign countries were convinced that a nation's greenhouse gas regulation was relatively lax and nevertheless observed leakage, the natural assumption would be that even low levels of regulation lead to significant leakage.

Second, nations that believe the public good will not be provided have an imperfect private substitute: adaptation — the process of preparing a nation for increased temperatures, rising seas, and the other consequences of global warming. Adaptation cannot fully counteract the effects of climate change,[137] but the benefits of adaptation are almost entirely internalized by the country that undertakes it. Although sea walls, improved air conditioning, and new agricultural systems are expensive and imperfect responses to global warming, the country that undertakes them receives the full benefit of these measures. There is little reason to think that countries currently inclined to adapt rather than participate in providing the public good of greenhouse gas regulation will be

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[136] This leakage is not dependent on industry's *knowledge* of the burden of regulation — greenhouse gas regulation will necessarily directly or indirectly harm the competitiveness of fossil fuel-dependent industries. This harm will tend to push industry overseas even if industry does not perceive the specific reason for different prices in different nations. And even if specific companies do not flee, leakage will nevertheless occur because price differentials will cause fossil fuel-dependent industries to shrink in regulating countries and grow in unregulated countries. *See supra* note 87 and accompanying text. Furthermore, reduced consumption of fossil fuels in regulating nations will make those fuels cheaper for consumers elsewhere, leading to increased use overseas. *Id.*

[137] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION, AND VULNERABILITY, SUMMARY FOR POLICYMAKERS 19 (2007). Adaptation is being aggressively pursued by many countries. *See id.*; ANTHONY GIDDENS, THE POLITICS OF CLIMATE CHANGE 162 (2009).

moved to change course by exaggerating how little the rest of the world is doing to provide that good.[138]

An opposite scenario in which a lack of transparency might induce others to regulate greenhouse gases might occur when, given a lack of information, foreign nations would overestimate a country's commitment to greenhouse gas regulation, and would thus be willing to do more. But there is little reason to think that foreign nations would be systematically overoptimistic on this front. Given the strong incentives to free-ride, the default assumption of foreign nations would likely be that opaque regulation was designed to make a show of cooperation without imposing significant costs on domestic industry. Indeed, the impasse in international negotiations has been driven by the perception that other countries are doing too little.[139] Thus, domestic regulators who want to marginally increase the chance of stringent regulation in other countries should make their regulations transparent.

B. A Carbon Tax or Funding for Pollution-Reducing Technology Would Do Most to Encourage Regulation in Other Jurisdictions

No domestic policy instrument for greenhouse gases can *ensure* that other countries will address greenhouse gas emissions, but a carbon tax is the most compatible with marginally increasing the incentive to regulate in other countries. A carbon tax imposes a relatively transparent and stable burden on emitters of greenhouse gases — a fixed price per ton of emissions. Regulators can use this price to calibrate either carbon tariffs or subsidies to domestic industry to prevent leakage, and its transparency will minimize the inevitable disputes with industry and other countries about whether the measures are sufficient or, conversely, protectionist. Regulators in one nation may also commit to raise such a tax in return for increased commitments to regulate from other countries. And a tax is relatively easy for other countries to adopt — taxes are visible and rule-like, and functioning countries have some ability to collect them.

Although some scholars have argued that taxes might undercut international cooperation because of "price cushioning" — in which countries adopt a headline carbon tax but then secretly rebate the costs to fossil fuel users[140] —

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[138] Even with private donations to charity, where there is no possibility of preventing free-riding or making matching commitments, experimental studies frequently reveal the opposite behavior: Participants "conditionally cooperate," donating more when they know that others have donated. *See generally* Urs Fischbacher, Simon Gachter & E. Fehr, *Are People Conditionally Cooperative? Evidence from a Public Goods Experiment*, 71 ECON. LETTERS 397 (2001). This may be because of a preference for reciprocity, perception of a social norm, or even a rational response to information asymmetry — donations from others may suggest that such donations are worthwhile. Richard Martin & John Randal, *How is Donation Behaviour Affected by the Donations of Others?*, 67 J. ECON. BEHAV. & ORG. 228 (2008). If these mechanisms also apply to nation states, we might expect that a lack of cooperation is unlikely to induce more cooperation in other countries, even in situations such as military defense or species protection.

[139] *See supra* note 72.

[140] *See* Wiener, *Global Environmental Regulation*, *supra* note 3, at 785–87; Thomas Heller, *The Path to EU Climate Change Policy*, *in* GLOBAL COMPETITION AND EU ENVIRONMENTAL POLICY 108, 122 (Jonathan Golub ed., 1998).

there is no reason to think that price cushioning is a problem unique to carbon taxes. Countries that wish to free-ride while appearing cooperative will always prefer to exaggerate the stringency of their greenhouse gas regulations; doing so may avoid a tariff, justify a payoff for cooperation, or simply win good will. So whether potential free-riding countries adopt greenhouse gas performance standards, a cap-and-trade system, or a carbon tax, there will always be a temptation to offset climate regulations with some kind of subsidy to greenhouse gas emitters.

Of course, if all countries could agree on the appropriate level of emissions for every other country,[141] then one might be able to assess stringency without reference to the carbon price: As long as emissions stayed at the agreed quantity the cap would be effective, regardless of any price cushioning.[142] But there is no such agreement on emissions levels, and it is doubtful that this kind of global agreement will emerge.[143] Without an objective or agreed baseline of what a country's emissions should be, carbon price will remain an important measurement of the stringency of unilateral climate regulation: Countries that wish to show that their cap or tax is stringent will be tempted to price cushion to exaggerate their regime stringency. Thus, monitoring price cushioning is a general problem to be solved rather than a special problem for carbon taxes.

In comparison with a carbon tax, cap-and-trade, which has been the focus of climate change legislation in the United States for a decade,[144] is less compatible with encouraging regulation in other countries. First, an optimal cap-and-trade system requires complexities that will hinder credible matching commitments.[145] Second, the connections between different domestic cap-and-trade markets, which are often mentioned as a reason to adopt cap-and-trade regulation, would actually exacerbate incentives to free-ride.[146] Third, archetypal cap-

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[141] Or perhaps even a group of the biggest emitters: Jonathan Wiener suggests that the "[t]he vast majority of global emissions — both current and future — could probably be addressed by a negotiation among the European Union, the United States, China, India, Russia, Japan, Canada, Australia, Brazil, and Indonesia." *Wiener, Think Globally, supra* note 89, at 1976.

[142] *See* Wiener, *Global Environmental Regulation, supra* note 3, at 785–87.

[143] *See supra* note 72 and accompanying text.

[144] Politicians in both political parties repeatedly proposed comprehensive cap-and-trade systems for greenhouse gases. *See, e.g.*, Climate Stewardship and Innovation Act of 2007, S. 280, 110th Cong. (2007) (co-sponsored by Republican Senators Collins, McCain, and Snowe, as well as Democratic Senators Durbin, Lincoln, and Obama); *see also* Climate Stewardship Act of 2007, H.R. 620, 110th Cong. (2007); Climate Security Act of 2007, S. 2191, 110th Cong. (2007); Climate Stewardship Act of 2003, S.139, 108th Cong. (2003). In the 2008 presidential election, both candidates supported a cap-and-trade system for greenhouse gas control. Andrew C. Revkin, *On Global Warming, McCain and Obama Agree: Urgent Action Is Needed*, N.Y. TIMES (Oct. 19, 2008), http://perma.law.harvard.edu/0FuZBaqgnBr. A cap-and-trade bill, entitled the American Clean Energy and Security Act, passed the House of Representatives on June 26, 2009 by a vote of 219 to 212, but died in the Senate. By 2010, the tide had turned against cap-and-trade to the extent that even Democratic Senators touted their opposition to it. During his winning campaign, Democratic Senator Joe Manchin dramatized his opposition to a cap-and-trade bill by running an advertisement in which he shot a physical copy of the bill with a rifle. John Collins Rudolf, *Taking Aim, Literally, at a Dead Climate Bill*, N.Y. TIMES (Oct. 11, 2010), http://perma.law.harvard.edu/0xhPHTVMF35.

[145] *See supra* notes 53–65 and accompanying text.

[146] *See supra* notes 69–73 and accompanying text.

and-trade regimes are designed to provide a certain quantity of reductions rather than a stable price. The lack of a stable price would aggravate the inevitable disputes that would accompany attempts to compensate for the burden of regulation with carbon tariffs or subsidies to domestic industry.[147] Fourth, cap-and-trade controls of greenhouse gases, while possibly a model for other developed countries, are unlikely to serve as a useful example for governments without the expertise or ability to make credible long-term commitments that are necessary to develop markets of tradable permits.[148] It may well be that a *multilateral* cap-and-trade system could be efficient if it were imposed by an international regulator,[149] but there is no such regulator, and *unilateral* cap-and-trade systems will do little to encourage foreign nations to regulate greenhouse gases.

Greenhouse gas performance standards, which are currently the principle greenhouse gas controls in the United States, also are not ideal for encouraging action overseas. There is no consensus regarding the burden that these rules place on domestic industry — in fact, the likely cost of these standards is usually the primary focus of debates concerning their wisdom.[150] As a result, any effort to compensate for this burden with subsidies to industry or carbon tariffs would result in particularly severe disputes regarding their appropriate size. This, in turn, would hamper the ability of regulators to prevent leakage, making it difficult to ensure that unilateral regulation would have any net benefit on global emissions. The other factors — potential for connection and usefulness of a model — are more equivocal for greenhouse gas performance standards. Although the more nebulous standards that are sometimes used in individual permitting decisions may be too opaque for matching commitments or to use as a model, some numerical standards may be useful on this front. But even numerical standards are inadvisable unless there are reasons to think that leakage is particularly unlikely.[151]

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[147] *See supra* notes 108–109 and accompanying text.

[148] *See supra* notes 128–129 and accompanying text.

[149] Jonathan Wiener has forcefully argued that, assuming caps on each country's emissions could be agreed to by all major emitters, an internationally administered cap-and-trade regime might be the most efficient possible greenhouse gas regulation. *See* Wiener, *Global Environmental Regulation*, *supra* note 3, at 752–97.

[150] *See* EPA, FINAL REGULATORY IMPACT ANALYSIS, *supra* note 104, at 6–20.

[151] Although leakage is a significant problem for climate regulation, there are other global problems where numerical standards may be appropriate because leakage is less severe. For instance, overuse of antibiotics is a global public bad: Antibiotics can stave off disease in humans and animals, but every time antibiotics are used they increase the risk of producing antibiotic-resistant bacteria. *See* Eric Kades, *Preserving a Precious Resource: Rationalizing the Use of Antibiotics*, 99 NW. U. L. REV. 611, 669 (2005). As a result, a range of command-and-control regulations, cap-and-trade schemes, taxes, or subsidies have been proposed to combat antibiotic overuse. *See* William M. Sage & David A. Hyman, *Combating Antimicrobial Resistance: Regulatory Strategies and Institutional Capacity*, 84 TUL. L. REV. 781, 803–20 (2010). But, in contrast with climate change, there is relatively little danger that using fewer antibiotics in domestic medicine will lead to increased use overseas — few patients would travel to other countries to find antibiotics. So performance standards for use of antibiotics in domestic medicine might be appropriate.

On the other hand, use of antibiotics in farming would be more subject to leakage because meat production could shift to countries where antibiotics are unregulated. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-04-490, ANTIBIOTIC RESISTANCE: FEDERAL AGENCIES NEED TO BETTER FOCUS EFFORTS TO ADDRESS RISK TO HUMANS FROM ANTIBIOTIC USE IN ANIMALS (2004), *available*

Tort liability has sometimes been proposed as an alternative climate policy,[152] but it is not well-suited to encouraging action overseas. To the extent that courts are less likely than regulators to preview their decisions and more likely to be independent of other policymakers, it would be harder to predict or monitor the behavior of nations where climate policy was set in court.[153] This would make it very difficult to offer credible matching commitments or calibrate appropriate tariffs that would prevent leakage to nations with lax greenhouse gas policies.

On the other hand, direct funding for greenhouse gas reducing technologies, which is another option that is sometimes proposed for addressing climate change,[154] is more compatible with encouraging foreign countries to regulate. First, funding is compatible with matching commitment connections between countries — a promise of a given number of matching dollars is probably the most transparent commitment that a country can offer. Second, subsidies do not create the same kind of leakage problems that arise when domestic greenhouse gas emitters are directly burdened — technology developed in first-mover countries could be used in follow-on countries.[155] Third, grants, subsidies, and prizes could serve as a very useful model for other countries; countries could implement similar policies or even simply contribute funds to existing funding streams. Of course, technology funding would not remove free-rider problems — such programs must be funded by taxes and other countries might forgo any greenhouse gas measures if they assume that funding programs elsewhere

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at http://perma.law.harvard.edu/0EoXMRDuUs2 ("While antibiotic use in animals poses potential human health risks, it also reduces the cost of producing these animals, which in turn helps reduce the prices consumers pay for food."). Thus, a tax system might be more appropriate for use of antibiotics in animals, because the market price created by these instruments would give a regulator information that could be used to compensate for the more stringent controls faced by the farming industry in cooperative countries.

[152] *See generally* Randall S. Abate, *Automobile Emissions and Climate Change Impacts: Employing Public Nuisance Doctrine as Part of a "Global Warming Solution" in California*, 40 CONN. L. REV. 591 (2008); David A. Grossman, *Warming Up to a Not-So-Radical Idea: Tort-Based Climate Change Litigation*, 28 COLUM. J. ENVTL. L. 1 (2003).

[153] *See* Sachs, *supra* note 127, at 879 (noting that leaving enforcement to judicial system may make it impossible to monitor cooperation, at least in the near term).

[154] The United States alone has experimented with several tactics for funding greenhouse gas reduction technologies, including direct funding for research, 42 U.S.C. § 16513(a) (2012) (authorizing loan guarantees for projects that "(1) avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases; and (2) employ new or significantly improved technologies"), long-term contracting for non-carbon-based energy, *see* Jim Rossi, *The Limits of a National Renewable Portfolio Standard*, 42 CONN. L. REV. 1425, 1427 (2010) (discussing impact of Public Utility Regulatory Policies Act of 1978, Pub. L. No. 95-617, 92 Stat. 3117 (1978), as encouraging renewable fuels such as "wind, solar, biomass, and geothermal"), and subsidies for the use of alternative energy, MOLLY F. SHERLOCK & MARGOT L. CRANDALL-HOLLICK, CONG. RESEARCH SERV., R41769, ENERGY TAX POLICY: ISSUES IN THE 112TH CONGRESS 9–10 (2011) (describing various tax credits and incentives for renewable energy sources). *See generally* Adler, *supra* note 4 (proposing the use of government-funded prizes for greenhouse gas reducing technology).

[155] *See generally* Sonja Peterson, *Greenhouse Gas Mitigation in Developing Countries Through Technology Transfer?: A Survey of Empirical Evidence*, 13 MITIGATION & ADAPTATION STRATEGIES FOR GLOBAL CHANGE 283 (2008) (describing mechanisms of technology transfer).

would provide cheaper technological solutions in the future.[156] But the worldwide distribution of funded technology avoids the most serious leakage problem, which is concentrating greenhouse gas emissions in countries that will not regulate.[157] Thus, it seems that these free-riding problems would be less serious than those faced by other policy instruments like cap-and-trade, tort liability, or performance standards.

Finally, U.S. states and other subnational actors should consider these same factors and implications when they adopt regulations to address global public bads like climate change. The tools at their disposal to fight leakage will be somewhat more limited, however, because the U.S. Constitution's dormant commerce clause generally forbids states from attaching restrictions to goods they import,[158] or otherwise controlling conduct in other states.[159] Indeed, the Supreme Court has specifically prohibited states from adopting regulations designed to "mitigate the consequences of competition between the states."[160] But, at the same time, other methods of stopping leakage, such as subsidies to domestic industries, may be viable.[161]

Otherwise, however, states' approaches should be broadly similar to nations choosing unilateral regulation of global harms. Again, this suggests that states should prefer policy instruments like carbon taxes and funding for green technology. This would represent a substantial shift from the focus of current state efforts, which have focused on cap-and-trade systems. For example, ten eastern states have formed the Regional Greenhouse Gas Initiative, a cap-and-trade scheme designed to stabilize and then slightly lower greenhouse gas emissions.[162] Similarly, California, as a leader of a coalition of western states, has

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[156] *Cf.* Lawrence Goulder & Koshy Mathai, *Optimal CO_2 Abatement in the Presence of Induced Technological Change*, 39 J. ENVTL. ECON. & MGMT. 1, 30 (2000) (describing how outside funding for innovation may cause companies to delay abatement efforts, on the assumption that cheaper abatement methods will be discovered later); *see also* Jaffe et al., *supra* note 89, at 55.

[157] In contrast to funding for innovative green technology, ongoing subsidies to alternative energy might merely displace fossil fuels to countries where they retain their competitive advantage because alternative energy sources are not subsidized.

[158] C&A Carbone, Inc. v. Town of Clarkstown, N.Y., 511 U.S. 383, 393 (1994) ("States and localities may not attach restrictions to . . . imports in order to control commerce in other States.").

[159] Healy v. Beer Inst., 491 U.S. 324, 336 (1989) (stating that regulation is forbidden by the dormant commerce clause if "the practical effect of the regulation is to control conduct beyond the boundaries of the State.").

[160] Baldwin v. G.A.F. Seelig, Inc., 294 U.S. 511, 522 (1935); *see also C&A Carbone*, 511 U.S. at 393 (finding that states may not "extend [their] police power beyond its jurisdictional bounds"); *see generally* Douglas A. Kysar & Bernadette Meyler, *Like a Nation State*, 55 UCLA L. REV. 1621 (2008); Joseph Allan MacDougald, *Why Climate Law Must Be Federal: The Clash Between Commerce Clause Jurisprudence and State Greenhouse Gas Trading Systems*, 40 CONN. L. REV. 1431 (2008).

[161] New Energy Co. of Ind. v. Limbach, 486 U.S. 269, 278 (1988) (stating that "[d]irect subsidization of domestic industry does not ordinarily" violate the dormant commerce clause). *But see* West Lynn Creamery, Inc. v. Healy, 512 U.S. 186, 199–201 (1994) (holding that a scheme that paired subsidy and tax was unconstitutional).

[162] Martella et al., *supra* note 5, at 19-30, 19-40 (also noting that three states are considering withdrawing from the initiative).

adopted a cap-and-trade system.[163] Regulators may have to shift this focus if they intend to encourage more action by other states.

CONCLUSION

Although regulators have made progress on many local environmental problems, global problems like climate change, species loss, and overuse of antibiotics continue to grow worse because no country can capture the full benefit of domestic regulations to address these problems.[164] To address these global problems, existing scholarship has built its hopes upon the promise of global treaties. But to do so is to build upon sand — the same dynamics that make problems global often make effective multilateral treaties unattainable. If there is a foundation for effective control of global problems, it is in well-considered unilateral regulations.

Thus, the optimal design of unilateral regulation of global public bads will be an increasingly pressing question for domestic regulators. Unilateral regulation will inevitably affect incentives to regulate in other countries, so domestic regulators must pay special attention to ensuring that their regulations will encourage rather than discourage action elsewhere. In the context of climate change, this focus means that regulators should adopt transparent measures that will help them (1) encourage matching actions in other jurisdictions, (2) limit leakage, and (3) model regulation for countries and states that are willing to follow suit. As a result, unilateral climate regulators should alter their emphasis on cap-and-trade systems and energy-efficiency standards and shift to measures like carbon taxes and funding for green technology, which will be more compatible with these goals.

Finally, there is promise in unilateral regulation. Major emitting countries have proven willing to adopt some level of control, and if careful design makes those efforts mutually reinforcing, they can effectively, if marginally, address global greenhouse gas emissions. Unilateral regulation will never "solve" the problem of climate change. But for every emission avoided there will be less warming, less sea level rise, less risk of catastrophic harm, and more time to invent the technology necessary to address the causes and consequences of climate change. It is high time that ongoing unilateral efforts were harnessed to accomplish this crucial purpose.

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[163] *Id.* at 19-30.

[164] Nemat Shafik & Sushenjit Bandyopadhyay, *Economic Growth and Environmental Quality: Time-Series and Cross-Country Evidence* (World Bank, Working Paper No. WPS 904, 1992), *available at* http://perma.law.harvard.edu/0BDyT4tT8oYgo.worldbank.org/6EOI3DQKU0 (documenting that local environmental problems are increasingly well controlled with increasing income while global environmental problems grow worse).