Regulatory Trading

David A. Weisbach†

Regulatory trading systems, such as the SO_2 cap-and-trade system, are ubiquitous in environmental and natural resources law. In addition to cap-and-trade systems for pollutants such as SO_2, NO_x, and CO_2, environmental and natural resources law uses trading in areas such as endangered species, water quality, wetlands, vehicle mileage, and forestry and farming practices. Trading, however, is rarely used as a regulatory approach in other areas of law. This Article seeks to identify the reasons for this dichotomy. To understand the dichotomy, the Article examines the uses of trading in environmental and natural resources law, where it has been successful, and where problems have arisen, including hot spots problems, environmental justice problems, measurement problems, and moral problems with the use of markets. It then considers the possibility of trading in six nonenvironmental areas of law to see whether trading can be helpful, and if not, why not. The analysis suggests a number of reasons for the dichotomy, including that (1) environmental problems tend to have larger costs and benefits, making it more worthwhile to incur the costs of a trading regime in environmental contexts than elsewhere; (2) trading may not work well because of hot spots, measurement, or other problems; and (3) trading may be inconsistent with the underlying premises of a regulatory system. Finally, in some cases, there is no good reason for the dichotomy other than institutional inertia, and trading should be considered as a supplement or replacement for existing regulatory approaches in those cases.

† Walter J. Blum Professor of Law, University of Chicago Law School. Send comments to d-weisbach@uchicago.edu. I am thankful for Jen Nou and Mark Templeton for discussions and the many valuable comments from workshops at the University of Chicago Law School and Washington University Law School. Special thanks to Richard Sandor for allowing me to participate in his class at the University of Chicago Law School, The Law and Economics of Natural Resource Markets.

INTRODUCTION

This Article addresses a puzzle. Trading systems, sometimes known as cap-and-trade systems, are deeply embedded in environmental and natural resources law. It is not easy to think of an environmental context where trading is not used.[1] In addition to traditional cap-and-trade for the control of air pollution, trading is used, among other areas, for motor vehicle fuel economy, endangered species, fish catch, farming practices, wetlands, and water quality. Federal agencies actively promote trading, often with entire offices with the purpose of developing environmental markets.[2] Private actors view environmental attributes as an asset class, with entrepreneurs devoted to expanding and developing trading, building out exchanges and other trading platforms, all with the hope of making a profit.[3]

---

1 See Part II for an examination of the use of trading in the environmental and natural resources context. There are some exceptions where trading is not used—most importantly, the regulation of hazardous air pollutants under § 112 of the Clean Air Act, 42 U.S.C. §§ 7401–7671q, and the regulation of hazardous waste under the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901–6908a (2020), and under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §§ 9601—9628 (2020). In both cases, trading would likely result in hot spots. For further discussion, see Part III.A.

2 *See generally, e.g.*, Off. of Envtl. Mkts., *Environmental Markets*, U.S. DEP'T AGRIC., https://perma.cc/SG8P-EEF7.

3 *See generally* RICHARD SANDOR, MURALI KANAKASABAI, RAFAEL MARQUES & NATHAN CLARK, SUSTAINABLE INVESTING AND ENVIRONMENTAL MARKETS: OPPORTUNITIES IN A NEW ASSET CLASS (2014); Terry L. Anderson & Dominic P. Parker,

Outside of the environmental and natural resources context, however, trading is not widely used as a regulatory tool. There are isolated exceptions in contexts such as tradable development rights,[4] taxi licenses,[5] airport landing slots,[6] and liquor licenses.[7] There have been proposals to use trading in other contexts, but few, if any, have been adopted.[8]

The puzzle is why we have this dichotomy. Why is almost any imaginable attribute traded if it is in the environmental or natural resources areas of law, but almost nothing is traded in other areas of law?[9] Solving this puzzle is interesting on its own. In addition, understanding the reasons why different areas of the law

Transaction Costs and Environmental Markets: The Role of Entrepreneurs, 7 REV. ENVTL. ECON. & POL'Y 259 (2013).

4 *See* Roderick M. Hills, Jr. & David Schleicher, *Building Coalitions Out of Thin Air: Transferable Development Rights and "Constituency Effects" in Land Use Law*, 12 J. LEGAL ANALYSIS 79, 80–81 (2020) [hereinafter Hills & Schleicher, *Building Coalitions*].

5 Kristian Niemietz, *The Effects of Quantity Restrictions in the Taxi Market*, INST. ECON. AFF. (Nov. 7, 2016), https://iea.org.uk/the-effects-of-quantity-restrictions-in-the-taxi-market.

6 Richard Littmann, Martin Bichler & Stefan Waldherr, *Trading Airport Time Slots: Market Design with Complex Constraints*, 145 TRANSP. RSCH. PART B: METHODOLOGICAL 118, 119–20 (2021).

7 Amanda Hoover, *Why Boston Needs Liquor License Reform*, BOSTON MAG. (Dec. 18, 2016), https://perma.cc/FNF8-2J4M.

8 *See, e.g.*, Peter H. Schuck, *Refugee Burden-Sharing: A Modest Proposal*, 22 YALE J. INT'L L. 243, 282–84 (1997) (proposing tradable refugee quotas); Ian Ayres & Gideon Parchomovsky, *Tradable Patent Rights*, 60 STAN. L. REV. 863, 890–92 (2007) (proposing tradable patent rights); Jesús Fernández-Huertas Moraga & Hillel Rapoport, *Tradable Immigration Quotas*, 115 J. PUB. ECON. 94, 104–05 (2014) (proposing tradable immigration quotas); Robert Cooter, *Market Affirmative Action*, 31 SAN DIEGO L. REV. 133, 144–45 (1994) (proposing tradable quotas for affirmative action). *See also generally* David de la Croix & Axel Gosseries, *Population Policy Through Tradable Procreation Entitlements*, 50 INT'L ECON. REV. 507 (2009) (proposing tradable procreation quotas). Some of these proposals seem intentionally provocative or perhaps are products of their time. The trading systems considered in this Article try to avoid some of the issues raised by these proposals regarding respect for individuals.

9 Jonathan Masur and Eric Posner engaged in a related but distinct inquiry motivated by the lack of Pigouvian taxation in U.S. regulatory policy. *See generally* Jonathan S. Masur & Eric A. Posner, *Toward a Pigouvian State*, 164 U. PA. L. REV. 93 (2015). In that article, Masur and Posner argued (1) that Pigouvian taxes are superior to either command-and-control or trading systems, (2) that in many areas, regulators have authority to impose Pigouvian taxes, and, therefore, (3) that they should do so. *Id.* at 98–99. I do not inquire whether existing statutes grant authority to impose trading systems. Instead, my goal is to understand the potential for expanding trading and the reasons for the stark dichotomy between environmental regulation and other forms of regulation. I differ with Masur and Posner on the first point regarding the comparison between trading and Pigouvian taxes.

take different strategies has the potential to offer insight into the underlying nature of the problems law seeks to solve.

The puzzle may not admit of a single solution.[10] The number of areas covered by laws and regulations where trading might plausibly be used, but is not, is vast, and the explanation might be different in each case. To try to find commonalities, I examine the design and structure of environmental trading, the problems it has faced, and how it has addressed those problems. Using this understanding, I consider six areas of law outside of the environmental context that are heavily regulated or might soon be, in each case examining whether trading can help improve the effectiveness of regulations.

I suggest that possible answers to the puzzle include the following: (1) The stakes are often higher for environmental regulation than other types of regulation, justifying the costs of running a trading system in environmental contexts but not elsewhere. (2) The problem of what are called hot spots in the environmental context may be more prevalent outside of environmental law, and if the hot spots problem is sufficiently severe, trading is not desirable. (3) The underlying rationale for regulation may be inconsistent with trading in many nonenvironmental contexts. For example, if the reason for regulating is an information failure, trading may (though not necessarily, as will be discussed) be undesirable because trading requires good information. Finally, (4) in some contexts, trading might be beneficial, which means that the only explanation for the puzzle is a lack of imagination, inertia, and other similar factors. That is, in at least in some contexts, other areas of law can learn from the experiences in environmental and natural resources law and use trading more broadly.[11]

---

10 One possibility is that in fact there is no puzzle. If nonenvironmental areas of law more often have well-defined property rights than environmental law does, trading would arise in the nonenvironmental context under what we identify as the market rather than a regulatory regime. Both areas of law would have trading, just in different guises. This observation, however, does not solve the problem because regulation is pervasive outside of the environmental context. Moreover, if this is part of the answer, it raises the question of why property rights are better defined in some areas than in others. There is a puzzle in need of explanation.

11 I do not consider markets in highly personal items, such as markets for sexual services, surrogacy, organs, or babies. The explanations for a lack of trading may be different for these types of items than those considered here. See Part III.C for a discussion of this limitation.

Part I begins the inquiry by examining how trading works using the example of trading in carbon dioxide (CO_2) to slow or stop climate change. Not only do emissions of CO_2 cause an important global problem, but CO_2 emissions are a good case for trading because (1) CO_2 is well-mixed in the atmosphere, (2) emissions are relatively easy to measure, (3) there is likely a wide variation in marginal costs of emissions reductions across emitters, (4) there is sufficient volume to have deep and liquid markets, and (5) moral, market failure, or other concerns about the use of markets in this context are either minor or nonexistent. A mnemonic for these conditions is the five Ms: trading works well when the item is well-*Mixed*, *Measurable*, has a wide variation in *Marginal* cost, generates deep and liquid *Markets*, and there are few or no *Moral* or *Market* failure concerns. When one or more of these conditions fail, trading will be a relatively less desirable regulatory mechanism than otherwise.

To understand the full extent of the puzzle explored here, it is useful to see the incredible penetration of trading in the environmental context. Its extent will, I believe, be surprising to most people not deeply familiar with environmental regulation. There are few areas of environmental regulation where trading is not used. Part II offers brief descriptions of some of the hundreds of environmental trading systems, including the (1) systems for trading pollutants subject to a mass or volume cap, such as trading systems for CO_2, SO_2, NO_x, and mercury; (2) systems where the trading is against a regulatory standard rather than against a physical limit, such as for lead in gasoline, vehicle fuel mileage, China's CO_2 intensity trading system, and renewable fuels;[12] and (3) more exotic trading systems such as those for wetlands, water quality, biodiversity, habitat, fish, and carbon offsets. Some of these more exotic trading systems have worked well. Others have not.

As mentioned, to understand whether it is desirable to expand the use of trading to new contexts, it is important to understand the problems with and limits of trading. Part III takes up

12 These systems are sometimes called tradable performance standards. A tradable performance standard sets a goal based on the intensity of pollution—such as gallons per mile driven or mass of lead per unit of gasoline—and allows polluters who do better than the standard to sell the excess compliance to polluters who do worse. *See* Sonia Yeh, Dallas Burtraw, Thomas Sterner & David Greene, *Tradable Performance Standards in the Transportation Sector*, 102 ENERGY ECON., July 30, 2021, at 1, 3.

this task and considers three of the five Ms in detail: (1) the problems presented by nonuniformly mixed pollutants, known as hot spots; (2) problems of measurement; and (3) moral and market failure problems. These three problems are, as we will see, particularly important outside of the environmental and natural resources areas of law, so they are worth a detailed exploration. (The other aspects of CO_2 trading—a wide variation in the costs of emissions reductions and the benefit of a deep and transparent market—are more self-evident and are not separately discussed.)

After this long windup, Part IV considers possible applications of trading outside of the environmental context. It considers six cases: (1) safety trading (both workplace and consumer products), (2) efficiency trading, (3) bank regulatory trading, (4) zoning trading, (5) trading to prevent externalities from big data, and (6) minimum wage trading. Some of these systems might plausibly work, while others present serious problems.

Part V draws the pieces together and concludes. Considering the range of cases, it suggests that the four reasons for a lack of trading outside of the environmental context listed above explain most of the cases.

I. TRADING BASICS

Although there is a long and extensive history of trading in environmental contexts,[13] one of the best applications for understanding the benefits of trading is relatively new: markets in CO_2 designed to address climate change. As of April 2022, there were more than thirty-four CO_2 markets in current operation around

---

[13] The theoretical foundations for trading go back to Ronald Coase. *See* R.H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960). Thomas D. Crocker and J.H. Dales developed Coase's idea into the concept of pollution trading. *See generally* Thomas D. Crocker, *The Structuring of Atmospheric Pollution Control Systems*, *in* THE ECONOMICS OF AIR POLLUTION 61 (Harold Wolozin ed., 1966); J.H. DALES, POLLUTION, PROPERTY & PRICES: AN ESSAY IN POLICY-MAKING AND ECONOMICS (1968). David Montgomery subsequently formalized the theory to show that trading can produce the least-cost allocation of abatement. *See* W. David Montgomery, *Markets in Licenses and Efficient Pollution Control Programs*, 5 J. ECON. THEORY 395, 410–11 (1972). For histories of the development of emissions trading, see generally Hugh S. Gorman & Barry D. Solomon, *The Origins and Practice of Emissions Trading*, 14 J. POL'Y HIST. 293 (2002), and see also Richard Schmalensee & Robert N. Stavins, *Policy Evolution Under the Clean Air Act*, 33 J. ECON. PERSPS. 27, 29–33 (2019).

the world,[14] and others have been proposed,[15] so, while new, we have considerable experience with the design and operation of these markets.

To illustrate the benefits of trading, suppose that there are just two sources of emissions of CO_2: High and Low. These might be, for example, large industrial facilities or fossil fuel–fired power plants. Each currently emits the same amount: one hundred units of CO_2 for a total of two hundred units. High's cost of reducing emissions, however, is higher than Low's. Low, for example, may have more ready access to emissions reductions technology, such as substitute production methods or fuel sources.

To reduce the harms from climate change, suppose that the government decides to reduce emissions from two hundred to one hundred units. The cost-minimizing allocation of the reductions would set the marginal cost of reducing emissions for High equal to those for Low. Because High's costs are higher than Low's, the cost-minimizing allocation of emissions would require Low to reduce more than High, up to the point where their marginal costs are equal. For example, the cost-minimizing allocation might allow Low to emit only twenty-five units and allow High to emit seventy-five.

The government, however, may not be able to determine or to implement the cost-minimizing allocation. A key reason is that the government may not know the marginal costs of emissions reductions for the two sources of pollution. This information might be private knowledge because it may depend on local features of the facilities—features that on-site operators will know but that the government will not. The government also may not be able to differentiate between the two plants because of fairness concerns, legal restrictions on treating similar entities differently, a desire for simplicity, or concerns about reliance (e.g., the legal system previously allowed each to emit the same amount).

If the government cannot differentiate between High and Low, it will have to require each individual facility to reduce emissions by the same amount, to fifty units each. It can, however,

14 THE WORLD BANK, STATE AND TRENDS OF CARBON PRICING 2022, at 15 (2022).

15 There are a number of bills proposing a market for CO_2 in the United States. For a list, see Marc Hafstead, *Carbon Pricing Bill Tracker*, RES. FOR FUTURE (Oct. 1, 2020), https://perma.cc/6FPX-DW7A. China is just now launching its market. *See* Bianca Nogrady, *China Launches World's Biggest Carbon Market*, 595 NATURE 637, 637 (2021).

still achieve the cost-minimizing allocation of reductions by allowing High and Low to trade emissions.

With each polluter allowed to emit fifty units, Low's marginal cost of emissions reductions will be less than High's. As a result, Low can sell the right to emit one unit of CO_2 to High at a price that will be profitable to both parties. High would then be able to emit fifty-one, and Low would be able to emit only forty-nine. The reduction in pollution would be the same, but the costs of achieving the reduction would go down. The parties would continue to have profitable trades until their marginal costs of emissions reductions are the same, with Low emitting twenty-five units and High emitting seventy-five. At that point, there would be no further profitable trades.

Said another way, if the government had perfect information and could differentiate between High and Low (and was seeking the cost-minimizing approach to emissions reductions), it would allow Low to emit only twenty-five units and allow High to emit seventy-five. Trading achieves this allocation even if the government does not have the necessary information or is otherwise restricted in its ability to differentiate between High and Low.

The same arguments would apply if there were many emitters with different costs of emissions reductions, as is the case with CO_2. In carbon markets, there are often hundreds or thousands of different sources subject to a cap. For example, the emissions trading system in the European Union covers approximately eleven thousand different sources of CO_2.[16] The polluters use a centralized clearing system to trade, where trading prices are public.[17] Polluters can see the market price of CO_2 by going to a website.[18] If they can reduce emissions for less than the market price, they can profit by selling a permit rather than using it. If their costs of emissions reductions are higher than the market price, they can profit by buying a permit rather than reducing emissions. The market will clear at a price that equalizes polluters' marginal costs of emissions reductions.

[16] Eur. Comm'n, *The EU Emissions Trading System (EU ETS)* 1 (2016), https://perma.cc/3SC9-2764.

[17] *Id.*

[18] *Id.*

There are a number of reasons why CO_2 trading works well in a properly designed market.[19] A key reason is that CO_2 mixes evenly in the atmosphere. In particular, the harm from the pollution is the same regardless of where the pollution comes from, whether it is from a coal-fired electricity-generating unit (EGU) in Ohio or from an automobile in China.

This assumption is important because trading allows the private market to determine which entities pollute. The government merely sets the overall target and the initial allocation of pollution rights. If pollution from one source causes different harm than pollution from another source, trading may make overall harms worse than an optimal allocation of pollution because it may allow the high-harm source to pollute more than is desirable.

To illustrate, suppose that the pollution being regulated was not CO_2 but instead was a toxic chemical that killed plant and animal life in the immediate vicinity of its emission. If the government determined that the safe level (i.e., the level below which it is not toxic) was fifty units in a geographic area, it could require each plant, High and Low, to emit at most that amount. Under our assumption about costs, however, trading would mean that High emits seventy-five units, while Low emits twenty-five. Low would be below the safe limit, but High would not. The harms would be greater than the initial fifty-fifty allocation of pollution rights which put both plants below the safe limit. This is not true in the climate context, so we need not worry about this problem. I return to this problem, known as hot spots, in Part III.A. Part III.A will also show how hot spots are related to, but distinct from, problems of environmental justice.

A second key reason why markets in CO_2 can work well is that the government has the ability to measure which entities emit CO_2. If the government cannot accurately measure pollution (or whatever is the target of the trading system), it cannot enforce compliance with the regime.

---

19 There are skeptics of CO_2 markets. *See generally* DANNY CULLENWARD & DAVID G. VICTOR, MAKING CLIMATE POLICY WORK (2020). While the skeptics point out many operational flaws in existing CO_2 markets, most or all of these flaws can be fixed in a properly designed market. *See, e.g.*, Katherine Needham, Frans P. de Vries, Paul R. Armsworth & Nick Hanley, *Designing Markets for Biodiversity Offsets: Lessons from Tradable Pollution Permits*, 56 J. APPLIED ECOLOGY 1429, 1430–32 (2019) (identifying four policy lessons that improve the cost-effectiveness of biodiversity offset schemes).

Measurement, of course, is required for any regulation of pollution. The key is that what is being measured when the government allows trading may be different than what is being measured with other types of regulation. For example, a command-and-control regulation may require the use of a particular technology. The government would have to be able to observe whether the technology is installed and used. If the regulation instead allowed trading in emissions (with polluters allowed to choose their own technologies), the government has to observe emissions. The costs of observation, and its accuracy, may be different for the two regulatory mechanisms because they require observation of different things.

Third, the benefit of trading depends on how much abatement costs vary among the regulated parties and whether, or the extent to which, the government is able to estimate and exploit the differences in costs. If High and Low had the same marginal costs of reducing pollution, there would be no gains from trade. The government's initial allocation of fifty units each would be the cost-minimizing allocation. Alternatively, if the parties' marginal costs differed but the government had perfect information, it could have assigned emissions reductions accordingly rather than relying on an equal allocation and trading (e.g., High gets to emit seventy-five and Low gets to emit twenty-five). But when marginal abatement costs vary and when private parties have more information about their cost structure than the government, trading can reduce costs.[20]

Fourth, the number of sources emitting CO_2 and the volume emitted are large. This allows CO_2 markets to be liquid and transparent. Liquidity lowers the costs of trading.[21] Transparency allows polluters to observe the price of credits so that they can compare that price to their marginal costs of abatement.

---

20 *See, e.g.*, Meredith Fowlie & Nicholas Muller, *Market-Based Emissions Regulation When Damages Vary Across Sources: What Are the Gains from Differentiation?*, 6 J. ASS'N ENVTL. & RES. ECONOMISTS 593, 595–96 (illustrating the ability of trading to facilitate reaching an efficient outcome even when there are knowledge asymmetries).

21 As we will see, some environmental markets are highly illiquid, which means that either selling excess credits or buying credits is cumbersome and, as a result, the markets may not produce the lowest-cost allocation of pollution. *See generally* Robert N. Stavins, *Transaction Costs and Tradeable Permits*, 29 J. ENVTL. ECON. & MGMT. 133 (1995) (explaining that low transaction costs are central to efficiency in environmental trading markets).

Another advantage of deep and liquid markets is that they often allow broad participation. This means that people or entities other than polluters can participate in the market. For example, in some markets, environmental groups or environmentally oriented individuals can buy and retire permits if their valuation of the environmental gains exceeds the permit price.[22] Moreover, deep and liquid markets allow the creation of derivatives in environmental credits.[23] Derivatives allow polluters to hedge risk and generate information about market expectations.

A final reason why CO_2 markets can work well is that most people seem to feel comfortable trading CO_2 emissions. As will be discussed in Part III, there may be cases, perhaps many cases, where trading seems inappropriate for one reason or another. Even those most opposed to the expansion of markets usually agree, however reluctantly, that trading in CO_2 is not objectionable.[24]

II. THE WIDE RANGE OF ENVIRONMENTAL TRADING

To get a sense of the scope of trading in the environmental and natural resources contexts, this Part provides a broad survey of the landscape of trading systems. The number and variety of trading regimes used in the United States—at the federal, regional, state, and local level—is vast, and many other countries also use trading extensively. A comprehensive accounting would go well beyond the purposes here. Instead, the goal is to get a sense of the extent of environmental trading, the variety of trading programs, and how well they have worked.

---

22 For an example in CO_2 markets, see *Make Net Zero a Reality, Right Now*, CLIMATE VAULT (Mar. 31, 2021), https://perma.cc/6MXW-SEZQ.

23 *See, e.g.*, *Emissions Products Overview*, EUR. ENERGY EXCH. AG (June 22, 2020), https://perma.cc/QM2J-5UNR.

24 *See* MICHAEL J. SANDEL, WHAT MONEY CAN'T BUY: THE MORAL LIMITS OF MARKETS 72–76 (2012) (agreeing that CO_2 markets are not morally problematic, despite being skeptical of markets generally).

I break trading systems into three categories. The first category is traditional cap-and-trade systems. These put a cap on the quantity of a pollutant and allow trading under that cap. The second category is what are called intensity or performance systems. These do not cap the quantity of a pollutant. Instead, they impose an intensity-based or performance target, such as an efficiency rating (e.g., miles per gallon), and allow trading against that target. A key lesson from these systems is that we do not need a quantity limit to benefit from a trading system. We can trade against almost anything that can be measured. The final category is what are sometimes called markets for ecosystem services.[25] These include items where it might be surprising to see trading, such as endangered species, habitat, wetlands, and water quality. They do not necessarily involve a particular pollutant. For example, the loss of an endangered species is not due to a single pollutant. Instead, these systems can involve a general goal, such as species preservation or biodiversity, and allow trading in attributes that correlate with that goal. These markets tend to be thinner, and trades in these markets are more carefully monitored than in the standard cap-and-trade systems that limit the quantity of a pollutant. For each category, I describe the general approach, list some of the most well-known systems, and then discuss in more detail one or several examples.

A. Quantity Limits on Pollutants—Traditional Cap-and-Trade

Quantity limits put a cap on the quantity of a pollutant, issue permits equal to the cap, and require polluters to hold a permit. Permits trade, allowing the market to allocate who pollutes. The CO_2 illustration in Part I is an example. Table 1 lists others.

25 Philip Womble & Martin Doyle, *The Geography of Trading Ecosystem Services: A Case Study of Wetland and Stream Compensatory Mitigation Markets*, 36 HARV. ENVTL. L. REV. 229, 234 (2012) (explaining that "ecosystem service" markets may be measured by factors such as the number of acres generating the benefits associated with an intact ecosystem).

TABLE 1: STANDARD CAP-AND-TRADE SYSTEMS

Pollutant	**Harm**	**Examples**	**Comments**
SO_2	Acid rain	Clean Air Act Amendments of 1990[26] SO_2 market	The most well-studied market
NO_x	Ozone and fine particles (PM 2.5)	REgional CLean Air Incentives Market (RECLAIM)[27]	Los Angeles basin
		Cross-State Air Pollution Rule (CSAPR) and Clean Air Interstate Rule (CAIR) (Transport Rule)[28]	*EPA v. EME Homer City Generation, L.P.*[29]
		NO_x State Implementation Plan (SIP) Call[30]	2003–2009
CO_2	Climate change	EU Emissions Trading System (ETS)[31]	Thirty-four markets in carbon as of 2022.[33] Vast literature on the EU ETS.[34]
		California[32]	

[26] Pub. L. No. 101–549, 104 Stat. 2399 (codified at 42 U.S.C. §§ 7401–7671q).

[27] *See* James M. Lents & Patricia Leyden, *RECLAIM: Los Angeles' New Market-Based Smog Cleanup Program*, 46 J. AIR & WASTE MGMT. ASS'N 195, 195–96 (1996).

[28] *Overview of the Cross-State Air Pollution Rule (CSAPR)*, U.S. ENVTL. PROT. AGENCY (Mar. 13, 2022), https://perma.cc/673Y-B4N7.

[29] 572 U.S. 489 (2014) (upholding the Transport Rule as a reasonable interpretation of the Clean Air Act).

[30] *See The NO_x Budget Trading Program: 2008 Highlights*, U.S. ENVTL. PROT. AGENCY (Oct. 2009), https://perma.cc/G82W-4QAW.

[31] *See* EUROPEAN COMMISSION, *supra* note 16.

[32] *Cap-and-Trade Program*, CALIFORNIA AIR RES. BD. (2022), https://perma.cc/26CG-KY7Z.

[33] THE WORLD BANK, *supra* note 14.

[34] *See generally, e.g.*, Frank J. Convery, *Origins and Development of the EU ETS*, 43 ENVTL. & RES. ECON. 391 (2009); A. DENNY ELLERMAN, FRANK J. CONVERY & CHRISTIAN DE PERTHUIS, PRICING CARBON: THE EUROPEAN EMISSIONS TRADING SCHEME (2010); A. Denny Ellerman & Barbara K. Buchner, *The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results*, 1 REV. ENVTL. ECON. & POL'Y 66 (2007); A. Denny. Ellerman & Paul L. Joskow, *The European Union's Emissions Trading System in Perspective*, PEW CTR. ON GLOB. CLIMATE CHANGE (May 8, 2008), https://perma.cc/5GAU-LTE4; A. DENNY ELLERMAN, BARBARA K. BUCHNER & CARLO CARRARO, ALLOCATION IN THE EUROPEAN EMISSIONS TRADING SCHEME: RIGHTS, RENTS, AND FAIRNESS (2007); Joseph Kruger, Wallace E. Oates & William A. Pizer, *Decentralization in the EU Emissions Trading Scheme and Lessons for Global Policy*, 1 REV. ENVTL. ECON. & POL'Y 112 (2007); LEGAL ASPECTS OF CARBON TRADING: KYOTO, COPENHAGEN, AND BEYOND (David Freestone &

To illustrate, consider the market in SO_2 created as part of the Clean Air Act Amendments of 1990. SO_2 is emitted from smokestacks of coal-burning EGUs, among other places.[35] Known as acid rain, SO_2 harms forests and lakes when it is precipitated out of the atmosphere.[36] Acid rain was particularly bad in the "Northeast, which is upwind of the large number of coal-fired generators located in the mid-Atlantic states and the Ohio Valley."[37]

To limit acid rain, the Clean Air Act Amendments of 1990 imposed an annual cap on emissions of SO_2 for specified entities (mostly EGUs) and allowed those entities to trade within that cap.[38] The program eventually covered almost all sources of SO_2, cutting emissions to about 50% of the 1980 level.[39] Permit markets were deep and liquid, trading on an exchange with supplemental derivative markets.

The SO_2 trading program is one of the first and one of the most important cap-and-trade systems. Most evaluations view it as a success.[40] Emissions were reduced at a more rapid pace and at a lower cost than expected—and than would have arisen under

---

Charlotte Streck eds., 2009); Sheila M. Olmstead & Robert N. Stavins, *An Expanded Three-Part Architecture for Post-2012 International Climate Policy* (Harv. Kennedy Sch. Fac. Rsch. Working Paper Series No. RWP09-036, 2009); Sheila M. Olmstead & Robert N. Stavins, *Three Key Elements of a Post-2012 International Climate Policy Architecture*, 6 REV. ENVTL. ECON. & POL'Y 65 (2012); Damien Meadows, Yvon Slingenberg & Peter Zapfel, *EU ETS: Pricing Carbon to Drive Cost-Effective Reductions Across Europe*, *in* EU CLIMATE POLICY EXPLAINED 29 (Jos Delbeke & Peter Vis eds., 2015).

35 Robert N. Stavins, *What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading*, 12 J. ECON. PERSPS. 69, 70 (1998).

36 *Id.*

37 Dallas Burtraw, David A. Evans, Alan Krupnick, Karen Palmer & Russell Toth, *Economics of Pollution Trading for SO_2 and NO_x*, 30 ANN. REV. ENV'T & RES. 253, 254 (2005) [hereinafter Burtraw et al., *Economics of Pollution Trading*].

38 *Id.* at 258.

39 Schmalensee & Stavins, *supra* note 13, at 37 (citing A. DANNY ELLERMAN, PAUL L. JOSKOW & DAVID HARRISON, JR., EMISSIONS TRADING IN THE U.S.: EXPERIENCE, LESSONS, AND CONSIDERATIONS FOR GREENHOUSE GASES 12 (2003)).

40 *See, e.g.*, A. DENNY ELLERMAN, PAUL L. JOSKOW, RICHARD SCHMALENSEE, JUAN-PABLO MONTERO & ELIZABETH M. BAILEY, MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM 195–96 (2000) [hereinafter ELLERMAN ET AL., MARKETS FOR CLEAN AIR]; Robert N. Stavins, *What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading*, 12 J. ECON. PERSPS. 69, 84 (1998); Schmalensee & Stavins, *supra* note 13, at 45; Dallas Burtraw, *Appraisal of the SO_2 Cap-and-Trade Market*, *in* EMISSIONS TRADING: ENVIRONMENTAL POLICY'S NEW APPROACH 133, 160–61 (Richard F. Kosobud ed., 2000) (arguing that SO_2 marketplaces lead to more effective and efficient regulation than command-and-control alternatives); Burtraw et al., *Economics of Pollution Trading*, *supra* note 37, at 259–66.

a command-and-control approach. Its success is an important reason for the proliferation of other environmental markets.

B. Intensity Standards or Performance Standards

With an intensity or performance standard, the government does not cap the total amount of a pollutant or the item it seeks to control. Instead, it issues a rule, such as an efficiency requirement (e.g., miles per gallon) or an intensity requirement (e.g., units of a pollutant per unit of a commodity).[41] All covered entities are required to meet the rule, but entities that exceed it can sell their excess compliance to entities that do not meet it. The trading is in what can be thought of as compliance units. Table 2 lists examples.

41 For literature examining the differences between intensity and quantity targets, see generally Carolyn Fischer & Michael Springborn, *Emissions Targets and the Real Business Cycle: Intensity Targets Versus Caps or Taxes*, 62 J. ENV'T. ECON. & MGMT. 352 (2011). *See also* Mort Webster, Ian Sue Wing & Lisa Jakobovits, *Second-Best Instruments for Near-Term Climate Policy: Intensity Targets vs. the Safety Valve*, 59 J. ENV'T ECON. & MGMT. 250, 256–58 (2010).

TABLE 2: INTENSITY TRADING

Performance standard	**Harm**	**Comments**
Lead	Lead poisoning	One of the earliest markets[42]
Corporate Average Fuel Economy (CAFE)[43]	Gasoline use	Trading in fleet average miles per gallon
CO_2 (China)	Climate	Largest CO_2 market in the world[44]
CO_2 (Clean Power Plan)[45]	Climate	Held invalid in *West Virginia v. EPA*[46]
Zero emissions vehicles	Vehicle emissions (all pollutants)	CA and nine other states.[47] Major source of funding for Tesla[48]
Renewable Portfolio Standards (RPS)	Utility emissions (all pollutants)	About half the states.[49] Renewable Electricity Certificates[50]
Low-carbon fuel	Lifecycle greenhouse gas emissions	California, Oregon, Washington, some EU countries[51]

[42] For a summary of the lead phasedown, see Richard G. Newell & Kristian Rogers, *The Market-Based Lead Phasedown*, *in* MOVING TO MARKETS IN ENVIRONMENTAL REGULATION: LESSONS FROM TWENTY YEARS OF EXPERIENCE 171 (Jody Freeman & Charles D. Kolstad eds., 2006).

[43] *Corporate Average Fuel Economy*, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN. (Sept. 19, 2022), https://perma.cc/5S35-TYW6.

[44] For a description of China's market, see Nogrady, *supra* note 15, at 637.

[45] Carbon Pollution Emissions Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,662 (Oct. 23, 2015), *repealed by* 84 Fed. Reg. 32,520 (July 8, 2019).

[46] 142 S. Ct. 2587 (2022).

[47] *See* Yeh et al., *supra* note 12, at 3.

[48] Arjun Kharpal, *What 'Regulatory Credits' Are - And Why They're so Important to Tesla*, CNBC (May 18, 2021), https://perma.cc/4NCS-QXPL.

[49] For a detailed explanation of each state's RPS, see *Renewable Portfolio Standards*, CTR. FOR ROBUST DECISION-MAKING ON CLIMATE AND ENERGY POL'Y, https://perma.cc/Z9JH-FFE7.

[50] *Renewable Energy Certificates (RECs)*, ENVTL. PROT. AGENCY (Feb. 25, 2022), https://perma.cc/26ZM-WJGD.

[51] KELSI BRACMORT, CONG. RSCH. SERV., R46835, A LOW CARBON FUEL STANDARD: IN BRIEF 5 (2021); ANIL BARAL, INT'L COUNCIL ON CLEAN TRANSP., SUMMARY REPORT ON LOW CARBON FUEL-RELATED STANDARDS 5–6 (2009).

Renewable Fuel Standard Program	Pollution from fuel use	Credits known as Renewable Identification Numbe. Early versions plagued by fraud.[52]
Energy efficiency	Energy use?	Mostly foreign markets.[53]

The Corporate Average Fuel Economy (CAFE) standards are a good example. The CAFE standards require fleets of passenger vehicles and, separately, fleets of light-duty trucks to meet or exceed specified fuel economy levels.[54] CAFE standards are imposed separately by the National Highway Traffic Safety Administration (NHTSA) and the U.S. Environmental Protection Agency (EPA), which differ in their purpose and in important details.[55]

---

52 Mike Newman, *The Problem of Invalidated RINs in the Renewable Fuel Standard*, STILLWATER ASSOCS. (Nov. 14, 2018), https://perma.cc/WE96-BY4X.

53 *See generally* Noah M. Sachs, *The Limits of Energy Efficiency Markets in Climate-Change Law*, 2016 U. ILL. L. REV. 2237 (2016).

54 49 U.S.C. § 32903.

55 The EPA sets fuel economy rules to limit emissions of CO_2. NHTSA sets fuel economy rules for a number of reasons, but one is to simply limit the use of gasoline. *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., FINAL ENVIRONMENTAL IMPACT STATEMENT: CORPORATE AVERAGE FUEL ECONOMY STANDARDS S-9 (2012) (listing a reduction in oil imports as an important benefit of the CAFE standards). Other benefits include reducing emissions of NO_x, volatile organic compounds, particulate matter, and SO_2 (all listed as social benefits in the Regulatory Impact Analysis). *Id.* at S-18–S-24; NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., FINAL REGULATORY IMPACT ANALYSIS: CORPORATE AVERAGE FUEL ECONOMY 909–13, 922 (2012). Because emissions of CO_2 are largely one-for-one with fuel use, the EPA standards end up with similar goals and structure as the NHTSA standards.

Although both are intensity standards and set similar goals, trading works slightly differently under the two sets of regulations. Under the NHTSA rules, manufacturers get credits for each one tenth of a mile per gallon each vehicle exceeds its standard. The credits depend on the rate of fuel usage but do not reflect actual fuel savings because they do not account for the actual miles that a given vehicle is driven. Instead, for cars and light trucks, the standard assumes a fixed lifetime mileage (195,264 miles for cars and 225,000 miles for trucks). As a result, credits for cars and credits for light trucks do not trade one-for-one. Benjamin Leard & Virginia McConnell, *New Markets for Credit Trading Under U.S. Automobile Greenhouse Gas and Fuel Economy Standards*, 11 REV. ENVTL. ECON. & POL'Y 207, 211 (2017).

The EPA uses a similar methodology, granting credits for miles per gallon below its required standards, set in terms of grams of CO_2 per mile. It, however, converts the credits to megagrams of CO_2 by multiplying the miles per gallon for a fleet by the same assumed miles per vehicle. U.S. ENVTL. PROT. AGENCY, THE 2021 EPA AUTOMOTIVE TRENDS REPORT 77 (2021). While this looks like it converts the standard to a quantity cap, it does not because the amount is not sensitive to the actual quantity of CO_2 that is released. It does have the benefit, however, of allowing one-for-one trading in credits because they are all in the same unit.

The rules were tightened in 2012, and an important component of the tightening was to allow trading. Trading was allowed within a manufacturer between its passenger vehicle fleet and its light-duty truck fleet and among different manufacturers.[56] In particular, if a manufacturer's fleet exceeds the minimum standard for fuel economy, it can sell the excess compliance to a manufacturer whose fleet does not meet the standards.[57]

One difficulty with evaluating the CAFE standards is that the trades are private. The NHTSA reports only the volume of each transaction, not its price.[58] Moreover, only manufacturers are able to participate in the market. Notwithstanding these problems, at least one analysis estimated that trading could reduce the compliance costs of a 40% increase in fuel economy in the period between 2012 and 2020 by between 7% and 16%.[59]

C. Ecosystem Services Markets

The final category is markets for ecosystem services. These markets vary widely. They often seek to preserve or enhance an overall ecosystem or ecosystem benefit, such as wetlands, biodiversity, or water quality. The markets then specify some set of attributes or metrics to be traded, the idea being that trading in that attribute helps achieve the broader goal. For example, markets in water quality may seek to limit water pollution, such as phosphorus and nitrogen, in either quantity or intensity,[60] or some other feature of water, such as salinity or temperature. Wetlands markets may use acreage of wetlands as the metric. Table 3 lists broad categories of these systems and examples of each.

---

56 49 U.S.C. § 32903(f), (g), *amended by* Energy Independence and Security Act of 2007, 42 U.S.C. §§ 17301–17305.

57 49 U.S.C. § 32903(f), *amended by* Energy Independence and Security Act of 2007, 42 U.S.C. §§ 17301–17305. Section 32903(f)(2) puts a floor on the trading by any manufacturer, so manufacturers cannot reduce their average fuel economy below a minimum by buying credits.

58 Leard & McConnell, *supra* note 55, at 217. The volume of trades is modest but not insignificant: about 7% of total credit holdings between 2012 and 2015. This volume was low in the early years and higher later. *Id.* at 216.

59 *See* Jonathan Rubin, Paul N. Leiby & David L. Greene, *Tradable Fuel Economy Credits: Competition and Oligopoly*, 58 J. ENVTL. ECON. & MGMT. 315, 327 (2009).

60 The distinction between this last category, ecosystem services markets, and the other two, will often not be clear. Nothing here depends on the distinction.

TABLE 3: MARKETS IN ENVIRONMENTAL SERVICES

Type	**Examples**	**Comments**
Water quality	Chesapeake Bay Watershed Nutrient Credit Exchange	Dozens around the world, including in the United States. Many are early and experimental.[61]
Biodiversity	Florida panther	Early and experimental.[62]
Wetlands	Neal Marsh Wetland, Chicago area	More than 4,000 wetlands mitigation banks in the United States.[63]
Fish species	New Zealand established its trading system in 1986[64]	Accounts for about 25% of global fish catch.[65]
Cabon offsets	California cap-and-trade system, Kyoto Protocol Clean Development Mechanism.	IPC models suggest vast quantities of negative emissions will be needed.[66] Offset markets are likely the major source of financing.

These markets can differ significantly from one another, so I provide a fuller discussion of these markets than I did for quantity and intensity markets.

61 *See* PAUL FAETH, WORLD RESOURCES INSTITUTE, FERTILE GROUND: NUTRIENT TRADING'S POTENTIAL TO COST-EFFECTIVELY IMPROVE WATER QUALITY 31 (2000).

62 *See Florida Panther Conservation Bank*, MITIGATION BANKING GRP., INC. (2022), https://perma.cc/RU6D-2KWK.

63 The Army Corps keeps track via the Regulatory In-lieu Fee and Bank Information Tracking System. *See* U.S. ARMY CORPS OF ENG'RS, *Regulatory In-Lieu Fee and Bank Information Tracking System*, https://perma.cc/S2VM-4LL4. As of September 20, 2022, the system lists 4,205 banks and sites. U.S. ARMY CORPS OF ENG'RS, *Regulatory In-Lieu Fee and Bank Information Tracking System: Banks & Sites*, https://perma.cc/8ALL-CMME.

64 *See generally* Richard G. Newell, James N. Sanchirico & Suzi Kerr, *Fishing Quota Markets*, 49 J. ENVTL. ECON. & MGMT. 437 (2005).

65 SANDOR ET AL., *supra* note 3, at 292–98; *see also* Ragnar Arnason, *Property Rights in Fisheries: How Much Can Individual Transferable Quotas Accomplish?*, 6 REV. ENVTL. ECON. & POL'Y 217, 232 (2012).

66 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2022: MITIGATION OF CLIMATE CHANGE, SUMMARY FOR POLICYMAKERS 27 (Priyadarshi R. Shukla, Jim Skea & Andy Reisinger eds., 2022).

1. Wetlands.

Wetlands provide a broad range of important environmental benefits, including water purification, flood control, and support of wildlife. To protect wetlands, § 301 of the Clean Water Act[67] prohibits the discharge of any pollutant by any person into the waters of the United States. Section 404, however, allows the Secretary of the Army to "issue permits . . . for the discharge of dredged or fill materials into the navigable waters at specified disposal sites."[68] These permits are known as 404 permits and are administered by the Army Corps of Engineers.

The Corps initially used a prescriptive approach that discouraged the development of wetlands or, if a permit was granted, required on-site mitigation.[69] By the mid-1990s, however, this process was viewed as too inflexible as well as not successful in maintaining wetlands functions.[70] Wetlands mitigation banking was viewed as a solution.

In wetlands mitigation banking, a specialized entity creates, restores, or preserves a "bank" of wetlands.[71] Land developers who are destroying a wetland can "buy" wetlands from the bank to ensure that the development does not generate a loss in overall wetlands. In effect, the transaction shifts the mitigation duties from the developer to the bank.[72] Wetlands trading differs from some other trading markets in that the trades are not between two entities subject to regulatory limitations on development. Instead, the trades are between developers and banks. The banks themselves are regulated to ensure compliance but are not themselves developers.

I am not aware of recent analyses of the effectiveness of wetlands banking. Jim Salzman and J.B. Ruhl, in a pair of articles from about twenty years ago, were skeptical about how well it

---

67 33 U.S.C. § 1311(a).

68 33 U.S.C. § 1344(a).

69 James Salzman & J.B. Ruhl, *"No Net Loss": Instrument Choice in Wetlands Protection*, *in* MOVING TO MARKETS IN ENVIRONMENTAL REGULATION: LESSONS FROM TWENTY YEARS OF EXPERIENCE 323, 324 (Jody Freeman & Charles D. Kolstad eds., 2006) [hereinafter Salzman & Ruhl, *No Net Loss*].

70 *Id.* at 324–26. For a review of the environmental importance of wetlands and issues related to their preservation, see generally NAT'L RSCH. COUNCIL, COMPENSATING FOR WETLAND LOSSES UNDER THE CLEAN WATER ACT (2001).

71 33 C.F.R. §§ 325, 332 (2008); 40 C.F.R. § 230 (2008).

72 Robert L. Glicksman, *Regulatory Safeguards for Accountable Ecosystem Service Markets in Wetlands Development*, 62 KAN. L. REV. 943, 950 (2014).

worked.[73] Their key concern was that we cannot easily measure the environmental benefits that different wetlands offer. As a result, wetland banking often uses acreage as a proxy, which Salzman and Ruhl called the "currency." Trading equal acreage can lead to a loss in the environmental benefits that wetlands offer.[74] In a more recent study, Philip Womble and Martin Doyle examined the geographic trading limits for wetlands banks (i.e., if a wetland is destroyed in one location, which locations are eligible for wetlands preservation or restoration to offset?).[75] They found internal inconsistencies in these criteria but did not attempt to measure the resulting change in wetlands functions.

Even aside from the problem of currency, there is good reason to be skeptical of wetlands trading. The initial trade allows a wetland to be destroyed, and we must then trust the bank to maintain an equivalent wetland for the indefinite future. Neither the developer nor the bank has strong incentives to ensure that the replacement wetlands functions well. Instead, we must rely on the regulatory agency—here the Army Corps—to police the replacement over a long period of time. As Salzman and Ruhl pointed out, the sale is not at all like the sale of a normal good, such as a bicycle, where the buyer has an incentive to police the quality of the good.[76] As a result, it would be surprising if the replacement wetlands were a full substitute for the destroyed wetlands over the indefinite future.

---

73 James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 STAN. L. REV. 607, 687–94 (2000) [hereinafter Salzman & Ruhl, *Currencies and Commodification*]; Salzman & Ruhl, *No Net Loss*, *supra* note 69, at 337–41; *see also* J.B. Ruhl & R. Juge Gregg, *Integrating Ecosystem Services into Environmental Law: A Case Study of Wetlands Mitigation Banking*, 20 STAN. ENVTL. L.J. 365, 378–80 (2001). These evaluations, however, were before the 2008 Corps-EPA Final Compensatory Mitigation Rule. Corps Mitigation Rule, 33 C.F.R. § 332 (2008); EPA Mitigation Rule, 40 C.F.R. § 230 (2008).

74 To illustrate, suppose that a developer destroys an acre of wetlands in area one and, to compensate, buys an acre from a bank in area two. If the actual ecosystem services are not the same, preserving acreage does not necessarily preserve wetlands services.

75 Womble & Doyle, *supra* note 25, at 271–79, 285–89.

76 Salzman & Ruhl, *No Net Loss*, *supra* note 69, at 337–38.

2. Water quality.

The Clean Water Act imposes a set of effluent standards implemented by permitting point sources of pollution.[77] The Act, however, does not regulate pollution from nonpoint sources, such as nutrient runoff from farms and lawns.[78] As a result, nonpoint sources are now the primary source of impairment in U.S. waterways.[79] Moreover, because of this dichotomous approach to regulating effluents, marginal abatement costs for non–point sources are much lower than for point sources.[80] Water quality trading is seen as a way of reducing emissions from non–point sources, taking advantage of their lower abatement costs.

While the Clean Water Act does not explicitly allow trading, the EPA has issued guidance that encourages trading to improve water quality.[81] The system uses the Total Maximum Daily Load (TMDL), which is an amount established by the states for a pollutant—a pollution budget—for each body of water that does not meet ambient standards for its designated use.[82] The TMDL includes all sources of pollution, including nonpoint sources. Allocating the TMDL to point sources establishes a baseline compliance standard for those sources.[83]

---

77 33 U.S.C. § 1342(a). In particular, the National Pollutant Discharge Eliminate System (NPDES) requires every point source to hold a permit limiting its pollutant discharges. The Act also requires states to set forth water quality standards, calculating the Total Maximum Daily Load (TMDL) for each pollutant that is impairing a body of water.

78 Karen Fisher-Vanden & Sheila Olmstead, *Moving Pollution Trading from Air to Water: Potential, Problems, and Prognosis*, 27 J. ECON. PERSPS. 147, 149 (2013).

79 *Id.*

80 *Id.*

81 *See generally* U.S. ENVTL. PROT. AGENCY: OFF. OF WATER, WATER QUALITY TRADING POLICY (2003). In 2009, it issued a toolkit to encourage the development of water quality markets. *See generally* U.S. ENVTL. PROT. AGENCY: OFF. OF WASTEWATER MGMT., WATER QUALITY TRADING TOOLKIT FOR PERMIT WRITERS (2009). For a summary of how water quality trading works, see generally SANDOR ET AL., *supra* note 3, at 265–82; Kurt Stephenson & Leonard Shabman, *Can Water Quality Trading Fix the Agricultural Nonpoint Source Problem?*, 9 ANN. REV. RES. ECON. 95 (2017), and James Shortle, *Economics and Environmental Markets: Lessons from Water-Quality Trading*, 42 AGRIC. & RES. ECON. REV. 57 (2013). *See also* Sheila M. Olmstead, *The Economics of Water Quality*, 4 REV. ENVTL. ECON. & POL'Y 44, 52–54 (2010).

82 U.S. ENVTL. PROT. AGENCY: OFF. OF WATER, *supra* note 81, at 4.

83 *See id.* at 1.

Runoff from nonpoint sources, however, cannot easily be measured. Moreover, nonpoint sources cannot be required to reduce pollution under the Clean Water Act.[84] They are incorporated into water quality trading by establishing best management practices (BMPs). For example, a BMP might involve conservation tillage or cover cropping. Nonpoint sources, such as farms, generate credits for sale in a water quality market by adopting BMPs beyond a baseline level, converting BMPs into estimated changes in pollution.[85]

In theory, water quality trading should lead to substantial cost reductions because of the large differences in marginal costs between point and nonpoint sources.[86] Water quality trading, however, is not yet widespread, and the programs tend to be relatively small.[87] A survey in 2013 identified three dozen active or completed programs; most of these were located in the United States, with some in Australia, New Zealand, or Canada.[88] Many of these programs have few trades or are largely inactive. Some programs, however, appear to be working, including the Chesapeake Bay trading program[89] and the Hunter River Salinity Program in Australia (where the trading is in water salinity).[90] There is currently a national network on water quality trading,[91] and both the EPA and the U.S. Department of Agriculture

---

84 Fisher-Vanden & Olmstead, *supra* note 78, at 148–49.

85 *Id.* at 152.

86 A World Resources Institute study in 2000 that was an important motivation for the adoption of water quality trading predicted an order of magnitude reduction in costs for removal of phosphorus. *See* FAETH, *supra* note 61, at 31 (2000).

87 *See* Fisher-Vanden & Olmstead, *supra* note 78, at 150; Shortle, *supra* note 81, at 58; James S. Shortle & Richard D. Horan, *The Economics of Water Quality Trading*, 2 INT'L REV. ENVTL. & RES. ECON. 101, 105 (2008); Olmstead, *supra* note 81, at 52; Stephenson & Shabman, *supra* note 81, at 100; U.S. GOV. ACCOUNTABILITY OFF., WATER POLLUTION: SOME STATES HAVE TRADING PROGRAMS TO HELP ADDRESS NUTRIENT POLLUTION, BUT USE HAS BEEN LIMITED 15 (2017).

88 Fisher-Vanden & Olmstead, *supra* note 78, at 150. The World Resources Institute, however, identified fifty-seven programs in roughly the same time period. *See* Mindy Selman, Suzie Greenhalgh, Evan Branosky, Cy Jones & Jenny Guiling, *Water Quality Trading Programs: An International Overview*, WRI ISSUE BRIEF, No. 1, 2009, at 1, 2.

89 *Trading and Offsets in the Chesapeake Bay Watershed*, U.S. ENVTL. PROT. AGENCY (last updated Apr. 27, 2022), https://perma.cc/V4VT-H7GH.

90 *Hunter River Salinity Scheme: Working Together to Protect River Quality and Sustain Economic Development*, DEP'T ENV'T AND CONSERVATION NEW SOUTH WALES (June 2006), https://www.environment.nsw.gov.au/resources/licensing/hrsts/hrsts.pdf.

91 *See National Network on Water Quality Trading*, NAT'L NETWORK ON WATER QUALITY TRADING, https://perma.cc/6DQS-7LYC.

(USDA) actively promote it.[92] There is every reason to believe that it will expand in the future, in large part as a method to control pollution from nonpoint sources.[93]

3. Biodiversity and endangered species.

Biodiversity offsets, also known as conservation banks or habitat banks, work similarly to wetlands banks, except they have the goal of preserving habitats for endangered species rather than wetlands.[94] The basic idea is that a developer who is otherwise going to "take" an endangered species (in the language of the Endangered Species Act),[95] can engage in compensatory mitigation by increasing habitat for that species elsewhere.[96] They do so by buying credits from a conservation bank, which preserves or creates conservation land. The land must "fit[ ] into the overall conservation needs of the listed species the bank intends to cover."[97]

---

92 For the EPA promotion of water quality trading, see *Water Quality Trading*, U.S. ENVTL. PROT. AGENCY (last updated Feb. 4, 2022), https://perma.cc/T3Y2-K4TJ. For the USDA promotion of trading, see, *Water Quality*, U.S. DEP'T AGRIC., https://perma.cc/U4GH-YPM5.

93 For example, the Abrams Environmental Law Clinic at the University of Chicago Law School recently proposed a watershed-wide water quality trading system in Illinois. *See generally* GERALD KEENAN PALMER, MARK TEMPLETON, ROBERT WEINSTOCK, JAYMAL PATEL ABRAMS, ALAINA HARKNESS & SVETLANA TAYLOR CURRENT, CONVENERS' REPORT ON THE ILLINOIS NUTRIENT TRADING INITIATIVE STAKEHOLDER PROCESS (2021).

94 For a book-length treatment of biodiversity banking, see generally CONSERVATION AND BIODIVERSITY BANKING: A GUIDE TO SETTING UP AND RUNNING BIODIVERSITY CREDIT TRADING SYSTEMS (Nathaniel Carroll, Jessica Fox & Ricardo Bayon eds., 2008).

95 16 U.S.C. § 1532(19).

96 The underlying law is, of course, a different law—the Endangered Species Act (ESA) instead of the Clean Water Act. Section 9(a)(l) of the ESA prohibits the "taking" of species of endangered fish and wildlife, and § 4(d) extends similar protection to species of fish and wildlife listed as threatened. *See* 16 U.S.C. §§ 1533(d), 1538(a)(l). The Fish and Wildlife Service (FWS) may permit activities which otherwise violate the take prohibition through interagency consultation under ESA § 7(a)(2), or through issuance of incidental take permits, also known as habitat conservation plan (HCP) permits, under ESA § 10(a). *See* 16 U.S.C. §§ 1536(a)(2), 1539(a).

To minimize the costs of the no-take rule, the FWS interprets Sections 7(a)(2) and 10(a) to allow landowners to engage in compensatory mitigation. Conservation banks offer a potentially less expensive—and, at the same time, more effective—method of compensatory mitigation. For a summary of the ESA conservation bank program, see generally J.B. Ruhl, Alan Glen & David Hartman, *A Practical Guide to Habitat Conservation Banking Law and Policy*, 20 NAT. RES. & ENV'T 26 (2005).

97 Memorandum from Matt Hogan, Dir. of the Fish & Wildlife Service of the U.S. Dep't of the Interior, to the Reg'l Dirs. & Manager of Cal. Nev. Operations, Guidance for the Establishment, Use, and Operation of Conservation Banks 5 (May 2, 2003), https://perma.cc/R55N-G2AE.

The U.S. Fish and Wildlife Service (FWS) implements biodiversity offsets in the United States under the Endangered Species Act (ESA) The underlying argument for conservation banks is that the ESA is unduly rigid, often imposing high and concentrated costs on landowners.[98] High costs create incentives for landowners to avoid application of the ESA (for example, by preemptively destroying a species) and reluctance by regulators to broadly enforce its provisions. If an alternative and equally good habitat for a species is preserved, habitat banks, in the words of FWS, "offer[ ] landowners economic incentives to protect natural resources, save[ ] developers time and money by providing them with certainty of pre-approved compensation lands, and provide[ ] long-term protection of habitat."[99]

A central question for habitat banks, as with wetland banks, is how to value different habitats. Ecosystems are complex, and different acres of land will not necessarily offer the same benefits. Trading acres, therefore, could lead to degradation of value. More complex valuation criteria, however, increase costs.[100] And as with wetlands banks, neither the landowner nor the habitat bank has an incentive to ensure quality, unlike the sale of a bicycle.

A survey in 2019 found 137 habitat banks in the United States, conserving about 153,000 acres of land, mostly in California.[101] The species most commonly protected through habitat banks is the Florida panther, followed by the Otay tarplant (a bright yellow flower). Credit prices for Burke's goldfields (a small annual herb) were the highest, although the market for these credits was thin. It is difficult to get a sense of the use of

---

98 *See* Ruhl et al., *supra* note 96, at 27.

99 Guidance for the Establishment, Use, and Operation of Conservation Banks, 68 Fed. Reg. 24,753, 24,753 (Apr. 25, 2003).

100 The Fish and Wildlife Service says that it uses a multidimensional system to determine credit values. In particular:

> Credit values are based upon a number of biological criteria and may vary by habitat types or management activities. When determining credit values, some of the biological criterion that may be considered include habitat quality, habitat quantity, species covered, conservation benefits, including contribution to regional conservation efforts, property location and configuration, and available or prospective resource values.

Hogan, *supra* note 97, at 9 (referencing Guidance for the Establishment, Use, and Operation of Conservation Banks, 68 Reg. at 24,753).

101 *See* Jagdish Poudel, Daowei Zhang & Benjamin Simon, *Habitat Conservation Banking Trends in the United States*, 28 BIODIVERSITY & CONSERVATION 1629, 1636 (2019).

biodiversity offsets in other countries. Estimates range from thirty-nine existing programs across all countries in a 2010 survey[102] to almost 120 countries with programs in a 2016 survey.[103]

Evaluations of biodiversity offset programs tend to be mixed.[104] A 2016 survey by the Organisation of Economic Co-operation and Development (OECD) concluded that the "evidence available to date points to somewhat mixed results in terms of the environmental effectiveness of existing biodiversity offset schemes."[105] The OECD, however, notes that in 2011, offset programs mobilized between $2.4 and $4 billion, which is nontrivial when compared to annual biodiversity aid, which was about $6.4 billion between 2012 and 2014.[106]

III. PROBLEMS WITH ENVIRONMENTAL TRADING

In Part I, I suggested five preconditions that make CO_2 trading a paradigmatic example of when trading can work (the five "Ms"): (1) uniform mixing, (2) accurate measurement, (3) a wide

---

102 BECCA MADSEN, NATHANIEL CARROLL & KELLY MOORE BRANDS, ECOSYSTEM MARKETPLACE, STATE OF BIODIVERSITY MARKETS REPORT: OFFSET AND COMPENSATION PROGRAMS WORLDWIDE 59 (2010).

103 ORG. FOR ECON. COOP. & DEV., BIODIVERSITY OFFSETS: EFFECTIVE DESIGN AND IMPLEMENTATION 2 (2016). This survey, however, does not clearly distinguish between wetlands banking and conservation banking, which are distinct programs implemented by separate agencies under U.S. law.

104 Theodore Panayotou, *Conservation of Biodiversity and Economic Development: The Concept of Transferable Development Rights*, 4 ENVTL & RES. ECON. 91, 98–100 (1994) (advocating for the use of transferable development rights in habitat conservation rather than species conservation); Joseph W. Bull, K. Blake Suttle, Ascelin Gordon, Navinder J. Singh & E.J. Milner-Gulland, *Biodiversity Offsets in Theory and Practice*, 47 ORYX 369, 371–76 (2013) (finding that biodiversity offsets have been inconsistent in their effectiveness due to their ongoing theoretical and practical problems); Stephen Polasky, Christopher Costello & Andrew Solow, *The Economics of Biodiversity*, *in* 3 HANDBOOK OF ENVIRONMENTAL ECONOMICS 1517, 1547–51 (K.-G. Mäler & J.R. Vincent eds., 2005) (discussing the challenges with perverse incentives in biodiversity offsets); Silvia Wissel & Frank Wätzold, *A Conceptual Analysis of the Application of Tradable Permits to Biodiversity Conservation*, 24 CONSERVATION BIOLOGY 404, 407–10 (2010) (discussing the challenges that biodiversity offsets must overcome); Needham et al., *supra* note 19, at 1430–33 (identifying four policy lessons that improve the cost-effectiveness of biodiversity offset schemes); Poudel, Zhang & Simon, *supra* note 101, at 1644 (finding that habitat conservation banking has "succeeded" in increasing the area and species conserved); Valérie Boisvert, *Conservation Banking Mechanisms and the Economization of Nature: An Institutional Analysis*, 15 ECOSYSTEM SERS. 134, 139–40 (2015) (arguing against conceptualizing commodification of natural resources purely as a market rather than as a management tool).

105 ORG. FOR ECON. COOP. AND DEV., *supra* note 103, at 16 (2016).

106 *Id.* at 17.

variation in marginal cost, (4) a liquid and transparent market, and (5) no moral objections or market failures that make markets inappropriate. Three of these are particularly relevant in considering trading in nonenvironmental contexts: mixing, measurement, and morals. I consider each of these in detail in this Part.

A. Mixing: Hot Spots and Environmental Justice

A widespread concern with environmental trading is that it can generate what are known as hot spots. A hot spot arises if, holding the cap or other goal fixed, the total amount of harm varies with the source of the harm. I start by illustrating the problem using a simple example, then discuss its relationship to the problem of environmental justice, and finally consider solutions.[107] The hot spot problem will be central to the discussion in Part IV, where I consider extending trading to nonenvironmental contexts, and it is therefore worthy of detailed examination.

1. The problem.

Hot spots can arise if the marginal harm is not the same for all polluters. Cap-and-trade systems equalize the price faced by all polluters within the system. Applying a cap-and-trade system to polluters that cause different marginal harms therefore means that some polluters will face a price that is too low and others a price that is too high, leading to an inefficient allocation of pollution.

To illustrate, suppose that there are two groups of polluters, P_1 and P_2, and two groups of victims, V_1 and V_2. Because of the way that the environment functions, such as the direction of the

[107] Concerns about hot spots have arisen in a number of trading regimes. For example, hot spots were a concern in the Clear Air Mercury Rule issued in 2005 and invalidated by the D.C. Circuit in 2008. *See* Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units, 70 Fed. Reg. 28,606, 28,630–28,631 (May 18, 2005) (to be codified at 40 C.F.R pts. 60, 72, 75); New Jersey v. EPA, 517 F.3d 574, 583 (D.C. Cir. 2008) (invalidating the regulations). Among other things, that rule allowed power plants to trade mercury emissions, which are generated from the combustion of coal. Mercury is a neurotoxin, particularly dangerous to fetuses and young children. Although there may be no safe level of mercury exposure, the danger goes rapidly up with exposure. As a result, two systems allowing the same overall level of mercury in the environment may produce different levels of total harm if one system generates greater concentrations of mercury than another. Trading might have had precisely this effect because local concentrations would be determined by abatement costs. A number of medical groups sued the EPA over this concern. *See generally* Bridget M. Kuehn, *Medical Groups Sue EPA Over Mercury Rule*, 294 J. AM. MED. ASS'N 415 (2005).

prevailing winds or the flow of water, P_1's pollution harms only V_1, and P_2's pollution harms only V_2. A tax on the P_1 polluters equal to the expected marginal harm they cause to V_1 and a tax on the P_2 polluters equal to the expected marginal harm they cause to V_2 causes all of the polluters to take the harms they cause into account. If the marginal harm to the two groups of victims is not the same, the taxes would not be the same. For example, if the harm of a unit of pollution from P_1 is greater than the harm of a unit of pollution from P_2, the tax on P_1 would be higher than the tax on P_2.

Suppose, instead, we put a separate cap on pollution from each of the two groups of polluters. The cap should be set at the level of pollution that equates the marginal harm from pollution to the victims to the marginal cost of abatement for the polluters. Trading within the P_1 group and trading within the P_2 group would induce an efficient allocation of pollution within each group. The caps for the two groups would be different if the cost structures are different, and as a result, the trading prices between the groups will differ. If the caps were set efficiently, the trading prices for each of the groups would equal the respective optimal taxes.

If we allow trading not only within each group of polluters but also between the groups, polluters in the group with the higher trading price, say P_1, will purchase permits from the other group, P_2. They were previously setting their marginal cost of mitigation equal to the higher permit price. By purchasing permits from P_2 and increasing their pollution, they can lower their costs. For similar but opposite reasons, the polluters in P_2 would be happy to sell permits to polluters in P_1 and reduce their pollution.

Trading off between the groups will continue until the permit price is the same for the two groups. The result is an increase in total harm even though the total amount of pollution remains the same. The reason is that polluters in P_1 face too low a price and pollute more than is optimal. The price facing polluters in P_2 is too high, so they pollute less than is optimal. These amounts offset in the total quantity of pollution—the increase in the quantity of pollution by P_1 is exactly offset by the reduction in the quantity of pollution by P_2. Nevertheless, total harm goes up because the increase in pollution by P_1 causes more harm than the benefit from the reduction in pollution by P_2. The reason is that the marginal harm to V_1 is greater than the marginal harm to V_2.

Note that the harm does not need to be the same for all individuals or locations to avoid hotspots. Even if the harm varies widely, there is no hot spot problem as long as the marginal harm is the same regardless of the source. For example, the harms from climate change are not evenly dispersed. Hot areas of the world and poor areas of the world are likely to suffer much more than rich areas and cold areas.[108] Emissions of CO_2, nevertheless, do not create a hot spot problem because the harms do not depend on the source.

Similarly, a hot spot does not arise just because we are able to trace the harm that a particular victim faces to a particular polluter. If the marginal harm to V_1 and V_2 were the same, trading would not cause an increase in total harm. The hot spot arose not because P_1 harmed only V_1 and P_2 harmed only V_2. It arose because the marginal harm from pollution by P_1 was not the same as the marginal harm from pollution by P_2.

Concerns about hot spots are often mistakenly combined with concerns about environmental justice (EJ).[109] EJ is concerned with disadvantaged groups bearing excess costs of pollution.[110] EJ, it has been said, "refers to any policy, practice, or directive that differentially affects or disadvantages (whether intended or unintended) individuals, groups, or communities based on race or

---

108 ERIC A. POSNER & DAVID WEISBACH, CLIMATE CHANGE JUSTICE 14–15 (2010).

109 For a discussion of the claims that hot spots and environmental justice are connected, see Daniel A. Farber, *Pollution Markets and Social Equity: Analyzing the Fairness of Cap and Trade*, 39 ECOLOGY L.Q. 1, 29–48 (2012).

110 POSNER & WEISBACH, *supra* note 108, at 60.

color."[111] For example, EJ advocates argue that locating, or excessively locating, polluting activities in minority communities raises distinct concerns about justice.[112]

EJ problems can arise even without a hot spot. Suppose that the pollution in this case was well mixed, so that harms were unrelated to whether the pollution came from P_1 or P_2, but that victims in V_2 were disadvantaged in one way or another, resulting in higher marginal harm from pollution. The result may be an EJ problem even though there is no hot spot. Similarly, going back to the original facts, if neither of the two groups of victims are disadvantaged, trading would induce a hot spot but no EJ concern.[113]

In addition, EJ problems can arise in contexts entirely outside of trading. A key concern is that because disadvantaged groups often lack political power, the political system will burden those groups with excess pollution. The allocation of the costs of pollution arises because of the political system, not because of a market. As a result, I will treat EJ as distinct from hot spots.

Before determining that a hot spot problem dooms trading, it is important to determine whether other regulatory systems can avoid the problem, and at what cost. In particular, if the government cannot differentiate among groups of victims using other regulatory systems, the hot spot problem will not be unique to trading. For example, if a command-and-control regulation has to

111 Robert D. Bullard, *The Legacy of American Apartheid and Environmental Racism*, 9 ST. JOHN'S J. LEGAL COMMENT 445, 451 (1994). For a history of the EJ movement, see generally LUKE W. COLE & SHEILA R. FOSTER, FROM THE GROUND UP: ENVIRONMENTAL RACISM AND THE RISE OF THE ENVIRONMENTAL JUSTICE MOVEMENT (2001). For a general review of the issue, see generally Paul Mohai, David Pellow & J. Timmons Roberts, *Environmental Justice*, 34 ANN. REV. ENV'T & RES. 405 (2009). For concerns about the environmental justice aspects of cap-and-trade, see Lily N. Chinn, Comment, *Can the Market Be Fair and Efficient? An Environmental Justice Critique of Emissions Trading*, 26 ECOLOGY L.Q. 80, 102–15 (1999); Noga Morag-Levine, *The Problem of Pollution Hotspots: Pollution Markets, Coase, and Common Law*, 17 CORNELL J.L. & PUB. POL'Y 161, 196–98 (2007); Seth B. Shonkoff, Rachel Morello-Frosch, Manuel Pastor & James Sadd, *Minding the Climate Gap: Environmental Health and Equity Implications of Climate Change Mitigation Policies in California*, 2 ENVTL. JUST. 173, 174–75 (2009).

112 *See, e.g.*, Bullard, *supra* note 111, at 461–63 (illustrating the deliberate locating of Houston's waste sites in minority communities).

113 Hot spots and EJ problems often coincide, however, because disadvantage may make marginal harm higher and disadvantaged communities may be less able to object to policies that hurt them. In the discussion below of trading outside of the environmental context, I treat them as distinct problems. Combining these distinct problems may lead to a misdiagnosis of the problem in a given context.

treat P_1 and P_2 the same in the above example, it too would generate a hot spot. That trading generates a hot spot in this case should not be a reason for rejecting trading.

2. Solutions.

The problem of hot spots was recognized in the very earliest literature on emissions trading, and a number of solutions have been proposed.[114] The first and simplest solution is to do nothing—to ignore the problem—on the theory that it is unlikely to be bad or that the costs of a solution would be more than the benefits.

The SO_2 trading system for acid rain took this approach. When it was being designed, analysts expressed concerns that emissions of SO_2 from particular locations in the Midwest would concentrate acid rain in spots in the East.[115] Notwithstanding these concerns, the 1990 program had a national SO_2 trading system that did not try to address hot spots. Retrospective reviews of the acid rain trading program indicate that this was the right approach: it did not create the expected hot spots. The reason is that the concerning plants in the Midwest were also the cheapest to shut down and replace with cleaner technology because those plants were already old.[116] The decision to do nothing to address hot spots ended up being both the simplest solution and without material downsides.

Should regulators decide to address hot spots, there are three general approaches that have been tried or suggested: trading zones, a nondegradation floor, and exchange rates.[117]

---

114 The initial solution, offered by W. David Montgomery in 1972, was called ambient air quality trading. *See* Montgomery, *supra* note 13, at 403–11. Ambient air quality trading creates separate pollution markets for each victim or class of victims, and polluters must buy permits in each of these markets. For example, if there are ten polluters and thirty classes or types of victims, each polluter would need to assemble permits for the harm it causes to each of the thirty victims. That is, each polluter would need a portfolio of thirty different types of permits. While this system fully solves the hot spot problem in the sense that it generates the cost-minimizing allocation of pollution that keeps pollution levels below whatever standard is set for each victim, it would be extremely complex. As a result, it is more a mathematical curiosity than a practical solution.

115 Jonathan Remy Nash & Richard L. Revesz, *Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants*, 28 ECOLOGY L.Q. 569, 588–97 (2001).

116 ELLERMAN ET AL., MARKETS FOR CLEAN AIR, *supra* note 40, at 130–36; Burtraw et al., *Economics of Pollution Trading*, *supra* note 37, at 143–49.

117 For a discussion, see T.H. TIETENBERG, EMISSIONS TRADING: PRINCIPLES AND PRACTICE 78–102 (2d ed. 2006).

3. Zones.

A zonal system restricts trading among polluters to groups that have similar effects on victims. In the example of hot spots given above, a zonal system would restrict trading to polluters within P_1 and polluters within P_2, but not allow trading between polluters in those groups. Under the simple facts of that example, this system would perfectly protect against hot spots. The cost would be that trading would be among smaller groups, resulting in thinner and less liquid markets. As the number of zones increases, the markets become smaller and thinner, generating a trade-off between market liquidity and pervasiveness of hot spots.

In more realistic cases, zonal systems do not fully solve the hot spots problem. To illustrate, suppose that most of the pollution from polluters in P_1 affects V_1, but some of it also affects V_2, and similarly pollution from P_2 can in part affect V_1. In this case, segregating P_1 from P_2 does not fully solve the problem. Instead, each polluter would need to be part of markets for each of the different classes of victims.

Zonal systems have been used a number of times in the environmental context. For example, the Cross-State Air Pollution Rule (CSAPR), the subject of the decision in *EPA v. EME Homer City Generation, L.P.*,[118] used trading zones to prevent hot spots.[119] As described in *EME Homer City Generation*, CSAPR is designed to address the interstate transport SO_2 and NO_x under the Good Neighbor Provision of the Clean Air Act.[120] These gases create ozone and fine particulate pollution (known as PM 2.5) in downwind states.[121] Because pollution in different upwind states can have varying effects in downwind states, the EPA limited trading to particular groups of states.[122] For example, the 2021 amendments to the CSAPR covered twenty-one states.[123] Because pollution from twelve of those states caused downwind states to exceed

[118] 572 U.S. 489 (2014).

[119] Werner Antweiler, *Emission Trading for Air Pollution Hot Spots: Getting the Permit Market Right*, 19 ENVTL. ECON. & POL'Y STUD. 35, 51 (2017).

[120] 42 U.S.C. § 7410(a)(2)(D)(i)(I).

[121] *EME Homer City Generation*, 572 U.S. at 496–97.

[122] *Id.* at 500–03.

[123] Revised Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS, 86 Fed. Reg. 23,054, 23,056–23,057 (Apr. 30, 2021) (to be codified at 40 C.F.R. pts. 51, 52, 78 & 97).

their air quality standards, the amendments created a trading zone of those twelve states, excluding the other nine.[124]

4. Trading with minimums.

An alternative approach is to disallow any trade that causes pollution to rise above a set level at a particular location or locations. The goal is to prohibit trades that generate hot spots but allow all other trades. There are a number of different ways to implement this approach. It was first suggested in what was called an "offset system," which would prohibit trades that result in a violation of an ambient air quality standard at any site.[125] Jonathan Nash and Richard Revesz suggested a nondegradation standard, which would allow trades as long as they do not make any area worse than they were prior to the implementation of the system.[126] These and related approaches can be combined: trades would be allowed only as long as they do not make any area worse than it was before trading and do not violate an ambient air quality standard.[127]

A problem with this approach is that each trade would need separate approval—approval that would require analysis and modeling to determine whether the trade would cause a violation of the minimum standard at distant sites. As a result, this approach may lead to illiquid markets. It might also be path dependent: if two trades combined would violate a minimum at some site but one would not, the trade that comes first would be allowed but the second would not.

5. Exchange rates, trading ratios, or margins of safety.

A final approach to limiting hot spots is to use "trading ratios." With trading ratios, a polluter may have to purchase more than one credit to offset one unit of pollution. Suppose, for example, that pollution from a particular site causes more harm at a distant location than pollution from other sites. We could demand

---

124 *Id.*

125 *See* Alan J. Krupnick, Wallace E. Oates & Eric Van De Verg, *On Marketable Air-Pollution Permits: The Case for a System of Pollution Offsets*, 10 J. ENVTL. ECON. & MGMT. 233, 238–42 (1983).

126 Nash and Revesz, *supra* note 115, at 624–36.

127 For a comparison of these and other minimum standard systems, see TIETENBERG, *supra* note 117, at 97–102.

that that polluter purchase enough credits for each unit of pollution to set the marginal cost of pollution reduction equal to the marginal harm. In principle, we could set ratios between all pairs of polluters to reflect the increase in marginal harm caused by pollution at the purchasing site and the reduction in marginal harm at the selling site.[128] Done correctly, trading ratios would eliminate hot spot problems.

The problem with a complete set of trading ratios is the complexity of estimating each ratio. To eliminate hot spots, the system would need a separate ratio for each pair of polluters because a trade between, say, *A* and *B* will have different downstream effects on victims than a trade between *A* and *C* or between *B* and *C*. As a result, full implementation of a trading ratio system requires a large amount of information and limits trading to bilateral trades rather than allowing trading to occur through a centralized market. Recent work suggests some simplifications that reduce accuracy but allow centralized market trading.[129] In addition, in some settings, such as water pollution, where the flows of pollution are unidirectional, simpler systems might work adequately.[130]

CSAPR is a current example of a trading ratio system that appears to be designed in part to address hot spots. Known in that regulation as the "assurance provisions," these provisions are designed to ensure that each state achieves its targeted emissions reductions by setting ratios for trades between polluters in different states.[131]

---

128 This approach was suggested by Nicholas Z. Muller & Robert Mendelsohn, *Efficient Pollution Regulation: Getting the Prices Right*, 99 AM. ECON. REV. 1714, 1718–19 (2009) *See also* Stephen P. Holland & Andrew J. Yates, *Optimal Trading Ratios for Pollution Permit Markets*, 125 J. PUB. ECON. 16, 18–19 (2015); Antweiler, *supra* note 119, at 43–44; Fowlie & Muller, *supra* note 20, at 601–02. Trading ratios have been used since the early days of emissions trading. They were not, however, designed to address hot spots. *See generally* Robert N. Stavins, *Experience with Market-Based Environmental Policy Instruments*, *in* 1 HANDBOOK OF ENVIRONMENTAL ECONOMICS 355 (K.-G. Mäler & J.R. Vincent eds., 2003). For example, many state-level ozone rules allowed purchase of credits from out of state but at a premium. These systems, however, do not seem to be focused on hot spots. Instead, they are focused on assuring environmental integrity of the system.

129 Antweiler, *supra* note 119, at 45.

130 *See* Ming-Feng Hung & Daigee Shaw, *A Trading-Ratio System for Trading Water Pollution Discharge Permits*, 49 J. ENVTL. ECON. & MGMT. 83, 87–92 (2005) (proposing a simple ratio system for water pollution).

131 Other examples include water quality trading using ratios for nitrogen trading in Long Island Sound, salinity trading in Australia's Hunter River Basin, and phosphorus trading in the Minnesota River. *See* Fisher-Vanden & Olmstead, *supra* note 78, at 159.

B. Measurement Problems

Environmental trading systems depend crucially on the ability of the government to measure pollution.[132] A key reason for the success of the SO_2 trading system was that it used an accurate system of emissions monitoring, ensuring that all emissions were supported by permits.[133] Similarly, the inability to measure forest carbon offsets has led to plausible claims of fraud and systematic overcrediting.[134]

Measurement, of course, is also required for other regulatory mechanisms. Trading does not introduce measurement problems where they would otherwise be absent. Different regulatory approaches, however, may require measuring different things, which means that even for the same environmental problem, different regulatory approaches may face easier or more difficult measurement problems.

In particular, command-and-control approaches that mandate the use of a particular technology need to measure whether the technology is in fact deployed. This may be relatively easy to observe. A trading system addressing the same environmental problem would ideally need to measure the extent of pollution from individual sources. The two regulatory approaches measure different things, and as a result, even if they address the same pollution problem, the measurement issues may be different.

The reason command-and-control regulation in the above example presents fewer measurement problems is that it uses a proxy for pollution—the deployment of a particular technology. This means that while measurement is easy, the control system is likely to be imperfect. The relevant comparison, therefore, is whether a trading system based on imperfect observation, or a proxy for pollution, is worse than a command-and-control system that relies on a (possibly different) proxy.

---

132 For the state of the art in the problem of imperfect measurement in regulatory systems such as cap-and-trade systems, see generally Mark R. Jacobsen, Christopher R. Knittel, James M. Sallee & Arthur A. van Benthem, *The Use of Regression Statistics to Analyze Imperfect Pricing Policies*, 128 J. POL. ECON. 1826 (2020).

133 *See* James Boyd, Dallas Burtraw, Alan Krupnick, Virginia McConnell, Richard G. Newell, Karen Palmer, James N. Sanchirico & Margaret Walls, *Trading Cases*, 37 ENVTL SCI. & TECH. 216A, 218A (2003).

134 *See* Lisa Song, *An (Even More) Inconvenient Truth: Why Carbon Credits for Forest Preservation May Be Worse Than Nothing*, PROPUBLICA (May 22, 2019), https://perma.cc/4WMZ-TYSS.

That is, we want to compare apples to apples: for a given environmental problem, we have some type of measurement technology that can variously measure parts of the problem, such as inputs, the deployment of types of technology or methods, and outputs. All regulatory systems, including trading systems, will have access to that same measurement technology. We want to know how well various regulatory systems work in this setting.

Wetlands banking provides a useful example. The core problem is that we cannot easily measure and aggregate various environmental services that wetlands provide. All regulatory approaches must use a proxy, or what Salzman and Ruhl called a "currency."[135] The command-and-control approach in the Clean Water Act is a flat-out prohibition on development that destroys wetlands.[136] It is a broad and expensive prohibition but uses a relatively easy-to-observe proxy for wetlands services. Wetlands banking tends to use flat acreage as its currency. Because flat acreage does not correspond to wetlands services, wetlands banking can lead to environmental degradation. Salzman and Ruhl suggested that this in fact has occurred for wetlands and that there has been a loss in wetlands services.[137]

Which instrument is better depends on a comparison of the costs and benefits of each approach. A flat prohibition on the destruction of wetlands might better ensure no net loss in wetlands services, but possibly at a greater cost.

C. Morals and Market Failures

A third possible problem with using trading as a regulatory tool is that markets—the buying and selling of items—may be seen as inappropriate in certain contexts. The literature on this broad topic focuses on market inalienability: cases where people may own or possess an item and freely transfer it, but may not buy or sell it.

There is a vast literature on market inalienability. Much of this literature focuses on intensely personal items, such as sex, organs, and surrogate pregnancy.[138] Another major line of scholarship addresses whether people should be able to sell their vote

---

[135] Salzman & Ruhl, *Currencies and Commodification*, *supra* note 73, at 612.

[136] 33 U.S.C. § 1344(f)(1)(E).

[137] Salzman & Ruhl, *No Net Loss*, *supra* note 69, at 341–42.

[138] There are several book-length works on these issues. *See generally* ELIZABETH ANDERSON, VALUE IN ETHICS AND ECONOMICS (1993); MICHAEL WALZER, SPHERES OF

in democratic elections.[139] Although some of the insights from the literature on markets in personal items and on voting might be helpful, my focus is resources, or legal regulation governing areas that are already within a market. Most of the considerations regarding intensely personal items or votes are not relevant in this context.

Within the domain of items already within the market, there are likely many fewer concerns with the use of trading as a regulatory tool. Nevertheless, scholars have identified a number of possible problems with markets that may apply to regulatory trading. The arguments are complex, and I offer only a brief overview here.

The most important problem that we will see in the examples in Part IV is market failure—particularly market failure because of information problems.[140] If the reason for regulating a sector is that actors lack information, using trading as a regulatory tool may not be appropriate. Trades by actors who lack information will not necessarily make them better off. For example, we may regulate conditions of employment on the theory that employees lack the information to evaluate those conditions on their own. If we believed that they had the necessary information to ensure trades make them better off, we might also not need to regulate employment in the first place. And if we think employees lack information and therefore need regulatory protection, they may trade in ways that do not make them better off.

JUSTICE: A DEFENSE OF PLURALISM AND EQUALITY (1983); DEBRA SATZ, WHY SOME THINGS SHOULD NOT BE FOR SALE: THE MORAL LIMITS OF MARKETS (2010); MARGARET JANE RADIN, CONTESTED COMMODITIES (1996); RICHARD M. TITMUSS, THE GIFT RELATIONSHIP: FROM HUMAN BLOOD TO SOCIAL POLICY (Ann Oakley & John Ashton eds., 1997). The number of additional works addressing these issues is vast. *See generally, e.g.*, Alvin E. Roth, *Repugnance as a Constraint on Markets*, 21 J. ECON. PERSPS. 37 (2007) (discussing the sale of kidneys); Martha C. Nussbaum, *"Whether from Reason or Prejudice": Taking Money for Bodily Services*, 27 J. LEGAL STUD. 693 (1998) (discussing the sale of bodies through sex work); Michele Goodwin, *Altruism's Limits: Law, Capacity, and Organ Commodification*, 56 RUTGERS L. REV. 305 (2004) (discussing the commodification of organs). On each of these subjects—legalizing prostitution, the sale of organs, and so forth—there are hundreds of articles.

139 *See generally, e.g.*, Richard L. Hasen, *Vote Buying*, 88 CALIF. L. REV. 1323 (2000); Saul Levmore, *Voting with Intensity*, 53 STAN. L. REV. 111 (2000).

140 For market-failure explanations of inalienability, see generally Lee Anne Fennell, *Adjusting Alienability*, 122 HARV. L. REV. 1403 (2009); Susan Rose-Ackerman, *Inalienability and the Theory of Property Rights*, 85 COLUM. L. REV. 931 (1985); Richard A. Epstein, *Why Restrain Alienation?*, 85 COLUM. L. REV. 970 (1985).

A second potential problem with using markets is that market allocation of a good can lead to inequities because the wealthy can more easily afford to purchase goods than can the poor.[141] The argument has strong intuitive appeal but limited explanatory power. We use markets to allocate many fundamental goods such as food, housing, and education. Rather than prohibiting market allocation of these goods, we provide minimums, such as food stamps, housing vouchers, and free (for lower schools) or discounted (for colleges) public education. Moreover, regulatory trading can address this problem in ways that more standard markets cannot because with regulatory trading, the government gets to assign the initial entitlements (e.g., how permits granting the right to pollute are allocated). By assigning entitlements appropriately, regulatory trading can reduce problems with wealth disparities rather than make them worse. Nevertheless, if participants in a market have unjust background conditions, we need to be cautious when introducing trading.[142]

A final concern with markets, often associated in the environmental context with Michel Sandel, is the claim that the meaning of some goods is degraded by market valuation and exchange.[143] Markets in these goods, it is claimed, crowd out valuable nonmarket norms.[144] In the pollution context, the claim is that cap-and-trade systems change the regulatory message from "pollution is

---

141 *See* Rose-Ackerman, *supra* note 140, at 948–49, 963, 968 (referring to goods and services generally); Hasen, *supra* note 139, at 1329–31 (referring to vote buying).

142 These two problems, information failures and inequities due to unjust background conditions, along with hot spot problems, may together cover the set of problems analogous to environmental justice that arise from the use of markets rather than because of the political system. Therefore, I do not separately discuss EJ concerns here.

143 SANDEL, *supra* note 24, at 112. In the context of highly personal goods or services, the same claim is made by many others. For example, Elizabeth Anderson argued that paid surrogacy changes the intimacy of pregnancy. Elizabeth S. Anderson, *Is Women's Labor a Commodity?*, 19 PHIL. & PUB. AFFS. 71, 82 (1990).

144 SANDEL, *supra* note 24, at 114. The most straightforward case of crowding out is where a substantial motivation for the provision of the good is altruism or other-regarding preferences. Sandel discusses examples such as lawyers who refuse to help the elderly at a discounted rate but would do so for free, *id.* at 121, Swiss villages that more likely to agree to host nuclear waste disposal sites if they are honored rather than paid, *id.* at 114–17, and individuals soliciting charitable donations who perform better when motivated by ideals than when paid. *Id.* at 117–18. While altruism and other-regarding behavior may be present in a wide variety of contexts, they are not likely the central issue in pollution control or in any of the potential trading cases considered below.

bad" to "pollution is okay if you pay to do it." This change in meaning has bad effects because people become more tolerant of pollution.

This concern has been labeled the "semiotic concern." The key criticism of the semiotic concern is that even taking it as currently true about some particular good or service, the meaning of buying and selling that good or service in a market is socially contingent and can be changed.[145] For example, Martha Nussbaum, quoting Adam Smith, has noted that opera singers were viewed like prostitutes who had to be paid exorbitant sums to compensate them for the stigma involved in using their body in public.[146] This social fact, which likely seemed to Smith to be fixed, has quite obviously changed. Opera singers are now lionized as divas. Our views of what is stigmatizing and what is not change over time. The same is true for pollution trading. Many opposed environmental trading, including in CO_2, because it was viewed as akin to an indulgence to pollute.[147] Few do now. As noted, environmental trading is pervasive. Whatever semiotic qualms we once had with environmental markets, few have them now.

Finally, even if we accept the semiotic claim as valid, it may not hold for most of the cases considered here—cases of goods or services that are already embedded in the market and that are already regulated (or are likely to soon be regulated). The inquiry would have to be specific for each good because the semiotic claim is about the meaning of trading in particular goods, not about markets in general.

IV. APPLICATIONS

With this background, we are ready to try to understand the potential for trading to improve the performance of regulations outside of the environmental or natural resources contexts. There are a vast number of areas of pervasive regulation to consider. To

---

145 *See* Jason Brennan & Peter Martin Jaworski, *Markets Without Symbolic Limits*, 125 ETHICS 1053, 1062–66 (2015). For a related discussion, see RICHARD H. MCADAMS, THE EXPRESSIVE POWERS OF LAW: THEORIES AND LIMITS 236–39 (2015).

146 Nussbaum, *supra* note 138, at 694.

147 *See* Gorman & Solomon, *supra* note 13, at 312–13; *see also* SANDEL, *supra* note 24, at 73–75 (supporting the sale of CO_2). *See generally* MARK SAGOFF, THE ECONOMY OF THE EARTH: PHILOSOPHY, LAW, AND THE ENVIRONMENT (2d ed. 2008) (criticizing the use of economics to set environmental policy but supporting the use of trading).

narrow the possible topics, I used the 2015 annual Office of Management and Budget (OMB) report to Congress on the costs and benefits of regulations.[148] Appendix A in that report lists annual benefits and costs of major final rules during the period from 2004 until 2013.[149] Using this list, I identified all regulations with estimated benefits over $1 billion to determine the areas of law where regulations tend to have the highest benefits.[150] A large majority are environmental regulations issued by the EPA, both in number of regulations and their benefits (which are often more than an order of magnitude larger than regulations in other areas). The second major set of regulations were vehicle safety regulations issued by NHTSA, followed by energy efficiency regulations issued by the Department of Energy (DOE) and various rules issued by Health and Human Services. No other agency had more than a small number of regulations with benefits over $1 billion during that ten-year period.[151]

This list excludes independent agencies.[152] OMB lists the number of major rules issued by independent agencies between 2005 and 2014 but not their costs and benefits.[153] During that ten-year period, there were 143 major rules issued by independent agencies (though some of these were jointly issued by more than one agency).[154] Of these, 76%were related to the financial industry.[155]

From this brief survey of the regulatory landscape, we can conclude that the two most important nonenvironmental areas of

148 OFF. OF MGMT. & BUDGET, 2015 REPORT TO CONGRESS ON THE BENEFITS AND COSTS OF FEDERAL REGULATIONS AND AGENCY COMPLIANCE WITH THE UNFUNDED MANDATES REFORM ACT (2015).

149 *Id.* at 97 app.A.

150 Alternatively, we can add up the benefits for each area of law for all major regulations during the ten-year period. The results are the same.

151 The breakdown of regulations with benefits over $1 billion during the period from 2004 to 2013 is as follows: DOE, four regulations related to energy efficiency; Department of Health and Human Services (HHS), two regulations; Department of Housing and Urban Development (HUD), one regulation on the Real Estate Settlement Procedures Act (RESPA); Department of Justice (DOJ), one regulation related to disabilities; Department of Labor (DOL), two regulations related to pensions and one on safety; Department of Transportation (DOT), eight regulations on vehicle safety; DOT joint with EPA, three regulations on vehicle efficiency; and EPA, twenty regulations. OFF. OF MGMT. & BUDGET, *supra* note 148, at 97.

152 *Id.*

153 *Id.*

154 *Id.*

155 *Id.*

regulation are safety regulation and financial regulation. Energy efficiency is a third category but might be thought of as environmental regulation. Because it plausibly falls out of the environmental area of law (energy law overlaps with environmental law but is not the same), I discuss the possibility of trading in energy efficiency briefly below.

This list covers only federal regulations, not federal statutes or state and local laws, so it is incomplete. Based on the current public debate, I believe that immigration, housing prices, employment policies, and big data are or will be central areas of regulation. Immigration trading has been previously proposed,[156] so I add only housing, employment policies, and big data to the list.

I end up with six areas of central importance either to current regulation or potential regulation: safety, big data, energy efficiency, employment, zoning, and finance.[157] Each of these topics is itself vast, so I only analyze select issues within each topic. The goal is to consider the potential to use trading in these areas and, if trading is not helpful, to understand why not.

Before turning to these topics, one answer to the puzzle posed here jumps out from the OMB list of significant regulations: the amounts at stake for environmental regulations are vastly larger than for most other areas of regulation. Given the costs of designing and operating a market, it may simply not be worth using markets in many other areas of regulation. The six areas discussed below, however, may be sufficiently important that if trading is an otherwise desirable tool, it is worth bearing the costs of designing and operating a market.

A. Safety Trading

Since the 1970s, the United States has extensively regulated safety.[158] Agencies whose primary mission is safety include the Occupational Safety and Health Administration (OSHA), the EPA, the National Highway Traffic Safety Administration (NHTSA), the Nuclear Regulatory Commission, the Consumer

---

[156] *See generally, e.g.*, Fernández-Huertas Moraga & Rapoport, *supra* note 88; Schuck, *supra* note 88.

[157] The largest area of pervasive regulation that I do not consider is health care.

[158] For a survey of safety regulation in the United States, see generally W. Kip Viscusi, *Regulation of Health, Safety, and Environmental Risks*, *in* 1 HANDBOOK OF LAW AND ECONOMICS 591 (A. Mitchell Polinsky & Steven Shavell eds., 2007) [hereinafter Viscusi, *Regulation*].

Product Safety Commission, the Food and Drug Administration, and the Consumer Financial Protection Bureau. Safety regulations regularly appear on OMB's list of the most significant regulations.[159] Most safety regulations use prescriptive, detailed rules, often requiring the use of particular technologies.[160] I explore here whether there is room to improve safety regulation with trading. I narrow the discussion to the regulation of workplace safety (primarily through OSHA) and automobile safety (primarily through NHTSA).

1. Workplace safety.

OSHA sets health and safety standards for workplaces. It regulates most private sector employers, all federal agencies, and, if covered in a state plan, state and local agencies. OSHA standards are divided into general industry, construction, maritime, and agriculture, and cover items such as fall protection, exposure to harmful chemicals or dangerous machines, and trenching cave-ins. Most of the standards are prescriptive, often mandating the use of particular technology described in fantastic detail.

To take one example, OSHA promulgated a standard for general industry for ladders.[161] The ladder rungs generally must be parallel, level, and uniformly spaced not less than ten inches or more than fourteen inches apart (as measured between the centerlines of the rungs), with different standards for telecommunication tower ladders, elevator shaft ladders, and step stools.[162] Ladders must be inspected before each work shift, and employees must face the ladder when climbing up or down it, using one hand to grasp the ladder.[163] And so on, for pages and pages. Similar regulations govern a massive number of other everyday technologies such as railings, as well as more exotic technologies, such as complex machines.

---

159 OFF. OF MGMT. & BUDGET, 2018, 2019, AND 2020 REPORT TO CONGRESS ON THE BENEFITS AND COSTS OF FEDERAL REGULATIONS AND AGENCY COMPLIANCE WITH THE UNFUNDED MANDATES REFORM ACT 7 n.7 (2020).

160 *See e.g.*, 29 C.F.R. § 1910.23 (2019) (providing prescriptive, detailed rules on ladders).

161 29 C.F.R. § 1910.23 (2019). "OSHA uses the term 'general industry' to refer to all industries not included in agriculture, construction, or maritime." *General Industries*, U.S. DEP'T LAB., https://perma.cc/T8X4-NQ2W.

162 29 C.F.R. § 1910.23(b)(2) (2019).

163 29 C.F.R. § 1910.23(b)(11)–(12) (2019).

OSHA's prescriptive-standards approach has, by most accounts, not been successful. It does not appear to have led to a significant reduction in workplace fatalities or injuries.[164] For example, although workplace fatalities have gone down since 1970, when the Occupational Safety and Health Act[165] (OSH Act) was passed, the rate of decline after 1970 was slower than the rate of decline before the OSH Act.[166] In addition, OSHA's approach has led to wildly varying costs of safety, usually measured in opportunity cost per life saved.[167] Estimates vary, and have generated significant controversy, but range from a low of about $100,000 per life (in 2002 dollars) for the standards regarding respiratory protection, logging, and electrical safety, to $77 million for the arsenic standard, and $78 billion for the formaldehyde standard.[168]

This wide variation in costs-per-life combined with the lack of overall effectiveness of the current approach indicates that there is room to increase workplace safety and lower costs. To this end, Cass Sunstein in 1991 proposed taxing unsafe workplaces.[169] A tax would impose a uniform cost for all safety violations leading to a given injury, and, therefore, improve the efficiency of OSHA standards. Jonathan Masur and Eric Posner made a similar suggestion twenty-four years later.[170]

Sunstein provided no details on what such a tax would look like or its estimated effects. Masur and Posner suggested that the tax be based on the expected harm from violating OSHA's existing standards.[171] To implement the tax, OSHA would still issue the same sorts of standards as it does now, but it would make them

---

164 For a general review, see Thomas J. Kniesner & John D. Leeth, *Regulating Occupational and Product Risks*, *in* 1 HANDBOOK OF THE ECONOMICS OF RISK AND UNCERTAINTY 493, 511–26 (Mark Machina & Kip Viscusi eds., 2014).

165 29 U.S.C. § 651.

166 *Id.* at 514 fig.9.7. There could, of course, be many factors explaining this, but the lack of clear evidence of benefits from the OSH Act is striking nonetheless.

167 *Id.* at 531.

168 *See* Viscusi, *Regulation*, *supra* note 158, at 630–31 tbl.2 (listing opportunity cost per life saved in 2002 dollars for a variety of safety regulations). This table is based on work by John Morrall of the Office of Information and Regulatory Affairs. *See* John F. Morrall III, *Saving Lives: A Review of the Record*, 27 J. RISK & UNCERTAINTY 221, 222–24 (2003). Morrall's original table was criticized because it included regulations that had been rejected or never adopted. *See* Lisa Heinzerling, *Regulatory Costs of Mythic Proportions*, 107 YALE L.J. 1981, 1984 (1998). The table these values are taken from includes only final regulations.

169 Cass R. Sunstein, *Administrative Substance*, 1991 DUKE L.J. 607, 640 (1991).

170 Masur & Posner, *supra* note 9, at 135.

171 *Id.*

so strict that almost everyone violates them.[172] The sanction for the violation would be set equal to the expected harm from the violation, thereby converting a mandate to comply with a standard to a Pigouvian tax.[173]

Masur and Posner's approach would require individual taxes for each type of harm, which would be informationally intensive and complex.[174] A trading system that lowers the informational burden might instead be built off of a performance-based system. The idea would be to set an overall safety requirement for employers in a given industry and allow employers to choose how to meet it. For example, employers who use ladders and other dangerous equipment would, under current law, have some expected level of employee harm. Employers could be required to maintain, or stay below, that level of harm, but be free to choose which workplace safety measures to adopt in order to do so. The approach would allow flexibility and trade-offs within each employer. Ladders could have fifteen-inch spacing but some other machine could be made safer to offset that risk. Trading among employers could then be allowed, with employers who exceed their overall safety requirement able to sell "safety credits" to employers who do not meet their requirement.

This system may be a substantial improvement over the current approach. The flexibility it allows, both within employers and between employers, should lower costs. Moreover, the system creates incentives to find methods of improving safety and lowering costs because these innovations can be used to generate safety credits that can be sold. And the clear safety target would be easy for the public to understand, allowing better public input into the safety regime. Finally, the system may lower administrative costs. Currently, OSHA is able to inspect only about 1% of employers each year, which means each employer expects to be inspected once a century.[175] Moreover, the inspections are likely to

---

172 *Id.*

173 It appears that Masur and Posner took this approach because the task they set for themselves was to see if there is authority under existing law to impose a Pigouvian tax. Existing law requires OSHA to issue safety standards rather than take a performance-based approach. Therefore, Masur and Posner built their tax on top of safety standards. *Id.* at 119.

174 *Id.* at 138.

175 Kniesner & Leeth, *supra* note 164, at 526. Of course, OSHA can target employers with bad safety records so that their audits are more effective than the simple calculation in the text. But even with targeting, the audit rate is low.

be ineffective because they require examination of an employer's compliance with a vast array of detailed rules. A system that looked at safety outputs such as fatalities and injuries would lower the information requirements for OSHA, allowing broader and more effective monitoring.[176]

The most important objection to this approach is that it fails to address, or possibly exacerbates, the market failure that workplace safety regulation is designed to address in the first place. In particular, a key justification for workplace safety regulation is that workers lack information about safety and, therefore, cannot adequately make the necessary trade-offs between safety and wages.[177] The precise level of worker information about workplace safety is disputed. It is clear that workers have some information. Labor market wages go up with the risk of injury, and workers quit hazardous jobs more frequently than safe jobs (indicating that they learn about safety while at work).[178] Nevertheless, a key justification for workplace safety mandates is the lack of worker information.

With a safety trading system (and also with Posner and Masur's and Sunstein's safety tax), workers would not know the safety level at any given firm. Firms with lower marginal costs of safety would sell credits to firms with high marginal costs of safety, generating interfirm differences in safety. If we believe workers cannot adequately judge safety, these differences may be undesirable. Workers and employers at high-risk firms would not appropriately adjust wages to compensate for the concentrated risk.

Moreover, firms with unsafe work environments may employ workers with weak bargaining power, such as workers from disadvantaged backgrounds, because these workers will be less able to demand compensating changes to their wages. Even if overall safety improves, this concentration of risk among disadvantaged workers might be a problem, a safety parallel to environmental

---

176 OSHA already requires reporting of this data. *See* Improve Tracking of Workplace Injuries and Illnesses, 87 Fed. Reg. 18,528, 18,528 (Mar. 30, 2022) (to be codified at 29 C.F.R. pt. 1904).

177 Kniesner & Leeth, *supra* note 164, at 503.

178 W. KIP VISCUSI, FATAL TRADEOFFS: PUBLIC AND PRIVATE RESPONSIBILITIES FOR RISK 107–08 (1992) [hereinafter VISCUSI, FATAL TRADEOFFS]; *see also* W. Kip Viscusi & Joseph E. Aldy, *The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World*, 27 J. RISK & UNCERTAINTY 5, 18–23 (2003) (demonstrating a risk premium for workplaces with high carcinogenic exposure).

justice. That is, just as environmental trading can concentrate pollution risk in undesirable ways, workplace safety trading may concentrate the risk of workplace injuries in undesirable ways.

It is not clear that this would happen. Safety records and, more particularly, purchases and sales of safety credits, could be made publicly available. Everyone would know, or could easily know, that a firm has purchased safety credits, and as a result, demand adjustments to wages. Moreover, given the ineffectiveness of the current approach, trading has the potential to create large gains. Overall safety levels could be increased at the same cost, reducing the concern. Even firms with concentrated risks might be safer than they are now. Finally, one or more of the solutions to the hot spot problem could be adopted. For example, safety trading could be allowed but not below a specified minimum. Nevertheless, trading may be contrary to be central reason for workplace safety regulation, and, therefore, be undesirable in this context.

2. Consumer products.

The second set of safety regulations I consider are those regulating the safety of motor vehicles. Primarily issued by NHTSA, the regulations provide a large number of detailed standards which car manufacturers must meet. Regulations govern the design of seatbelts, windshield wipers, brake hoses, transmission shift sequences, rearview mirrors, side impact protection, door locks, and dozens more.[179] Each of these standards are described in almost blueprint-level detail. These regulations interact with other rules and government programs, such as speed limits, road design, fuel economy standards; the availability of public transportation, zoning, and remote work arrangements that affect how much, where, and when people drive; and state driver licensing rules, and drunk driving laws. Consumer awareness of risk and driving habits also affect safety. Tort law is layered on top of the NHTSA regulations as an additional method of regulating safety. The topic of automobile safety is overwhelmingly complex.

The question is whether trading can improve on some aspects of this complex mix of regulation. The detailed prescriptive rules

179 *See e.g.*, 49 C.F.R. § 571.208(S4.1.1.2) (2022) (seatbelts); 49 C.F.R. § 571.104 (2012) (windshield wipers); 49 C.F.R. § 571.106 (2017) (brake hoses); 49 C.F.R. § 571.214 (2022) (side impact protection).

issued by NHTSA are an obvious candidate. Rather than prescribing safety systems in fantastic detail, NHTSA could adopt a system that resembles the CAFE standards. It would set an overall safety goal and require each manufacturer to meet it. Manufacturers that exceed the goal could sell their safety credits to manufacturers that fail to meet the goal. Manufacturers could then decide for themselves how best to build safe vehicles.

One problem is that manufacturers do not have full control over the safety of the vehicles they build. For example, weather events generating dangerous road conditions happen more in some years than others. As a result, we cannot actually "cap" the total vehicle-related deaths or other injuries. Deaths per mile driven (rather than total fatalities) has been steadier, showing only modest upticks in recent years from its 2014 low (with the exception of 2020, which had a substantial increase).[180] It might be possible to trade credits based on deaths per mile, though even this is not entirely within the control of manufacturers. If deaths per mile went up in a given year, such as it did in 2020, manufacturers may all fail the standard, and so there would not be any standard-exceeding manufacturers to buy credits from.

Similar problems can arise in environmental markets. For example, if there is a cap on pollution from EGUs in a given time period, unexpected weather conditions, such as an unusually bad heat wave, might mean that EGUs need to produce more electricity, putting pressure on the emissions cap. There are a number of market-design solutions that can reduce the problem.[181] One is to allow trading of permits across time as well as among polluters within any given time period. Trading across time takes the form of "banking" permits in one period to use in a future period, and "borrowing" permits from a future period to use in the current period. Banking and borrowing reduce volatility in permit prices and allow polluters to better plan their operations. In addition, the government can hold a reserve of permits that it can sell to reduce volatility. And finally, some have suggested that there be

[180] For example, after a long period of relatively steady decline, vehicle deaths have been increasing since 2011, in total, per population, and in per miles driven. *See National Statistics (2020)*, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., https://perma.cc/J5NE-5KDV.

[181] In the SO_2 market, permittees must pay a penalty for any overage and must secure permits to make up for that difference in the following year (or later if the EPA Administrator allows them to). *See* 42 U.S.C. § 7651j(a) (2020).

a separate market in "episode" permits which can be used for designated events, such as unexpected heat waves.[182] These types of solutions could be adapted for a vehicle safety market.

A version of environmental justice concerns might arise with vehicle safety trading: less expensive vehicles that low-income individuals can afford might become less safe, while expensive vehicles purchased by people with higher incomes would become safer. It is not clear how to evaluate this claim because the alternative is to force lower-income people to spend more to buy safer vehicles. To the extent it is a problem, minimum safety levels, akin to the solutions for hot spots, could help alleviate it.

I do not think any of the five concerns listed above (measurement, mixing, morals, markets, and margins) are a serious concern for vehicle-safety trading. The most difficult problem is one of market design given that vehicle-related deaths and injuries are not entirely within the control of manufacturers.

3. Summary.

The lack of safety trading may be due to some of the concerns identified above, most importantly that the market failure may be an information failure and that same lack of information may impede trading. Moreover, there may be concerns analogous to environmental justice concerns. Nevertheless, trading in safety seems to be relatively promising, and many of the problems can likely be solved through the design of the market.

B. Efficiency Trading

The Department of Energy (DOE) imposes energy conservation standards and test procedures for residential products and commercial and industrial equipment. To date, it has issued standards for more than sixty categories of appliance and equipment types.[183] As noted, these standards often have sizable benefits, and outside of environmental regulations, are among the most significant regulations issued by the federal government.

---

182 TIETENBERG, *supra* note 117, at 121–23.

183 Energy Policy and Conservation Act (EPCA) (III)(B), Pub. L. No. 94–163, 89 Stat. 871 (1975), *amended by* National Energy Conservation Policy Act (NECPA), Pub. L. No. 95–619, 92 Stat. 3206 (1978); National Appliance Energy Conservation Act of 1987, Pub. L. No. 100–12, 101 Stat. 103; National Appliance Energy Conservation Amendments of 1988, Pub L. No. 100–357, 102 Stat. 671; Energy Policy Act of 1992, Pub. L. No. 102–486, 106 Stat. 2776; Energy Policy Act of 2005 (EPACT 2005), Pub. L. No. 109–58, 119

Energy efficiency standards are individualized: each class of products, such as refrigerators, heat pumps, televisions, and so forth, has its own energy efficiency standard.[184] The reason appears to be that the statute requires this. It sets forth specific energy standards for different products, instructing the DOE to determine whether they should be amended.[185]

Energy efficiency is a relatively easy case for trading. Unless the efficiency standards were set across different products so that the marginal cost is the same, energy efficiency trading should be able to achieve the same aggregate efficiency level at a lower cost.

We already have examples for the design of the system. Energy intensity can be traded in the same way that fuel economy is traded in the CAFE standards for vehicles. A similar system currently exists in twenty-one states where utilities trade energy efficiency using what are called Energy Savings Certificates, or ESCerts.[186] Europe uses a system with White Certificates.[187] India also uses ESCerts for its utilities.[188] Energy efficiency trading is a case where there may be substantial gains and where we understand the market design. There appears to be no good explanation for the lack of energy efficiency trading.

C. Bank Regulatory Trading

Financial institutions routinely fund their operations with short-term debt, such as demand deposits or repos, but often make longer-term investments, such as term loans. Short-term funding combined with longer-term investments, however, generates the risk of a run: when a short-term lender withdraws money from a financial institution, it increases the risk that the financial institution will not have sufficient funds to pay other short-term

---

Stat. 594; Energy Independence and Security Act of 2007 (EISA 2007), Pub. L. No. 110–140, 121 Stat. 1492) (codified as amended at 42 U.S.C. §§ 6291–6317).

184 *See* 42 U.S.C. § 6295.

185 42 U.S.C. § 6295.

186 *See Energy Savings Certificates,* WORLD RES. INST. 1 (Oct. 2008), https://perma.cc/KE9D-H5CQ.

187 For a summary of systems used around the world and a contrary view on their effectiveness, see generally Sachs, *supra* note 53.

188 India's can be found here: *ESCerts Trading*, BUREAU ENERGY EFFICIENCY, GOV. INDIA, https://beeindia.gov.in/content/escerts-trading.

lenders.[189] Lenders, anticipating this problem, may race to withdraw funds when there is bad news.

One of the central approaches to addressing this problem under current law is an approach known as "capital adequacy regulation."[190] Capital adequacy regulations require a financial institution to have equity in its capital structure equal to a certain fraction of its assets (often measured in complex ways to reflect risk). A cushion of capital protects against bank runs because that cushion can be used to pay off short-term debt. While the precise level of the equity cushion that should be required—and how to measure it—is subject to significant debate, most scholars of the financial system agree that some version of minimum capital ratios is desirable.[191]

Capital adequacy rules are, in the terms used here, an intensity requirement. They do not limit the total amount of short-term debt, so they are not a quantity limit. Instead, they limit the amount of short-term debt relative to equity, which is simply the intensity of the use of short-term debt. The question is whether trading around this intensity limit can improve capital adequacy regulations.

Before addressing the possibility of capital-intensity trading directly, note that because of the tremendous flexibility in financial markets and the cleverness of bankers, there are already versions of capital adequacy trading in the markets. Known as capital relief trades, they allow banks with insufficient equity relative to their overall (risk-weighted) capital to shift risk to entities that have adequate capital or that are unregulated.[192] The structure of these trades is complex and beyond the scope of this Article, but the core idea is that a third party agrees to assume some fraction of losses on risky assets held by the financial institution, effectively lowering the denominator of its capital ratio.

Capital relief trades are not quite the same thing as intensity trading. The goal of capital relief trades is to actually transfer risk

189 *See generally* Douglas W. Diamond & Philip H. Dybvig, *Bank Runs, Deposit Insurance, and Liquidity*, 91 J. POL. ECON. 401 (1983). For a simple explanation of these results, see generally Douglas W. Diamond, *Banks and Liquidity Creation: A Simple Exposition of the Diamond-Dybvig Model*, 93 FED. RSRV. BANK RICHMOND ECON. Q. 189 (2007).

190 *See* Eric A. Posner, *How Do Bank Regulators Determine Capital-Adequacy Requirements?*, 82 U. CHI. L. REV. 1853, 1853–54 (2015).

191 *See id.* at 1863 n.40.

192 *See* Michael Rapoport & Ryan Tracy, *The Hot Thing for Wall Street Banks: Capital-Relief Trades*, WSJ, Aug. 18, 2015.

to third parties. Intensity trading is nominal: If a polluter buys pollution credits from a different polluter, the first polluter continues to pollute more than otherwise allowed. The pollution itself is not transferred. Nevertheless, capital relief trades are a close cousin to intensity trading in the sense that they allow a financial institution to meet capital adequacy requirements with minimal changes to its business practices.

Capital-intensity trades, as opposed to capital relief trades, would involve a financial institution with a capital ratio in excess of its required ratio receiving a credit—just a piece of paper—that it could sell to financial institutions with capital ratios below their requirements. There would be no movement of actual capital or risk. As with other types of trading, the rationale is that trading would allow firms that can more easily have high capital ratios—that is, firms that have lower marginal costs of having a high level of capital—bear those costs.

A key effect of capital-intensity trading is that some firms would be below the required capital level while some firms would be above it. It would create an average capital level for all regulated financial firms but would not guarantee that any given firm is at that level. Whether this makes sense depends on whether we care about average capital levels or the capital level of each firm.

I am not aware of modeling on this issue. In many cases, ensuring the overall or average capital level of financial firms should suffice. If a firm with low capital levels loses money and is at risk of a run, firms with high capital levels can bail them out and, in fact, have an incentive to do so because they can purchase the entity at a fire-sale price. This is precisely what happened with Long-Term Capital Management: firms that were better capitalized were able to step in to prevent its collapse, and those firms made money by doing so.[193] On the other hand, capital-intensity trading might make things worse because it would make it harder for outsiders to know whether any given firm is adequately capitalized. In a crisis, this could generate real problems.[194]

---

193 Franklin R. Edwards, *Hedge Funds and the Collapse of Long-Term Capital Management*, 13 J. ECON. PERSPS. 189, 197–200 (1999); ROGER LOWENSTEIN, WHEN GENIUS FAILED: THE RISE AND FALL OF LONG-TERM CAPITAL MANAGEMENT (2001).

194 John Cochrane suggested a Pigouvian tax on short-term debt as an alternative to capital adequacy regulation. John H. Cochrane, *Toward a Run-Free Financial System*, *in*

We can characterize the difference between requiring specified capital levels at individual firms and requiring an overall capital level for the financial sector as a hot spots problem. Holding the overall level of capital the same, it may matter which firms hold that capital, the same way that when holding the level of pollution the same, it may matter which firms pollute. This means that the solutions to the hot spots problem may help here. For example, we could allow trading down to a specified capital ratio floor and no more, akin to a trading minimum for hot spots discussed above. Similarly, trading could be subject to trading ratios. For example, the trading ratio might go up as an individual firm's capital level goes down, making it more expensive the lower the capital level.

To summarize, bank regulatory trading may (or may not—we do not know) suffer from a hot spot problem, which potentially explains the lack of trading. Solutions to the hot spot problem from the environmental context, however, may allow us to solve the problem in the financial institutions context.

D. Zoning Trading: Reverse Transferable Development Rights

As a number of authors have observed, house prices have gone up in many areas of the country to levels that are unaffordable to most people, and housing policy is reaching crisis levels.[195] Roderick Hills and David Schleicher called it a "national catastrophe."[196] Christopher Elmendorf and Darien Shanske noted that "the vision of the thriving city as an engine of socioeconomic mobility is increasingly a thing of the past."[197] The core problem is that incumbent landowners often oppose increasing housing supply or density (known as Not In My Back Yard or NIMBY), and

---

ACROSS THE GREAT DIVIDE: NEW PERSPECTIVES ON THE FINANCIAL CRISIS 197, 198–99 (Martin Neil Baily & John B. Taylor eds., 2014). A tax would have exactly the same information problem. His key argument for using a tax instead of a trading system is a Weitzman-type argument that the marginal benefit curve for additional capital is flat. *See id.* at 217 ("The top of a hill is flat."). The marginal cost curve may also be relatively flat. As Cochrane argued later in his paper, there may be little or no cost to requiring banks to finance with more equity. *See id.* at 220–25; *see also* ANAT ADMATI & MARTIN HELLWIG, THE BANKERS' NEW CLOTHES: WHAT'S WRONG WITH BANKING AND WHAT TO DO ABOUT IT 94–97 (2013) (arguing for very high equity requirements).

195 Hills & Schleicher, *Building Coalitions*, *supra* note 4; Christopher S. Elmendorf & Darien Shanske, *Auctioning the Upzone*, 70 CASE W. RES. L. REV. 513, 516–17 (2020).

196 Hills & Schleicher, *Building Coalitions*, *supra* note 4, at 81.

197 Elemendorf & Shanske, *supra* note 195, at 516–17.

because they are incumbent, they have undue influence over housing policy. The result is a lack of affordable housing and reduced mobility with potentially significant overall costs,[198] including possibly reducing the growth of the national economy.[199]

A prominent, and perhaps the only long-term, solution to this problem is to increase the supply of housing in areas where demand is high. Increasing housing supply requires changing local zoning rules that restrict new building, known as "upzoning." Zoning changes, however, are routinely blocked by local constituents.[200] It is far easier to say we should change zoning rules than to actually do so.

Recent work attempting to find solutions to this problem has incorporated trading or other market mechanisms, focusing on how these mechanisms can help solve *political* as opposed to economic problems. The key idea is to allocate the returns from market-based mechanisms to the sympathetic or powerful. These groups would then stand to gain from increasing the housing supply. The possibility of gaining these returns can allow these individuals or groups to form coalitions that can change the local political dynamics of zoning.

For example, Hills and Schleicher examined how transferable development rights can be used to build coalitions in favor of increasing the housing supply.[201] Transferable development rights, analyzed in *Penn Central Transportation Co. v. City of New York*,[202] involve the sale of the right to build by an area that is otherwise restricted to areas that are not. They are about making building *restrictions*, such as a prohibition on building above

198 A recent paper estimated that the "tax" due to zoning restrictions was approximately $400,000 for a quarter-acre lot in San Francisco. *See* Joseph Gyourko & Jacob Krimmel, *The Impact of Local Residential Land Use Restrictions on Land Values Across and Within Single Family Housing Markets*, J. URB. ECON., July 1, 2021, at 1, 2. Elmendorf and Shanske estimate zoning restrictions in San Francisco cost about $430 per square foot. Elmendorf & Shanske, *supra* note 195, at 544; *see also* David Schleicher, *Stuck! The Law and Economics of Residential Stagnation*, 127 YALE L.J. 78, 115–21, 127–35 (2017) (suggesting that there may be substantial macroeconomic costs to housing restrictions); Edward L. Glaeser & Joseph Gyourko, *The Impact of Zoning on Housing Affordability* 5–6 (Nat'l Bureau of Econ. Rsch., Working Paper No. 8835, 2002) (finding that zoning restrictions create high housing prices).

199 *See* Edward Glaeser & Joseph Gyourko, *The Economic Implications of Housing Supply*, 32 J. ECON. PERSPS. 3, 5 (2018).

200 *Id.* at 6–7, 27.

201 Hills & Schleicher, *Building Coalitions*, *supra* note 4, at 81–84.

202 438 U.S. 104 (1978).

the Grand Central Terminal, less costly. Hills and Schleicher argued that if the rights to receive transferable development rights are given to popular or politically influential owners, these groups will have an incentive to form a coalition in favor of development.[203]

Alternatively, Elmendorf and Shanske argued that allowing municipalities to more easily capture more of the gains from upzoning will create incentives for political entrepreneurs to form coalitions in favor of increased housing supply.[204] To do this, they suggested that municipalities auction zoning permits. Buyers in the auction could them sell them in a market. Developers would have to assemble sufficient permits, either at the initial auction or on the secondary market, to meet whatever increase in zoning they require.

These proposals illustrate how markets can be used to allocate returns from zoning changes to overcome the political constraints on housing supply. Building on these ideas, consider a third approach more closely aligned with trading in the environmental context. The approach builds on successful upzoning in the past several years around the country, which all followed a similar pattern.

The most prominent recent example of successful upzoning was the Minneapolis 2040 urban plan.[205] The 2040 plan did many things to reduce housing costs, such as increasing housing density along transportation corridors, but among the most striking change was that it effectively eliminated single-family zoning by allowing up to three dwelling units on individual lots in areas that were previously primarily single-family zoned.[206]

Similar state-level initiatives passed in Oregon (in 2019)[207] and in California[208] and Massachusetts (in 2021).[209] The Oregon law requires medium-sized cities to allow duplexes in areas zoned

---

203 Hills & Schleicher, *Building Coalitions*, *supra* note 4, at 83–84.

204 Elmendorf & Shanske, *supra* note 195, at 546.

205 *See* City of Minneapolis, *Access to Housing*, MINNEAPOLIS 2040, https://perma.cc/RP3C-WY3U.

206 *Id.*

207 H.B. 2001, 80th Leg. (Or. 2019).

208 S.B. 9, 2021–2022 Reg. Sess. (Cal. 2021).

209 H.5250, 191st Leg. (Mass. 2021). For a summary, see Daniel J. Bailey, Paula M. Devereaux, Gareth I. Orsmond, Donald R. Pinto, Jr. & Joel Quick, *Massachusetts Makes Broad Changes to the Zoning Act*, NAT'L L. REV (Jan. 16, 2021), https://perma.cc/QHH9-5EUV.

for single-family housing. Large metro areas, including Portland, are required to allow people to build duplexes, triplexes, fourplexes, cottage clusters, and town houses in residential areas.[210] The California law eliminated single-family housing within cities on a state-wide basis.[211] The Massachusetts law allows multifamily or mixed-used development as of right in eligible locations and accessory dwelling units on the same lot, also as of right.[212]

The key factor in all these cases is to impose the burden of increasing housing density in what was perceived to be a fair manner, often based on an equality principle, such as "everyone bears an equal burden." Overall, there are large gains from increasing housing supply, but no one group wants to bear the costs on its own. By making everyone share equally, an equal-burden requirement can overcome collective action problems in the zoning context.[213] It appeals to a kind of folk wisdom of everyone helping.

While fair-share or equal-burden approaches may be able to overcome collective action problems, they do not necessarily result in a good allocation of the resulting resource, in this case additional density. Like a simple command-and-control regulation that applies equally to all actors, a fair-share allocation may fail to take advantage of differing cost structures that actors face.

For the same reasons that trading can improve on command-and-control outcomes in the environmental context, trading may be able to improve on an equal-burden zoning rule in the housing context. That is, trading may allow a municipality to combine the advantages of equal burden sharing to overcome collective action problems without the inefficiencies that equal burden sharing would impose.

---

210 H.B. 2001, 80th Leg., 2019 Reg. Sess. (Or. 2019).

211 S.B. 9, 2021–2022 Reg. Sess. (Cal. 2021).

212 H.5250, 191st Leg. § (19)(1) (Mass. 2021).

213 Roderick M. Hills, Jr. & David N. Schleicher, *Balancing the "Zoning Budget"*, 62 CASE W. RES. L. REV. 81, 120–24 (2011) (suggesting an equal burden-sharing requirement can overcome collective action problems with zoning); *see also* David Schleicher, *City Unplanning*, 122 YALE L.J. 1670, 1720–23 (2013) (arguing that zoning policy design can stimulate development). *See generally* Roderick M. Hills, Jr. & David Schleicher, *Planning an Affordable City*, 101 IOWA L. REV. 91 (2015) (outlining how zoning influences housing market supply and demand).

The basic idea is to upzone a metropolitan area, solving collective action problems via a fair-share or equal-burden mechanism. Then, allow landowners to trade the new density requirements in a market, allowing the additional housing to be built where it is most efficient. Areas that do not want the additional density—e.g., they want to stay single family—could sell, or pay someone to take, the additional density. Areas that want the additional density, or are willing to be paid to accept it, would acquire it.

To illustrate, imagine a city with mostly single-family zoning, perhaps with higher-density zoning near transportation hubs and downtown. Either all or most of the city would be upzoned, so that whatever density limitation is currently in place would be increased. (Alternatively, the fair-share mechanism could be tailored in some way, as was done in Minneapolis, Oregon, and California.) Each lot would be allocated one additional "density unit" for each housing unit currently allowed. The density units can be traded in a market, so that if someone wanted to build a four-unit building in what is now a single-family zone they would acquire two additional density units in the market (they have one to start, they get one new one through the upzone, so they need two more).

A leafy single-family neighborhood that wants to stay that way could collectively transfer the additional density units to landowners in areas that are willing to accept more housing. The leafy neighborhood would remain single-family while the area accepting the density would now allow triplexes or greater density. The price of density might be negative in the sense that the leafy neighborhood would have to pay the accepting regions to take the density. Everyone would face an equal or fair burden, but the market would ultimately determine where the additional housing got built.

There would be a number of important hurdles in designing the market. One is analogous to the hot spot problem: excessive local density. The problem would arise if a developer acquired a large number of density units and used them to build in excess of some reasonable limit for that location. Any harm from very high-density housing (if there is a harm) would be concentrated in the local area, much like pollution concentration. Perhaps this is not a harm—very high density might be good—but if it is a harm, one of the hot spot solutions might be needed. For example, there could be caps on using density units based on the underlying density of the surrounding area (akin to the "trading minimums" solution to hot spots). Alternatively, increased density above some threshold might require more than one density unit, like a trading ratio.

A second market-design problem would be fraudulent transfers similar to the problem with wetlands banks. Suppose a neighborhood that wants to stay single-family has to pay to get rid of their density units—the price is negative. Rather than selling density in the market, they could sell it at a nominal fee to a "developer" who has no intention of using it. One solution is to require purchases and sales to go through a centralized exchange or "zoning bank" with the bank constrained to sell density to developers with plausible plans to use the density units. The trades could be canceled if the units are not built within a specified time period, perhaps with a penalty to avoid gaming.

To summarize, these and other problems mean that market design would require attention and care. With proper design, however, a density market might make upzoning more palatable to many landowners, resulting in less opposition and more overall housing supply as well as more efficient housing location. The Hills and Schleicher transferable development rights proposal or the Elmendorf and Shanske auction approach are alternatives, and elements of all three ideas can be combined. What is clear is that there is very likely room for trading to help solve the housing crisis we currently face.

E. Big Data

The collection and use of personal data may be one of the central regulatory problems in the immediate future. One concern is privacy. The aggregation of large volumes of personal data allows firms to create personalized environments for their customers but also to potentially invade their privacy. Privacy concerns can arise because of how companies use personal data (including possibly discriminatory uses), because of the loss of anonymity, and because of leaks of personal data.[214]

A second distinct concern is that the large-scale use of personal data may create external effects—that is, effects on third

---

[214] *See* EXEC. OFF. OF THE PRESIDENT, BIG DATA: SEIZING OPPORTUNITIES, PRESERVING VALUES 39–47 (2014).

parties as well as society as a whole. For example, collection of data from one group of users may allow a data collector to train algorithms or otherwise use the data when it interacts with other individuals, such as by targeting those other individuals with false information. Targeting individuals with false information can, in turn, harm society because individuals exposed to false information may take harmful actions.

I focus here on this second problem, which Omri Ben-Shahar analogized to pollution.[215] Because "data pollution," to use his term, affects third parties, contractual remedies or remedies that focus on duties between data providers and data collectors cannot cause parties to internalize these costs. As a result, Ben-Shahar has suggested using the tools of environmental law, such as command-and-control regulations, Pigouvian taxes, and liability rules, to control these externalities.[216]

Most relevant for our purposes, Ben-Shahar has suggested imposing a Pigouvian tax on the provision of data. The purpose of the tax is to cause providers and collectors to internalize the harms (net of benefits) from data aggregation. The tax would be imposed at the point of data collection, such as the sale of a good on a website. It would be remitted by the consumer to emphasize to people the costs they impose on society when they give up their data.

The tax rate itself would be equal to the marginal external harm (net of benefits) from the data provision. Ben-Shahar emphasized that estimates of these harms would be highly uncertain.[217] Indeed, a given provision of data might have benefits or costs, depending on how it is used, but its use may not be known

---

[215] Omri Ben-Shahar, *Data Pollution*, 11 J. LEGAL ANALYSIS 104, 110–18 (2019); *see also* Jack M. Balkin, *The Fiduciary Model of Privacy*, 134 HARV. L. REV. F. 11, 14–16 (2020) (arguing for fiduciary responsibilities on the behalf of data companies); Dennis D. Hirsch, *Protecting the Inner Environment: What Privacy Regulation Can Learn from Environmental Law*, 41 GA. L. REV. 1, 23 (2006) (arguing that "[t]he privacy injuries of the Information Age are structurally similar to the environmental damage of the smokestack era" because of negative externalities and problems of collective action). *See generally* Jack M. Balkin, *2016 Sidley Austin Distinguished Lecture on Big Data Law and Policy: The Three Laws of Robotics in the Age of Big Data*, 78 OHIO ST. L.J. 1217 (2017) (calling for a set of rules to ensure that big data is a beneficial resource); A. Michael Froomkin, *Regulating Mass Surveillance as Privacy Pollution: Learning from Environmental Impact Statements*, 2015 U. ILL. L. REV. 1713 (2015) (analogizing data pollution to environmental pollution and suggesting a regime like NEPA).

[216] Ben-Shahar, *supra* note 215, at 133–48.

[217] *Id.* at 139.

at the time of provision. For example, the provision of data to Facebook may have external benefits, such as allowing Facebook to customize other users' experiences. But Facebook appears to have used personal data to distribute false political ads, generating widespread harm. Whether the provision of any individual piece of data has net positive or net negative benefits may not be known at the time the data is provided, which would make determining the appropriate tax rate hard.

A data tax would also need a definition of a unit of data. Is my purchase of a Beanie Baby on a given date and location the same size unit of data as information that I drove to the grocery store and purchased takeout sushi, and is that the same size unit as my web searches for articles of an intimate nature?[218] Ben-Shahar has suggested that the tax should be tailored for different kinds of data (e.g., sensitive data would be taxed at a higher rate than less sensitive data) and type of collector (e.g., collectors that cause greater external harms would face a higher rate).[219] That means that what is needed is a set of multipliers, where different types of data are treated as differently sized units of data, relative to some base unit (e.g., the purchase of a Beanie Baby on a given date and location).[220]

Let us suppose that a data tax is workable and provides benefits that ex post remedies, such as bans on inappropriate use of data, cannot (or that a data tax can usefully be used in conjunction with ex post remedies). The question is whether trading can also work and how it compares to a data tax.

The basic design could be similar. However, a trading system would work better if imposed on data collectors, rather than on data providers. The reason is that it would be far more difficult to require individuals to function within a trading system than it would be to require the businesses that collect data to do so.

Imposing the system on data collectors may have other advantages. As Ben-Shahar noted, the expected harm may vary by the type of data collector and by the volume of data that any one entity has. By imposing the trading system on collectors, it can be

---

218 Ben-Shahar has suggested that the problem of defining a unit of data is unique to trading systems. Ben-Shahar, *supra* note 215, at 137 (discussing problems with defining a unit of data in the trading context). But the problem arises in the tax context as well and should be largely identical in both places.

219 *Id.* at 141.

220 *See id.* at 146.

tailored to take these factors into account. For example, if larger collections of data have the potential to do greater harm than smaller collections, the permit requirement could go up nonlinearly with the volume of data that any one collector has.[221] Similarly, permit requirements could be greater for data types that are more likely to cause external harms.

Ben-Shahar's chief concern with a trading system is that a trading system would have to impose quantity or intensity limits.[222] It is not clear what these limits should be, or even how they would be defined, given that data is nonrivalrous. Data in this sense is not like pollution where there is a physical amount that we can measure and limit.[223]

There may be some solutions to Ben-Shahar's concerns, both through careful definition of when a permit is needed and through design of the trading system. For example, quantity limits can be made flexible by having the government issue more permits and buy back permits when price goes above or below limits. Applying the system only to large data collectors reduces concerns about new entrants. The problem of duplication might be solved by focusing on use rather than holding.

A remaining question is whether a tax or a permit system is preferable in this context. The design considerations are roughly parallel, and, as I have written before, their core attributes are basically the same.[224] The framing of the two policies, however, is different, and framing seems to matter to both design decisions and public support. It is not clear which is better in these regards, so it is valuable to have both under consideration.

Summarizing, a key problem with data trading (and with a data tax) is market design. Measurement presents a persistent challenge: it is difficult to measure a unit of data, to determine who holds it, and to determine what the appropriate limits or caps should be. These measurement problems may be too large to overcome.

---

221 This is a hot spot problem: the overall harm depends on which entities are expected to pollute. A permit requirement that depends on the volume of data is akin to a trading ratio.

222 *See* Ben-Shahar, *supra* note 215, at 135–36.

223 *Id.*

224 *See* David Weisbach, *Instrument Choice is Instrument Design*, *in* U.S. ENERGY TAX POLICY 113, 117–32 (Gilbert Metcalf ed., 2011).

F. Minimum Wage Trading

The final area of pervasive regulation that I consider is employment. Stagnating wage growth among low-wage earners is one possible contributor to growing inequality.[225] Among the most debated responses is to increase the minimum wage. The effects of doing so are likely complex and subject to substantial empirical uncertainty.[226]

Although just about everything about the minimum wage is disputed, one aspect that I believe is not is that the minimum wage is for the most part a uniform rule that does not take into account the different types of individuals and companies that it affects.[227] There is, however, no reason to think that either the costs or the benefits (in terms of poverty reduction or some similar measure) are uniform. This problem has the same structure that other problems have where trading is helpful: trading helps tailor uniform command-and-control regulations to the circumstances of individual actors. A question, therefore, is whether trading can help in the minimum wage context.

The core idea for minimum wage trading would be that firms that pay workers above the minimum wage would earn credits that they could sell to firms that pay workers below the minimum wage. For example, if trading applied to fast-food hourly workers in a municipality, and the minimum wage were $15 per hour, fast-food franchises paying wage earners below $15 per hour would have to buy credits to offset those low wages from fast-food franchises paying wage earners above $15 per hour.

There are a number of immediate hurdles to implementing this scheme, hurdles that perhaps cannot be overcome. To start, trading of this sort would transform the minimum wage from a

---

225 Kevin M. Murphy & Robert H. Topel, *Human Capital Investment, Inequality, and Economic Growth*, 34 J. LABOR ECON. S99, S102–12 (2016).

226 The literature is extensive. *See generally, e.g.*, Alan Manning, *The Elusive Employment Effect of the Minimum Wage*, 35 J. ECON. PERSPS. 3 (2021); Thomas MaCurdy, *How Effective Is the Minimum Wage at Supporting the Poor?*, 123 J. POL. ECON. 497 (2015); Doruk Cengiz, Arindrajit Dube, Attila Lindner & Ben Zipperer, *The Effect of Minimum Wages on Low-Wage Jobs*, 134 Q.J. ECON. 1405 (2019); Peter Harasztosi & Attila Lindner, *Who Pays for the Minimum Wage?*, 109 AM. ECON. REV. 2693 (2019).

227 There are some exceptions, such as for waiters. In addition, because the federal minimum wage has not been changed, states and localities have adjusted their minimum wage, effectively allowing tailoring to local conditions. *See, e.g.*, S.B. 437, 54th Leg. 1st Sess. 2019 (N.M. 2019) (increasing New Mexico's minimum wage above the federal minimum wage).

minimum to an average. To illustrate, suppose a community established a $15 minimum wage with trading. Firms that pay workers, say, $20 per hour could sell the excess wages to firms that pay workers less than $15 per hour. On average, wages would be $15 per hour, but some firms would be above that and some below.

An average wage law would likely have different motivations than a minimum wage law. Increasing average wages might, for example, increase overall prosperity and reduce poverty, but it would not guarantee that every individual earns some minimum amount. A community might care as much, if not more, about the former as the latter, or vice versa. Similarly, one argument for the minimum wage is that employers have power in setting wages because of market concentration.[228] In this case, we care about raising the average wage, not the minimum.

A second hurdle, mentioned above, is that many firms pay wages far above the minimum for many classes of workers (e.g., professional services firms, such as firms of doctors or lawyers). Even a small number of these firms within the trading system might generate enough wage credits to effectively nullify the minimum wage for other workers.

There are a number of possible solutions. One, suggested in the example given above, is to allow trading only within particular classes of workers, such as nonmanagerial workers at food establishments or certain types of establishments.[229] The logic for this approach is similar to the logic for using trading zones to limit hot spots.

An alternative, possibly complementary, solution is to phase out the credits as workers' wages go up. For example, the goal might be to increase average wages among low-wage workers. Increasing someone's wages from $50 to $60 per hour would not help offset the harms of paying other people below $15 per hour. If this is the goal, credits might be generated only for workers below some wage level. To avoid a cliff effect, the credits could be phased out.

---

[228] *See* Manning, *supra* note 226, at 21–22 & 21 n.7; ERIC A. POSNER, HOW ANTITRUST FAILED WORKERS 24–29 (2021).

[229] A large fraction of workers earning the federal minimum wage have food-preparation and service jobs. *See Characteristics of Minimum Wage Workers*, BUREAU LAB. STATS. (Feb. 2021), https://perma.cc/M5HA-GE93.

The final and most significant hurdle to minimum wage trading is that the trading is in money rather than in some other unit, such as pollution. To illustrate, if the minimum wage were $15, it would cost a company $1 more to pay a worker $16, and a company would save $1 if it pays a worker $14. There would be no benefit to the company that wishes to pay $14 to pay a $1 to the company paying $16. A dollar is always worth a dollar, so there would be no benefit to trading. In equilibrium, therefore, there would be no trades. Nobody offers to sell dollars in exchange for dollars.

The possible saving feature is that the market may often be out of equilibrium because of entry and exit of firms. For example, a firm who pays workers $18 per hour may enter a market and have $3 credits to sell. If it sells them for less than $3, it makes money and the firm buying them makes money. Until the price is bid up to $3, there could be trades. In effect, minimum wage trading can be thought of as a way to encourage entry into a community of higher wage jobs.

V. Lessons and Conclusions

This Article started with a puzzle: Why is trading so pervasive in the environmental context but rarely used in other contexts? I tried to answer this by (1) understanding trading in the environmental context, including where it has been used, what the problems have been, and what solutions are available; and (2) using this learning to see whether trading is feasible in a number of highly regulated nonenvironmental contexts.

I draw several lessons from this exercise, each a partial answer to the puzzle. First, environmental regulation often has more at stake than other areas of regulation. Given the costs of setting up a market and keeping it up and running, it may not be worth using trading systems in many areas of regulation.

Second, in some nonenvironmental areas of law, trading may not be the best regulatory approach. For example, addressing externalities from data collection may best be done through other regulatory approaches. Minimum wage trading and zoning trading may not be feasible, and, in the case of the minimum wage, trading would change the nature of the regulatory constraint.

Finally, there are likely unexploited opportunities for trading in nonenvironmental contexts. In these cases, the lack of trading might just reflect the slow diffusion of ideas and inertia. Trading was initially developed in the environmental context, and its use in other places may just be a matter of proper market design and time.