



The Hidden Disequities of Carbon Trading: Carbon Emissions, Air Toxics, and Environmental Justice

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So long as transaction costs are low, the creation of a tradeable permit to emit carbon should allow bargaining for emission rights among buyers and sellers, resulting in an efficient allocation of carbon emission rights. However, the trading of carbon credits may have socially unjust consequences. In this article, we explore some hitherto unrecognized disequities. One of these may be the creation of toxic hotspots as the trade of carbon may bring with it a transfer of air toxics, as well. We illustrate the argument by examining emissions from refineries participating in California's cap-and-trade program. These considerations are a concern for the larger question of carbon mitigation as the global community strives to identify feasible, yet just, approaches to reducing greenhouse gas emissions. Contrary to the idea of alienable rights, the transfer of carbon affects people and place in ways not internalized by these market instruments.

Keywords: carbon trading, ethics, environmental justice, public policy, air toxics, cap-and-trade

INTRODUCTION

How should the global community govern in the area of climate change mitigation? One way is through command-and-control regulation. Suppose a central government were to simply require each carbon emitter to reduce its emissions by a set amount (e.g., 30%). This disadvantages each emitter to differing degrees, since the opportunity cost of giving up a unit of carbon is higher for some than others. Should the government try to allocate carbon reduction requirements (or, what amounts to the same, carbon emission permits) in some way that accounts for these? But this introduces the complex problem of having to figure out how much each emitter should emit, which is a daunting task for a government agency.

The solution to this problem in governance, as Ronald Coase proposed, was to create a tradeable instrument (Coase, 1960). Rather than have government dictate each party's actions through direct (command-and-control) regulation, a market would be created wherein parties could bargain for the right to determine their actions. For the case at hand, this would be a carbon emission permit, allowing the bearer the right to emit a certain tonnage of carbon each year, that could be bought and sold between parties. So long as the costs of inter-party transactions are low and there are numerous sellers and buyers, then this arrangement should lead to negotiations between parties that results in a reduction in total carbon emissions in the most efficient manner possible.

For example, if it costs party A twice what it costs party B to reduce a unit of carbon, then A could pay B an amount in between A's and B's unit cost, so that B would reduce additional carbon on behalf of A, who would then not need to reduce its own emissions. In such an arrangement, both parties are better off, financially, than the command-and-control solution of each party reducing its carbon a pre-determined amount.

Arguments against the trading solution often involve the non-trivial nature of transaction costs and thinness or markets – in these cases, trading would not lead to the Pareto optimal solution. Most revolve around imperfections in the market, while invariably validating the general notion of the market-based solution.

To be sure, the economics literature has been paying attention to inequitable outcomes of market processes (more recently, by Piketty, 2014 and Stiglitz, 2012). Their point is that, unless there is intervention in or oversight of markets, that the “haves” can take advantage of imperfections in the markets (such as monopolies, rentseeking, and asymmetric information) to increase their relative wealth over the “have nots.” This informs the present reflection, where we slightly modify the above point to include the increasing exposure of the “have nots” to adverse conditions compared to the “haves.”

Scholars of ecological economics have pushed this point further by arguing that markets are inherently deficient in many ways that further inequity. Some scholars suggest that, in many cases, market corrections, such as pricing carbon, can address these (as suggested by Daly, 2007). Other scholars maintain that there are fundamental reasons, such as incommensurable values (in the sense of being non-translatable to utility) that prevent such market adjustments from correcting the inequity (see Spash, 2020 for a review). Our position is to be open to both possibilities. As we discuss below, one issue is that of co-pollutants, which are air toxics that may be “traded along” with carbon when a firm purchases carbon credits. It may be that pricing co-pollutants into the trading regime may suffice to internalize the externalities discussed below. Then again, exposures to these co-pollutants may introduce effects, such as decreases in life span among community residents, that may be incommensurable.

While we do not attempt any extensive review of the literature on carbon trading, we hazard to guess that many proponents of cap-and-trade unwittingly adopt an ideological bias to their analyses – i.e., markets as the core principle on which their scholarship is based. But beyond these, there are other considerations that lie outside the (Coasean) political economic model and which deal with some potentially unjust consequences of trading. We take up some of these concerns in the next section.

POTENTIAL DISEQUITIES

There are a number of persistent issues with carbon trading. Some of the problem can be traced to the imperfect design of carbon markets, such that Coase's conditions are not met. For example, a true Coasean situation would allow all stakeholders, including community residents affected by factory emissions, to participate in the bargaining. While, strictly speaking,

some carbon markets (such as California's) allow everyone to participate in concept, practically speaking, residents would not be able to due to limitations in ability to pay, collective action problems, and the refusal to recognize the need to pay to keep their environment clean.

Scholars have raised ethical questions vis-a-vis carbon trading. One is the question of inalienable rights, or the ethics of allowing an entity to pay another to avoid meeting its ethical obligation (Caney and Hepburn, 2011). Another is the possible incommensurability of some goods (Aldred, 2012) – as the tragedy that may be wrought by global climate change may simply not be translatable into monetary terms. From a neocolonial perspective, some critics charge that carbon trading is yet another example of neoliberal practices that perpetuate existing imbalances – e.g., an industrialized North versus a pre-industrial South (Bachram, 2004).

There are other potentially adverse and unjust consequences of trading. One of these is the potential creation of sacrifice zones – i.e., carbon emissions may accumulate in one area as a big local emitter continues emitting carbon by buying credits from sources in other areas. For example, several scholars have pointed to the way oil refineries, a major class of carbon emitters, is disproportionately sited in underprivileged communities (Pulido et al., 1996; Graham et al., 1999; Carpenter and Wagner, 2019). The problem is that emitting carbon sometimes means emitting other air contaminants – what other scholars refer to as co-pollutants (Walch, 2018). In other words, there are unrecognized externalities to carbon trading. Trading carbon may mean also implicitly trading air toxics like benzene, dioxin, and ammonia. There is at least the potential for such schemes to maintain or exacerbate already existing exposures of lower-income, minority communities to landscapes of environmental injustice (Shonkoff et al., 2011).

This paper argues that the equity of carbon trading is too often glossed over. Proponents of cap-and-trade, often from schools of business and economics, too easily dismiss these concerns by assuring that carbon markets can be designed to monitor disequities, without showing how in fact this is to be done without dismantling the market mechanism. Most fundamentally, the argument against commodification (a word which tends not to be used by the above scholars) is best understood in relational terms – i.e., industries and their activities invariably have a (negative or positive) relationship with the surrounding community, and one cannot treat these or their products as alienable from their context (Lejano and Funderburg, 2016). Decisions cannot be made as if these communities had no interest or voice in the matter.

To make our point, we use a brief case study to provide a practical illustration of how trading can injure some communities while benefiting a broader constituency. This agglomeration of carbon emissions compounds already existing inequities since, often, emitters are disproportionately sited in so-called environmental justice communities. These types of sources we examine such a situation, where oil refineries can increase their carbon emissions, with attendant implications for air toxics emissions. These large emitters can purchase carbon credits from the market to reduce their carbon reduction requirement, but in

adding to a firm's carbon emission, other "co-pollutants" can in fact be released along with carbon (Watch, 2003). This was, in fact, what researchers discovered when analyzing trading of NOx emission credits associated with California's RECLAIM program (Lejano and Hirose, 2005).

ILLUSTRATION

In 2013, the state of California launched its cap-and-trade program, which sets a cap on emitters responsible for 85% of the state's carbon emissions and allows emitters to buy and sell carbon credits from a centralized clearinghouse. Each emitter is also allowed to meet up to 8% of its reduction obligation by purchasing so-called offsets from carbon sequestration project like forestry and mine methane capture (California Air Resources Board (CARB), 2015). It is now one of the largest carbon markets in the world.

There has been limited investigation of the environmental justice dimensions of California's cap-and-trade program. Cushing et al. (2018) suggested that participants in the program were disproportionately located in economically disadvantaged communities and that co-pollutants were correlated with carbon emissions.

As a brief illustration of the argument being made in this paper, we focus on oil refineries in the state of California. An examination of carbon emissions from these refineries indicated that, from 2016 to 2017, six refineries in fact increased their emissions. The question is, was this accompanied by a parallel increase in air toxics emissions?

We find that emissions of air toxics have, in fact, increased along with carbon emissions. The calculation method is described in the Appendix, and we summarize the results in the following table. **Table 1** shows the calculated change in non-carcinogenic hazard potential (expressed as the percentage change) from each refinery. For all but one of the refineries, the increase in carbon emission was accompanied by a significant increase in hazard index. The regression line corresponds to the following equation (intercept set at zero):

$$\% \text{ change carbon} = 2.67 \times \% \text{ change in Hazard potential}$$

In other words, a 10% increase in carbon emissions translates to, on average, an approximately 27% increase in hazard potential. We emphasize that our example is used simply to illustrate potential pitfalls of carbon trading and, so, we do not include any tests of statistical significance for such a small sample size.

TABLE 1 | Percentage change in carbon emissions and hazard index of air toxics emissions (2016–2017).

| | % Change in C | % Change in HI |
|------------|---------------|----------------|
| Refinery A | 1.9 | −2.6 |
| Refinery B | 6.7 | 47.7 |
| Refinery C | 16.1 | 12.2 |
| Refinery D | 6.2 | 9.3 |
| Refinery E | 20.5 | 34.9 |
| Refinery F | 19.4 | 108.7 |

Also note that relative changes in individual refinery emissions is one indicator, but the total aggregate change is also important. In the case of the refineries, the aggregate hazard index (summed over all six refineries) is seen to have increased by 31% between 2016 and 2017 (See Appendix for an explanation of how aggregate hazard potential is determined.) The results are shown graphically, along with the regression line, in **Figure 1**.

These patterns reveal a potential for carbon trading to create spatially inequitable patterns where emissions concentrate in already impacted communities. This flies in the face of the notion that carbon is a pollutant that mainly has global, but not local, impacts. But when other things are traded along with carbon, there is the potential for the creation of air toxics hotspots (along with the agglomeration of other negative impacts such as noise, dust, diesel traffic, and others).

Of course, the dynamics of factory emissions are complex. Not all of the air contaminants being emitted by a source rise and fall in perfect proportion to carbon emissions, because many things are operating at the same time. For example, state regulatory programs aimed at specific contaminants, such as dioxin, can result in this particular class of contaminants to decrease while others increase (as we found in the case of one refinery). Nevertheless, the pattern is important: the right to emit more carbon can carry with it, inherently, the opportunity to increase other (noxious) activities as well. To put it more plainly, it is never *just carbon* that is being exchanged.

The above is a simple practical demonstration of one aspect of the argument that carbon trading can have unanticipated disequities. Of course, a fuller analysis can examine a longer period of time and the larger universe of carbon emitters, but this brief example suffices to illustrate the argument.

DISCUSSION

Though the idea of sustainable development was founded on a notion of intra-generational equity, scholars have pointed to the absence of justice considerations in many sustainable development proposals (e.g., Agyeman, 2014). In this article, we focus on the justice implications of carbon trading, consistent with ideas about being more critical of market-based solutions, instead of simply assuming that minor corrections to market design are all that are needed (e.g., Blue, 2016).

It also helps to reflect on the broader agenda of sustainable development. The carbon trading program is part of the State of California's objective of achieving carbon neutrality by 2045¹. This advances one of the Sustainable Development Goals (SDGs), which the United States signed onto in 2015 –SD 13 (Climate Action). And, yet, we see that focusing on one SDG goal may conflict with others – in this case, SGD 11 (Sustainable Cities) which targets, among other objectives, reduce the adverse per capita environmental impact of cities². In California, the latter is codified in the state's Air Toxics "Hot Spots" Information

¹Executive Order B-55-18 to Achieve Carbon Neutrality, signed by Edmund G. Brown, Jr., Governor of California, September 10, 2018.

²<https://www.un.org/sustainabledevelopment/cities/>

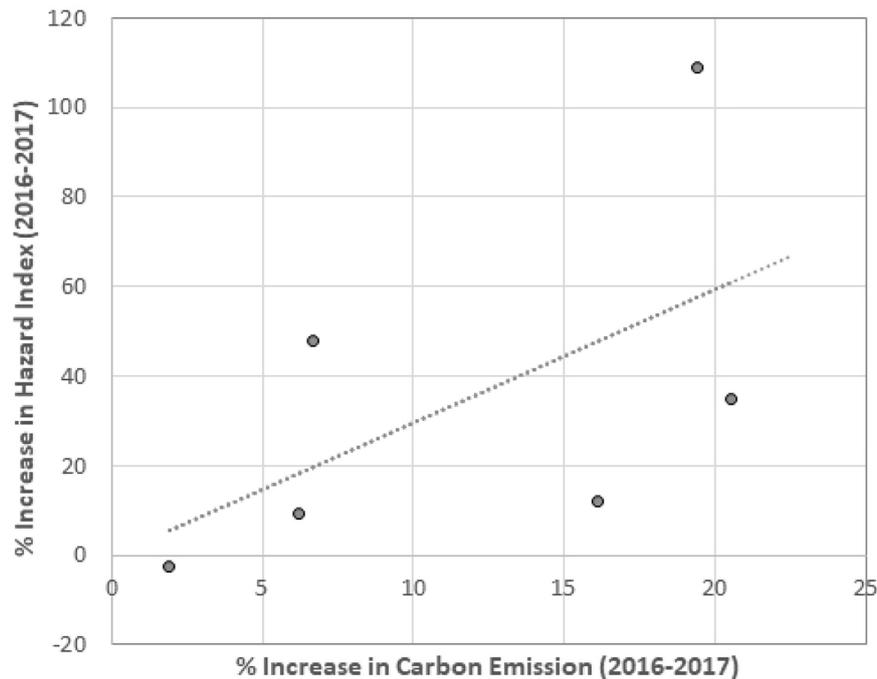


FIGURE 1 | Graph of changes in emissions between 2016 and 2017 of carbon and hazardous air pollutants.

and Assessment Act, which aims to reduce risks from industry emissions to surrounding neighborhoods³.

Since the idea of creating carbon markets for greenhouse gas mitigation was proposed, there has been a small chorus of dissent from those who question its underlying ethical bases and its real-world consequences. In the above case, we illustrate how externalities are present, such that carbon trading results in the exchange of things other than just carbon (including air toxics). Even more fundamentally, critics of the commensurability assumption of trading (i.e., that global climate change can be priced) suggests that, even when such side-effects are recognized, they cannot be properly priced. If one allows for the incommensurability argument, then the idea of externalities does not suffice, and no adjustment of the price of carbon can correct for the fundamental disequities.

Related to this is the fact that communities that serve as recipients of carbon credits have no say in the matter. The concern about sacrifice zones is relevant, whether our analysis examines phenomena on local, regional, or global scales.

There are broader spatial injustices that overshadow even the spillover effects described above. Most generally, there is a fundamental discrepancy in that the entities benefiting from the sale of carbon credits are different from the populations that suffer from being near carbon emitters. This pertains not just to pollution but to unjust social and labor practices, poor living conditions, etc. – in other words, while local entities may benefit, local populations do not and, in fact, suffer from the continuance of these carbon emitting entities.

There is another, broader issue concerning the spatial inequities in level of industrialization, such that the Global South continues to be the rural feedstock for the industrialized North, maintaining a lesser degree of development in non-industrialized parts of the world. Carbon trading, in concept, does nothing to alleviate this and, furthermore, has the potential for further increasing such spatial inequities.

The appeal of the carbon trading concept is that it simplifies the otherwise complex discussions regarding carbon. Simply create a market, and buyers and sellers will negotiate directly around the rights to emit carbon – taking government, community, and labor out of the discussion. But this simplicity is also the problem, since the reductionist form of governance allows the discussion to be reduced to the simplest terms: carbon and money. What we suggest is that the task of reducing carbon may not be so simplistic and may not be reducible to economic considerations (eschewing the cultural, ethical, and historical). The other publics (government, community, labor) need to be brought back in and be part of the complex moral debate about who gets to emit carbon, and how much.

To be able to address some of the inequities of carbon trading, we to intervene in the design of the carbon market. For example, addressing the issue of co-pollutants would require combining additional point-of-source toxics reduction technologies to accompany each trade for the purchasing source. Proponents of pricing mechanisms would undoubtedly consider pricing in the cost of these co-pollutants into the price of carbon, but this has the disadvantage of still allowing the accumulation of toxics in specific areas. And, ultimately, if one is convinced of more fundamental issues like incommensurable

³<https://ww2.arb.ca.gov/our-work/programs/ab-2588-air-toxics-hot-spots>

values, then this may mean foregoing cap-and-trade altogether in favor of more conventional command-and-control approaches. Regardless, any of these measures would need to be accompanied by aggressive monitoring of toxics emissions and other impacts (including nuisance conditions like odor and noise) in specific neighborhoods.

To be sure, some researchers suggest that California's cap-and-trade program is not creating hotspots (e.g., Walch, 2018). But two questions arise (among others). First, are there no increases in air toxics when one looks at the most local level (i.e., the vicinity around each plant)? Moreover, even if there were no increases in ambient air toxics concentrations around each plant, there is still a potential inequity in that some neighborhoods have improved, in terms of air quality, compared to others (Cushing et al., 2018).

The larger implication has to do with questioning the notion of alienable rights, which lies behind the idea of carbon as a transferable good. Proponents of carbon markets have played on the narrative that carbon trumps everything, and that the single-minded pursuit of carbon reduction is a global, universal imperative (Lejano and Nero, 2020). But there is more to carbon as a universal, global good – in fact, carbon is part

of the landscape of a place. The transfer of carbon reshapes these landscapes. Areas that receive carbon credits become just a little bit more industrial and areas that give them away become less so. The proposition is that the movement of carbon affects people and place in ways that carbon markets cannot correct for.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

RL conceptualized the study, designed the empirical case study, and wrote 80% of the manuscript. WK conducted a review of trading regimes and wrote 20% of the paper. CC extracted refinery data for the case study and calculated changes in emissions. All authors contributed to the article and approved the submitted version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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APPENDIX

Carbon emissions for oil refineries in California were downloaded from the database maintained by the state as part of its program, California's Regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR) – the data can be found at <https://ww2.arb.ca.gov/mrr-data>. Comparing greenhouse gas total emissions in 2016 and 2017, it was determined that a number of oil refineries increased carbon emissions during that one year span. The percentage increase, from 2016 to 2017, in total carbon emissions are shown in **Table 1**.

For each of these refineries, air toxics emissions data were obtained from the national Toxics Release Inventory (TRI) database, which monitors emissions of non-carcinogenic and carcinogenic air constituents released by large sources each year. The emissions data can be obtained from the TRI database search page: <https://www.epa.gov/enviro/tri-search>.

The TRI data provides annual emissions (in pounds) of each constituent for each emitter. Since we are only interested in the percentage increase in total hazard index or HI (and not in the absolute values of the hazard indices), relative changes can be calculated by simply dividing the annual emission rate by the respective Reference Exposure Levels (RELs) for each constituent. The percentage change is simply obtained (for constituent x) as:

$$\% \text{ Change in HI (constituent } x) = [(Emission_{x,2017} - Emission_{x,2016}) / Emission_{x,2016} - 1] \times REL_x \times 100\%$$

Each refinery emits a number of toxic pollutants that appear in the state's table of hazardous air pollutants. The different pollutants have differing levels of toxicity, as indicated by the official state listings of RELs or reference exposure levels⁴. To be able to add up the toxicity from all the combined pollutants, we convert each constituent into a "reference pollutant" by dividing the amount of a pollutant emitted by its individual REL, for example:

hazard potential of benzene in terms of reference pollutant = mass of benzene emitted/REL for benzene.

This allows us to convert each of the pollutants emitted by a refinery into one reference pollutant and to add them all up to get an aggregate hazard potential. The aggregate hazard potential is simply the total amount of toxic pollutants, each converted into a common reference pollutant, emitted by the refinery. Note that we do not attempt to calculate actual risks to nearby residents, as this requires modeling plume dispersion for each refinery (and, besides, this is not the purpose of this exercise).

⁴<https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary>