THE ADDITIONALITY DOUBLE STANDARD

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Carbon offsets are widely criticized for lacking additionality. The public debate, however, has failed to recognize that the problem of additionality goes far beyond offsets. It arises any time the government subsidizes an activity. Programs with longer histories than offsets and far more money at stake offer valuable lessons for managing lack of additionality in offsets. The article sets out the current efforts to prove offset additionality, explains why major government programs present comparable additionality challenges, and show why other programs' problems of additionality are perceived as significantly different than those for offsets. We examine the toolkit used to address additionality in subsidies and show how this can be usefully applied to offsets. Offsets are central to many climate pledges, so it is critically important they be credible. But the challenge of managing offset additionality need not be understood in isolation. It is, in fact, a common problem with tested solutions.

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Introduction

The international law firm, Squire Patton Boggs, announced in June 2022 that it would become "net zero" by 2035.[1] Nor is this law firm alone. In recent

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1. Habiba Cullen-Jafar, *Squire Latest Law Firm to Commit to Net-Zero Carbon Emissions*, ALM Global (June 21, 2022), https://perma.cc/9W4J-93WM.

years, ambitious commitments to reduce greenhouse gases have become the new normal. Net zero commitments have been announced by thirty-three nations (including the European Union, Canada, and the UK)[2] as well as 5,200 companies (including Ford, Microsoft, and American Airlines).[3] Some of these reductions may come from reduced emissions at source, but how can a law firm go to net zero? Squire Boggs and many of the other parties committing to this ambitious goal will rely on "carbon offsets," a market predicted to be between $200 billion and $1 trillion per year by 2050.[4]

Carbon offsets are greenhouse gas emissions reduced or avoided offsite that are then claimed by a party seeking to reduce its own emission levels. For example, a company that has made a net zero promise may continue to emit carbon dioxide in its own operations but claim to meet its target by paying others to plant trees, to reduce levels of deforestation, or to upgrade machinery with more fuel-efficient technologies.

In principle, offsets make good sense. The costs of reduction opportunities are not the same in all places, and greenhouse gases are global pollutants. It can be more efficient to pay for low-cost reductions offsite than more expensive reductions onsite. Indeed, a large fraction of the Intergovernmental Panel on Climate Change's projections for reducing global greenhouse gas emissions are premised on offsets and other "negative emissions" mechanisms.[5]

Offsets, however, have become a popular target of criticism. Scholars,[6] lawyers,[7] newspapers,[8] even comedians such as John Oliver,[9] have taken aim at the issue of "additionality"—that reductions in emissions be *additional* to those

2. *Net Zero Targets*, Climate Action Tracker.
3. Eric Roston, *Corporate Net-Zero Goals Don't Add Up to a Net-Zero Planet*, Bloomberg (June 27, 2022), https://perma.cc/EQ9U-3KPG.
4. Frank Watson, *Global Carbon Offsets Market Could Be Worth $200 Billion by 2050: Berenberg*, S&P Global Commodity Insights (May 13, 2020,), https://perma.cc/7AZG-7J88; Kerri Chyka, *Carbon Offset Market Could Reach $1 Trillion With Right Rules*, BloombergNEF (Jan. 23, 2003), https://perma.cc/9D7Z-UNZQ.
5. *See infra* note 46.
6. *See, e.g.*, Charles F. Mason & Andrew J. Plantinga, *The Additionality Problem with Offsets: Optimal Contracts for Carbon Sequestration in Forests*, 66 J. Env't Econ. & Mgmt. 1, 1 (2013).
7. For example, a recent class action lawsuit was filed against Delta Airlines, alleging false and misleading claims of progress toward net zero emissions because its offsets are not additional. The complaint states that "[n]early all offsets issued by the voluntary carbon offset market overpromise and underdeliver on their total carbon impact." Andrew Jeong, *Delta's Carbon-neutral Pledge is "Greenwashing," California Lawsuit Says,* Wash. Post (May 31, 2023), https://perma.cc/4FK4-A2P4.
8. *See, e.g.*, Maggie Astor, *Do Airline Climate Offsets Really Work? Here's the Good News, and the Bad.*, N.Y. Times (May 18, 2022), https://perma.cc/D9T2-VC9L; Patrick Greenfield, *Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows,* The Guardian (Jan. 18, 2023), https://perma.cc/8YXQ-F8QR.
9. *Last Week Tonight with John Oliver: Carbon Offsets*, HBO cable broadcast (Aug. 21, 2022).

that would have otherwise occurred.[10] For example, if the trees that the company pays to have planted were going to be planted anyway, or the forest they promise to conserve was never going to be logged, there are no additional emissions reductions to offset the company's emissions onsite. Issuing offset credits or paying for actions that otherwise likely would have happened anyway undermines the cap in a cap-and-trade system and wastes money in a subsidy system. This challenge of additionality has been described by some as a "fatal flaw" of offsets.[11] A number of high-profile media stories have exposed offsets that clearly were not additional (such as payments for not logging in a bird refuge).[12]

Additionality, though, can be difficult to prove. It requires showing what would have happened in the absence of the offset. For example, if a company pays to conserve a forest on a plot of land, proving additionality requires showing that the forest would likely have been logged absent the payment. The tests require demonstrating a counterfactual—what behavior would have been in a hypothetical world without the offset.[13] Because the counterfactual never in fact occurs, demonstrating the counterfactual is necessarily speculative. Thus, to ensure additionality, a number of standards organizations have developed tests to demonstrate that each particular project that generates offsets is additional.[14] This can be methodologically complicated, costly and, notwithstanding the best of efforts, uncertain.

The close focus on offset additionality seems reasonable at first glance. We should demand value for money and credibility for net zero claims. But upon closer inspection it reveals a troubling double standard. In short, the debate over offset additionality has missed a key point—additionality is not solely a problem with carbon offsets. In fact, *additionality risks arise in many policies throughout government with far more money at stake*, from Medicare and Low Income Housing Tax Credits to the recently passed Inflation Reduction Act. More generally, any time the government subsidizes an activity it runs into the

10. *See, e.g.*, *Frequently Asked Questions: What Does "Additionality" Mean and Why Is It Important?*, Gold Standard, https://perma.cc/MP2Q-XRMM.

11. *See, e.g., Na'im Merchant, The Fatal Design Flaw in Most Carbon Offsets*, Carbon Curve (Feb. 28, 2021), https://perma.cc/F62Y-VAZV; Rob Jordan, *Stanford-Led Study Finds Flaw in Global Effort to Mitigate Carbon Emissions*, Stanford News (Nov. 4, 2016), https://perma.cc/Z44U-ULBD.

12. *See* Ben Elgin, *These Trees Are Not What They Seem*, Bloomberg (Dec. 9, 2020), https://perma.cc/CVZ5-XAYS.

13. As a recent study concluded, "it is difficult to empirically analyze non-additionality and other kinds of crediting errors because counterfactual scenarios are unobservable directly and can only be estimated indirectly through rigorous study with sufficient data and careful experimental design." Grayson Badgely et al., *Systematic Over-Crediting in California's Forest Carbon Offsets Program,* 28 Glob. Change Biology 1433, 1434 (2022).

14. *See* Am. Carbon Registry, ACR Validation and Verification Standard 15–18 (2018), https://perma.cc/K2RT-X44J; *see also* Verra, VCS Methodology Requirements 34–40 (2022), https://perma.cc/A3LR-T4X7; Gold Standard Found., Principles & Requirements 16–18 (2019), https://perma.cc/L8FG-GH6W.

problem of additionality: the subsidy payments may go to activities that would have occurred without the subsidy.

As we will show, the parallels between offsets and subsidies are easy to miss because different terms are used to describe the problems, and the problems are framed differently. For example, a subsidy might be described as "poorly targeted" or as generating "windfall profits" rather than being non-additional. Governments, however, rarely require individualized testing of additionality for every application. Instead, a variety of less demanding approaches are used, from simply ignoring the problem to using proxy measures of additionality that are easier to apply than individualized testing. Carbon offsets' demand for extensive proof of additionality is, it turns out, an outlier.

This article examines the reasons for this disparate treatment, asking what carbon offsets can learn from the treatment of additionality in other policy contexts, contexts with long histories of development and large amounts of money at stake. We start by providing background on offsets and describe current efforts to prove offset additionality. We then survey the landscape of major government policies, showing that the problem of additionality is ubiquitous and, in many cases, similar to the carbon context. We consider reasons why additionality is perceived differently for offsets, arguing that the differences are largely the result of framing and are not substantive. Finally, we examine approaches taken to manage additionality in other contexts and apply these lessons and their insights to carbon offsets.

Lack of additionality is viewed as core to the integrity of offsets. Because offsets are so central to many climate pledges, ensuring credible additionality is thus a key to achieving corporate and governmental climate goals. But the problem of offset additionality (and how to manage it) cannot be understood in isolation. Much can be learned from how lack of additionality has been managed in other programs that raise similar concerns.

I. A Primer on Offsets

As noted, offsets are emissions reductions (including removals) that are used to compensate for emissions that occur elsewhere.[15] Because CO_2 mixes globally in the atmosphere, it does not matter where emissions reductions take place. The effects on the climate are the same if an entity reduces its own emissions while emissions continue offsite or it continues its own emissions and reduces emissions offsite. The costs of the second option, however, may be lower. Carbon offsets allow organizations to take advantage of those lower costs, thereby lowering the overall costs of reducing greenhouse gases.

15. For a useful summary of offsets, *see Carbon Offset Guide*, Carbon Offset Rsch. & Educ. Program, https://perma.cc/J39T-CVNN.

To illustrate using a simple example, suppose that a cap-and-trade system limits emissions of CO_2 from a region or industry sector to 100 tons. The cap-and-trade system would issue 100 certificates, each allowing the holder to emit one ton of CO_2 for each certificate of CO_2 it holds.

If the cap-and-trade system allows offsets, a regulated actor can pay for emissions reductions elsewhere. For example, a regulated actor might pay a landowner to reduce emissions by 5 tons. The regulated actor would be treated as now holding an additional 5 certificates, allowing it to emit 5 more tons of CO_2 from its own operations. Total emissions stay at 100 tons. If the reductions offsite are less expensive than those within the cap-and-trade system, the costs of achieving the 100 ton goal is lower.

Offsets can be divided into two categories: avoided emissions and removals. Avoided emissions offsets reduce emissions relative to the emissions that would arise under business-as-usual. For example, an avoided emissions offset might be created by paying a third party to adopt a cleaner technology, such as substituting renewables for fossil fuels or paying for a third party to make energy efficiency improvements. One common type of avoided emissions offset involves paying for reduced emissions of high global warming potential gases, such as preventing methane leaks from landfills or reducing leaks from HFC-generating facilities.

Removal offsets involve taking CO_2 out of the atmosphere and storing it to prevent it from reentering the atmosphere. Removal technologies, also known as "negative emissions technologies" or NETs, vary widely.[16] Reforestation can remove CO_2 from the atmosphere through photosynthesis, storing the carbon in plants or soils. Changes in agricultural practices, such as changing tillage practices or using plants with deeper roots, can increase carbon stored in soils. The Intergovernmental Panel on Climate Change's models of carbon removals are based on a technology known as BECCS (Bio-Energy with Carbon Capture and Storage). With BECCS, crops are combusted in power plants to generate electricity. The carbon that is released during this process (when the plants are burned) is captured at the smokestack, compressed, and stored generating negative emissions.

To date, there have been about 1.7 billion registered offset credits from 7,466 different projects.[17] Of these, 40.9% are for forestry and land use and

16. For an overview, *see* Jan C. Minx et al., *Negative Emissions—Part 1: Research Landscape and Synthesis*, 13 Env't Rsch. Letter art. no. 063001 (2018); Sabine Fuss et al., *Negative emissions—Part 2: Costs, potentials and side effects*, 13 Env't Rsch. Letter art. no. 063002 (2018); Gregory F. Nemet et al., *Negative Emissions—Part 3: Innovation and upscaling*, 13 Env't Rsch. Letter art. no. 063003 (2018).

17. To get a sense of scale, annual global emissions of CO_2 are about 37 billion tons, which means that the offset market is currently small relative to emissions. There are likely many more offsets that are not registered and are likely of low quality. As we will discuss, most users of offsets now require them to be registered. Our data is from the Berkeley Voluntary Registry Offsets Database, developed by the Berkeley Carbon Trading Project. Ivy S. So

32.4% are for renewable energy. The remainder is from waste management (5.9%), household and community emissions reductions (6.3%), changes to industrial processes (6.2%), and a number of smaller categories. The dominant category of forestry projects, making up 24.8% of all projects, are related to a U.N. framework known as REDD+, which focuses on forestry projects in developing countries.[18]

Offsets are a central tool used to meet commitments to reduce emissions such as corporate or country net zero promises. In a corporate net zero promise or other voluntary program, offsets allow the business to continue to emit in its own operations while meeting, or claiming to meet, its net zero promise. Given how few significant emissions reduction opportunities exist for many sectors (such as steel, cement manufacturing, or air transport), corporate net zero promises will need to rely to a large extent on offsets. Consider the example of Squires Patton Boggs in the Introduction. There are very few reduction opportunities in the office, thus offsets are the only feasible way to counterbalance their emissions (this is even more true if they include their plane flights in the net zero goals).

Offsets also play an important role in many cap-and-trade systems or other systems of emissions reductions mandated by international agreement or domestic law. One of the earliest such systems was the Clean Development Mechanism (CDM), created as part of the Kyoto Protocol.[19] The CDM allowed countries to meet Kyoto Protocol commitments by buying "certified emissions reductions" units from CDM projects in developing countries. Some CDM credits were allowed to be used in the post-Kyoto European Union Emissions Trading System.

In the United States, both the California cap-and-trade system and the Regional Greenhouse Gas Initiative allow offsets. Each of these programs has specific rules for offsets, including how many a particular polluter can use, the types of allowable projects, and how the offset projects are certified. For example, California, among other things, requires all offsets to be listed with one of three specified offset registries and limits the geographic scope of allowable offsets.[20]

Before describing the challenge of offsets in more detail, it is worth noting that there are a number of other significant concerns with offsets we will not address in this article. A key problem is that offsets may not ultimately remove

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et al., *Voluntary Registry Offsets Database v8,* U.C. Berkeley Goldman Sch. of Pub. Pol'y (2023), https://perma.cc/5M9P-2HXN.

18. *Id.*; *see also What is REDD+?*, U.N. Framework Convention on Climate Change, https://perma.cc/DF7Y-K9Y8.

19. *The Clean Development Mechanism*, U.N. Framework Convention on Climate Change, https://perma.cc/2YQZ-S9RE.

20. *Offset Project Registries*, Cal. Air Res. Bd., https://perma.cc/GX72-PMWW; Cal. Air Res. Bd., Technical Guidance for Offset Verifiers: Verification of Offset Project Data Reports 42 (2013), https://perma.cc/9DY2-TTLU.

CO_2 from the atmosphere, a problem known as "permanence." Offsetting emissions one-for-one with non-permanent reductions results in a net increase in emissions at some point in the future, when the reduction is reversed. For example, carbon stored in forests may be released if the forest later burns or is logged. Once that happens, there is no longer any offsetting reduction in emissions or removal. Counting the offset upfront as fully offsetting other emissions may end up miscounting.

Another problem with offsets is called "leakage." Leakage arises if the emissions reduced by an offset simply shift to another location. For example, preventing deforestation on one plot of land does no good if the plot next door is deforested instead. As with permanence, counting offsets without adjusting for leakage can provide more reduction credits than are warranted.

Offsets may also simply be fraudulent, with some of the more outrageous examples described in the next section.

A separate criticism, unrelated to the quality of the offset, is strategic—that offsets allow polluters to continue to pollute when they should instead be focused on reducing their own emissions.[21] Although the concern takes a variety of guises, the underlying worry is that stopping climate change requires shifting away from fossil fuel use, and allowing polluters to use offsets delays that shift, possibly locking in fossil fuel infrastructure that will continue to pollute in the future.

II. Additionality

As described above, the problem of lack of additionality arises if the emissions reductions from the offset would have happened even without the offset. To illustrate, recall our example of the cap-and-trade system that allows a total of 100 tons of emissions but does so by allowing 105 tons of emissions by regulated entities because it is offset by 5 tons of reductions elsewhere. If those 5 tons of reductions would have occurred anyway, the offset actually *increases* the total level of emissions, effectively busting the cap.

A similar logic holds for net zero promises. To allow for, say, 5 tons of residual emissions onsite while meeting a net zero promise, there needs to be an additional 5 ton reduction offsite. If the offset reductions are not additional, the net zero promise has not been met.

But how can cap-and-trade systems or net zero promisors prove the 5 tons of emissions reductions offsite are really additional, that they would not have occurred but for the payment for the offset? We can only observe the world with the payment for the offset. We cannot observe whether it would have arisen

21. Kristoffer Tigue, *Why do Environmental Justice Advocates Oppose Carbon Markets? Look at California, They Say* (Feb. 25, 2022), https://perma.cc/DVQ7-BSSX.

without the payment. As a result, we need methods of inferring behavior in a hypothetical world.

To make this even more difficult, note that neither the polluter nor the offset provider has any incentive to ensure that the offset is additional. The offset provider can charge less for the offset if it is not changing its behavior. It gets paid for what it was going to do anyway. The polluter can save money by purchasing less expensive "offsets" and, therefore, may be more than happy to purchase offsets that are not additional. This has the potential to demonstrate Gresham's Law, where bad currencies drive out good ones.[22] Just as silver-plated coins drive out coins actually containing silver, inexpensive non-additional offsets may drive out truly additional offsets unless there is some external mechanism that ensures offset credibility.[23]

A. Certification

To try to ensure that offsets are credible, cap-and-trade systems often require offsets to meet strict standards, including certification by an outside entity. Similarly, corporations seeking to make credible net zero promises often use certification entities and standards.

There are currently four major private certification entities for offsets. Verra's Verified Carbon Standard is by far the dominant certifier, with 64% of all registered offsets.[24] The Gold Standard (14.2%), the American Carbon Registry (5.2%), and Climate Action Reserve (4.2%) make up the remainder of private registries. In addition, California's Air Resources Board certifies projects and has certified 12.4% of registered offsets.[25]

All of these certifications attempt to compare the emissions that would have arisen in a hypothetical world without the offset to those that occur with the offset. The difference measures the additional amount of emissions reductions that the offset delivers. Because the certifications cannot actually measure the emissions in the hypothetical world without the offset—that world does not exist—the certifications look to indicators that help estimate what the hypothetical world would have looked like. They might, for example, look at legal requirements or financial requirements to try to estimate whether the offset project would have otherwise been required or been financially feasible.

To illustrate, the American Carbon Registry (ACR) describes its additionality testing as follows:[26]

22. *See generally* Frank Whitson Fetter, *Some Neglected Aspects of Gresham's Law*, 46 Q. J. Econ. 480 (1932).
23. *See Gresham's Law: Why Bad Drives Out Good As Time Passes*, Farnam Street, https://perma.cc/DFA5-796E.
24. Our data is from the Berkeley Voluntary Offsets Database developed by the Carbon Trading Project. So et al., *supra* note 17.
25. *Id*.
26. Am. Carbon Registry, *supra* note 14, at 15.

> To qualify as additional, ACR requires every project to pass either an approved performance standard and a regulatory additionality test, or a three-pronged test of additionality in which projects demonstrate that the activity exceeds currently effective regulations, exceeds common practice in the relevant industry sector and geographic region, and faces at least one of three implementation barriers: financial, technological, or institutional.
>
> In order to demonstrate a project faces the financial barrier:[27]
>
> The [verification body] shall review internal financial pro formas and historic/projected cash flow analyses prepared by the Project Proponent and/or an external party to confirm the validity of the financial barrier claim. The [verification body] should assess to what extent the assumptions used in the financial barriers analysis are defensible, how a variation on those assumptions (sensitivity analysis) could affect the outcome of the financial barriers test, and how likely such variations are during the project life.

Verra[28] and the Goal Standard[29] use similar approaches. They attempt to measure the emissions that would have occurred absent the offset by looking at

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27. *Id*. at 16.
28. The Verra standard provides three methodologies for project proponents to prove additionality on a project-by-project basis: project methods, performance methods, and activity methods. Similar to the American Carbon Registry, project methods require demonstrating that the project is (1) surplus to regulatory requirements, (2) not common practice in the relevant industry/region, and (3) faces either an investment, technological, or institutional barrier higher than those faced by alternative projects. Performance methods require showing that the project (1) is surplus to regulatory requirements, and (2) meets certain benchmarks or proxy benchmarks for carbon emissions or sequestering. Activity methods involve demonstrating that the project is surplus to regulatory requirements, and that the project either (1) has a "low level of penetration relative to its maximum adoption potential" meaning the activity has been adopted at a rate of no more than five percent of its maximum potential, and in cases where relevant technology has been commercially available in the applicable region for less than three years, significant barriers must exist to further adoption, (2) is not the most economically attractive option available, or (3) does not have any significant sources of revenue aside from the sale of carbon credits. Verra, *supra* note 14, at 35–40.
29. The Gold Standard determines additionality for individual projects and broader programs using the latest version of any United Nations Framework Convention on Climate Change approved additionality tool, such as the Clean Development Mechanism (CDM) Methodological Tool, or another tool upon Gold Standard approval. Gold Standard Found., *supra* note 14, at 16. Using the CDM tool, the proponent can show the project would not have occurred absent the sale of carbon credits either because: (1) there was a more cost-effective option that resulted in greater emissions, (2) there was a less technologically advanced and less risky alternative option that would have resulted in greater emissions, (3) compliance with prevailing industry standards or practices would have resulted in greater emissions, or (4) some other specified barrier exists that would have prevented the project from taking place. U.N. Framework Convention on Climate Change, Methodological Tool:

various indicators of likely behavior, such as financial barriers or laws or regulations that constrain behavior. They typically do this on a project-by-project basis.

The major expense from certification arises from the substantial legal, accounting, and econometric work to establish both the emissions in the hypothetical world and the emissions with the offset. Typically, offset providers hire consultants to perform these studies, and the certifying entities review the studies to see whether they meet their standards.[30]

The increasing interest in offsets has also led to the creation of secondary markets in certifications. For example, there are now at least two offset rating agencies, Sylvera and BeZero, that rate offsets much the way that credit agencies rate bonds.[31] These agencies use both the data provided by the project documentation as well as their own measurements to estimate offset quality. Offset purchasers can, theoretically, look to offset ratings to ensure that the offsets they purchase are additional.

B. Evaluation

Whether these certification efforts and the secondary market monitoring are worthwhile depends on how much they improve offsets relative to the costs of certification.

The certification entities themselves are inexpensive (with costs in the thousands or tens of thousands of dollars to certify an offset project) but this is because most of the work is outsourced to consultants who prepare the documentation. Consultants do not make their prices public[32] nor have we been able to find recent estimates of these certification costs. One estimate, from about 10 years ago, examined all-in costs, including insurance, monitoring, and certification costs, for forestry offset projects.[33] All-in costs varied from 30% to 270% of project income. Of these costs, 8-50% were for regulatory approval, which includes certification. The result is a broad range of possible costs, possibly as low as a few percentage points to costs in excess of the flows from the project.

Demonstration of Additionality of Small-Scale Project Activities 4 (2020), https://perma.cc/J74H-EYNQ.

30. *See, e.g.*, *Validation and Verification*, Verra, https://perma.cc/4F56-SVAL.
31. Ed Ballard, *Tech Startups Race to Rate Carbon Offsets*, Wall St. J. (Jan. 5, 2022), https://perma.cc/7EVA-EEKU.
32. For example, SCS Global Services is a prominent provider of offset verification services. They state that verification takes three to six months but do not make their costs publicly available. *See Carbon Offset Verification*, SCS Glob. Servs., https://perma.cc/HLT9-UYY9.
33. Timothy R. H. Pearson et al., *Transaction costs for carbon sequestration projects in the tropical forest sector*, 19 Mitigation and Adaptation Strategies for Glob. Change 1209 (2014). Another study, also from 2013, expressed concern that the transactions costs of certification may deter the use of offsets. *See* Oscar J. Cacho et al., *Transaction costs of carbon offset projects: A comparative study*, 88 Ecological Econ. 232, 233 (2013).

Nor is it straightforward to estimate how much certification improves carbon offsets because that requires estimating what offsets would look like absent certification requirements or with alternative certification rules. We do know that with the current certification approach, there are significant concerns about the quality of offsets. These concerns arise from both published critiques about individual projects as well as studies that examine the market as a whole.

One project that garnered considerable public attention involved the largest land trust organization in the world, The Nature Conservancy. It sold offset credits for avoided deforestation. The group claimed that it had placed a conservation easement on a forest to prevent it from deforestation. All well and good, until it was revealed that the land was a bird refuge which was probably the *last* forest that would be under threat of logging.[34] These offsets were certified by the American Carbon Registry. Similarly, the Massachusetts Audubon Society sold offsets on 9,700 acres of its land in western Massachusetts, land that almost certainly was going to stay conserved.[35] The California cap-and-trade system, administered by the California Air Resources Board (CARB), certified the offsets because the land could legally have been logged.[36] In a Pro Publica investigation of offsets provided by a forestry offset project in the state of Acre, on the western edge of Brazil, researchers found cow pasture where there should have been trees generating carbon offsets. These offsets were used by FIFA to help fulfill an emissions pledge it made before the World Cup in Brazil[37] and had been certified by Verra.[38]

There are fewer systematic studies, but those we are aware of show that a large fraction of offsets may not be additional.[39] For example, one study looked at forest carbon offsets allowed in the California cap-and-trade system.[40]

34. Mark Kauzlarich, *These Trees Are Not What They Seem*, Bloomberg (Dec. 9, 2020) https://perma.cc/DCF8-XCZD.
35. Lisa Song & James Temple, *A Nonprofit Promised to Preserve Wildlife. Then it Made Millions Claiming It Could Cut Down Trees*, ProPublica (May 10, 2021), https://perma.cc/JHG2-M7FV.
36. *See generally California's Compliance Offset Program*, Cal. Air Res. Bd. (2021), https://perma.cc/RA95-YQB7.
37. 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/D9XV-WA8C.
38. *Id*.
39. *See, e.g.,* Thales A. P. West et al., *Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon*, 117(9) Proceedings of the National Academy of Sciences 24188 (2020) (examining 12 REDD+ projects in the Brazilian Amazon and finding the accepted methodologies for quantifying carbon credits overstate impacts on avoided deforestation and climate change mitigation).
40. Grayson Badgley et al., *Systematic over-crediting in California's forest carbon offsets program*, 28 Glob. Change Biology 1433 (2022). Note that the California system in this paper used a standardized approach rather than a project-by-project approach.

The study called into question nearly a third of the analyzed credits.[41] A study by the British newspaper, *The Guardian*, and Greenpeace found that forest protection schemes used by airlines to offset emissions and verified by Verra were inconsistent and overstated threats to the trees.[42]

One temptation in the face of these problems would be to write off offsets altogether, and some commentators have called for just that.[43] If there is no simple way to ensure that any given offset, or offsets overall, genuinely reduce emissions, perhaps it is better to require companies or countries to reduce their own emissions onsite even if, in theory, offsets might lower costs. For this reason, many companies claim to shun offsets,[44] and programs have arisen that allow companies to reduce emissions without the use of offsets.[45]

We are sympathetic to this view—net zero emissions requires onsite emissions to be largely eliminated in the not-too-distant future and extensive reliance on offsets might hinder that goal. But the total abandonment of offsets would not solve the additionality problem. The reason is that, as the Intergovernmental Panel on Climate Change (IPCC) has made clear, to meet either the 2°C or 1.5°C goals of the Paris Agreement we must have large scale negative emissions in the near future.

In its most recent assessment report, the IPCC considered pathways to keeping temperatures within the Paris goals.[46] The overwhelming majority of these pathways, and all of the plausible pathways, require emissions removals substantially in excess of any remaining positive emissions at some point in the not too distant future, generating net negative emissions. Net negative emissions may need to be large, possibly on the order of 10 gigatons per year (for reference, current emissions of greenhouse gases are about 40 gigatons per year).

41. *Id*. The study relied on statistical analysis to conclude large-scale overcrediting, arguing that the counterfactual scenarios for specific projects are based on an inaccurate calculation of regional average carbon stocks.

42. These claims were strongly challenged by Verra, who stated, "the Guardian did not understand how its methodologies worked, or the VCS rules, the investigation was 'fatally flawed' and had not produced fact-based journalism . . . [and was] a 'hit piece' because of Greenpeace's opposition to carbon credits." Patrick Greenfield, *Carbon offsets used by major airlines based on flawed system, warn experts,* The Guardian (May 4, 2021), https://perma.cc/9YZJ-3VVA.

43. Chris Greenberg, *Carbon Offsets are a Scam*, Greenpeace (Nov. 10, 2021), https://perma.cc/ZKE7-XE7W; George Monbiot, *Carbon offsetting is not warding off environmental collapse – its' accelerating it*, The Guardian, (Jan. 26, 2022); Song, *supra* note 37.

44. Amrith Ramkumar et al., *Companies Stall Climate Action Despite Earlier Promises*, Wall St. J. (Sept. 19, 2023), https://perma.cc/26AM-XKMJ.

45. One prominent example is the Climate Vault. This program purchases carbon permits from existing cap-and-trade programs and stores them. The program prominently claims that this approach avoids the pitfalls of offsets while allowing a company to reach net zero. Climate Vault, https://perma.cc/WT8S-U4GU.

46. *See, e.g.*, Elmar Kriegler et al., *Cross-Chapter Box 3*, *in* Climate Change 2022 – Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the IPCC 326 (2022), https://perma.cc/8TQM-8EP6.

While there are a variety of removal technologies, many are the same as those currently used for offsets, such as forestry and agriculture.[47] Thus creating incentives for negative emissions, whether through offsets or otherwise, requires addressing additionality. Even if we limited or banned the use of offsets for the immediate future, the problems they raise, including additionality, will still be present. We cannot get away from the problem. For example, if forestry is a source of negative emissions, policies designed to increase forest carbon storage would need to determine whether the claimed carbon storage is additional, thereby generating the needed negative emissions, or whether the claimed additional carbon storage is illusory.

Given (1) that aggressive greenhouse gas reduction pathways mean we cannot abandon incentives for negative emissions and (2) that the current approach to additionality is plausibly both costly and ineffective, we believe it is worth examining how other policy instruments manage additionality. As we discuss below, subsidy programs have long faced the same additionality problems that offsets face and for the most part approach the problem very differently than the offsets world does. We should consider whether these alternative approaches might better encourage emissions reductions and removals.

III. The Ubiquity of Additionality

While the term additionality is primarily used in the carbon setting, the challenge of proving additionality is ubiquitous. Any time the government seeks to subsidize a behavior, it risks paying individuals who would otherwise have engaged in the desired activity without the subsidy. There are hundreds, possibly thousands, of subsidies under current law, which means that the problem of additionality is inescapable.

To illustrate this, we start with a concrete example, the Low-Income Housing Tax Credit (LIHTC), showing how it suffers from additionality problems that are parallel to those faced by offsets. We then consider other policy areas to show that the problem is pervasive.

The LIHTC is a tax credit that subsidizes the acquisition, construction, and rehabilitation of affordable housing for low-income tenants. Enacted as part of the 1986 Tax Reform Act, it is the country's longest running program for the construction of low-income housing. Since its inception, it has helped finance about 3 million new housing units.[48]

47. For a summary of negative emissions technologies, *see* Minx et al., *supra* note 16; Fuss et al., *supra* note 16; Nemet et al., *supra* note 16. Carbon capture storage and BECC do not pose the same additionality concerns, but they are years from adoption at scale.

48. Corianne Payton Scally et al., Urban Institute, The Low-Income Housing Tax Credit: How It Works and Who It Serves v, 1, 4, 12 (2018), https://perma.cc/BVC7-EVYA.

The LIHTC operates through the tax code, granting private developers a tax credit for qualifying projects. It is allocated to states on a per capita basis (with a minimum dollar amount for low population states). State housing agencies allocate the credit to developers though a competitive process. Developers usually sell the credits (through a syndication) to investors to raise equity for the housing project. The investors can claim the credit over a 10-year period starting when the project is placed in service.[49]

To be eligible for the LIHTC, a project must meet two tests. The "income test" requires that a specified fraction of the units be rented to tenants with sufficiently low income. There are a number of ways to meet this test. For example, the test is met if 20% of the units are rented to tenants earning 50% or less of the area median income adjusted for family size (AMI). The "gross rents test" requires that rents (adjusted for bedroom size) do not exceed a specified fraction of AMI, with the fraction depending on how the income test is met.

The LIHTC faces serious additionality problems. While it has helped finance about 3 million new housing units, some, perhaps many, of those units would have been built without the credit. We know there was demand for 3 million units by people earning a fraction of the AMI so, while new supply of housing without the credit might not have fully satisfied that demand, it almost surely would have satisfied some of it.

Any of those units, the units that would have been built absent the LIHTC, are non-additional in precisely the same way carbon offsets can be non-additional. A carbon offset provides a subsidy to engage in an activity, such as planting a tree, or refraining from an activity, such as logging. The subsidy comes in the form of a credit that can be used in a cap-and-trade system or in the form of social credit that a company gets when it claims to meet a net zero promise. This social credit can be monetized through higher sales to customers who like purchasing from a net zero company, by attracting ESG investors, or by attracting particular types of workers (or paying them less). If the offset is non-additional, the subsidy does not meet the goal of slowing climate change.

Similarly, if housing units financed by the LIHTC are non-additional, the subsidy provides a monetary benefit to investors in the form of lower taxes but does not meet the goal of reducing housing stress. In both cases, there is a social loss from lack of additionality—less greenhouse gas reduction or less low income housing going to needy tenants.

While similar in their additionality risks, the LIHTC has no rule comparable to the additionality protocols for carbon offsets to *prove* that the housing units financed by the LIHTC would not have otherwise been built. For example, states and developers do not have to estimate the housing units that would

49. Tax Reform Act, 26 U.S.C. § 42. For new projects, the present value of the credits is equal to 70% of the costs of construction (the qualified basis). For rehabilitated projects, the credits are worth 30% of the qualified basis. *Id.*

have been built absent the credit and show that units that receive credit financing are additional to those units.

In fact, once you start to look, problems of additionality are everywhere. Consider the most recent large subsidy bill passed, the Inflation Reduction Act and its $369 billion (over 10 years) funds for climate and energy provisions.[50] Every one of its six highest costing provisions creates problems of additionality. For example, the clean energy production tax credit ($51 billion) provides a 0.3 cent per kilowatt-hour credit for clean energy produced by the taxpayer at a qualified facility.[51] Similarly, the clean energy investment credit in section 48E ($50 billion) provides a 6 percent credit for the costs of specified energy properties.[52] Neither rule includes any provisions to ensure that the subsidized facilities are additional. The same holds for the advanced manufacturing production credit ($31 billion), the zero-emission nuclear power production credit ($30 billion), and the residential energy efficient property credit ($22 billion).[53] All of these provisions subsidize some activities that likely would have arisen anyway. None attempts to ensure additionality.

The same is true for the major safety net programs that provide benefits to specified individuals. For example, Medicare provides health insurance and prescription drug coverage for most people over age 65. The size of these programs is vastly larger than the size of any existing climate program, and two or three orders of magnitude larger than existing offset programs.[54] Safety net programs suffer from additionality problems—they provide benefits to individuals or families who, in many cases, would have been able to obtain those benefits without the safety net program.

To provide a more comprehensive overview, Table 1 provides a sample of major subsidy programs and their provisions (or lack of provisions) to address additionality. The Appendix provides a more complete list of programs. Many programs have no provisions to address additionality. As a result, a large fraction of the subsidy may go to non-additional individuals, households, or activities.

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50. Emma Newburger, *Schumer-Manchin Reconciliation Bill has $369 Billion to Fight Climate Change – Here are the Details*, CNBC (July 28, 2022), https://perma.cc/2G6K-GJVN.
51. Inflation Reduction Act, 26 U.S.C. § 45Y. A qualified facility is a facility placed in service after December 31, 2014, which produces no greenhouse gases. *Id*.
52. *Inflation Reduction Act Creates New Tax Credit Opportunities for Energy Storage Projects*, McGuireWoods (Dec. 27, 2022), https://perma.cc/KTM7-LYTR.
53. Anne Field, *Leveraging Advanced Manufacturing Credits in the Inflation Reduction Act*, Wall St. J. (Nov. 7, 2022), https://perma.cc/5N34-7WPU; Off. of Nuclear Energy, Inflation Reduction Act Keeps Momentum Building for Nuclear Power (2022), https://perma.cc/ALA9-X86A; Cong. Budget Off., Estimated Budgetary Effects of H.R. 5376, the Inflation Reduction Act of 2022 (2022), https://perma.cc/4EPN-DFXX; Internal Revenue Serv., Fact Sheet: Frequently Asked Questions About Energy Efficient Home Improvements and Residential Clean Energy Property Credits (2022), https://perma.cc/R5B3-YH7U.
54. Medicare is about $1.2 trillion/year, and Social Security is $1.1 trillion/year. *FY 2023 Spending by Budget Function*, USA Spending, https://perma.cc/4DN5-8YMD.

Some, as we will discuss in Part IV, use rough proxies for additionality such as income, targeting low-income households or individuals. For example, the LIHTC has an income requirement for renters. As we will discuss, this provides a rough screen to exclude some non-additional individuals or households.

A small number of subsidies do have more rigorous additionality tests similar to those used in the carbon offsets world. These subsidies tend to be work substitutes: disability benefits, unemployment insurance, and Temporary Assistance for Needy Families (TANF). They require a case-by-case showing that even without the benefit, the individual would not have been able to obtain work in much the same way that proving additionality for offsets requires showing the level of emissions without the offset. The work requirement acts to ensure that there are no non-additional recipients. It is worth noting that such work requirements are often criticized as intrusive and expensive.[55] Proposals for simpler systems, such as a universal basic income, would eliminate these additionality tests.[56]

Table 1: Federal Subsidies with Additionality Problems

Safety Net Programs (FY 2023 costs)[57]	**Additionality Problem**	**Additionality Filters**
Medicare ($1.2 trillion)		
Provides health insurance to people over 65 with an eligible work history.	People might have purchased health insurance anyway.	None
Social Security ($1.1 trillion)		
Provides retirement benefits to eligible individuals (for the most part, people over age 65).	Pays benefits to people who have sufficient retirement savings.	None
Selected Tax Programs (2023 costs)[58]		
General Business Tax Credit (§ 38), made up of 35 different credits, including:		
Low-income housing tax credit (§ 42) ($10.5 billion): tax subsidy to developers to build housing for low-income renters.	Might pay for housing that would otherwise be built.	Income and rental tests for renters as a proxy.

55. *See, e.g.*, Nicholas Bagley, *Opinion: Enforcing Work Requirements is a Waste*, The Detroit News (Dec. 5, 2019), https://perma.cc/2HZX-UD8N.
56. Michael W. Howard, *The U.S. Could Solve Its Poverty Problem with a Universal Basic Income*, Sci. Am. (Jan. 6, 2023), https://perma.cc/5AP3-GRDY.
57. *FY 2023 spending by Budget Function*, USA Spending (Sept. 29, 2023), https://perma.cc/65HJ-EZKU.
58. U.S. Dep't of the Treasury Off. Of Tax Analysis, Tax Expenditures 22 tbl.1 (2023).

Research and development credit (§ 41) ($22 billion): 20% tax subsidy for the development of products or processes.	Might pay for research that would have been done anyway.	Applies for expenses above a base amount.
Charitable contribution deduction (§ 170) ($79 billion/year)		
Deduction for contributions to 501(c)(3) organizations.	Contributions made without the deduction.	None
Inflation Reduction Act (10 year estimates from revenue estimates)		
Clean energy production credit (§ 45Y) ($51 billion)		
Subsidy per kilowatt hour for electricity produced at qualified facilities.	Might subsidize facilities that would otherwise have been built.	None
Clean energy investment credit (§ 45E) ($51 billion)		
Provides a credit based on the costs of a qualified facility.	Facilities might have been built anyway.	None
Advanced manufacturing production credit ($31 billion)		
Tax credit for domestic production and sale of qualifying solar and wind components. The credits vary by the particular technology.	Credit might not be needed.	None

IV. Framing

Part II showed that the problem of additionality is ubiquitous, just as much a concern with the LIHTC and other subsidies as with offsets. In conversations with experts on carbon markets and environmental law professors over the past year, however, they seem clearly uncomfortable with this observation and push back, arguing that offset additionality is fundamentally different than additionality in other contexts. This reaction has been surprising to us but seems widely held. We set out the likely explanations for this below.

One reason why the commonality across all of these examples may not be widely recognized is that the language used in each area tends to be different. In the tax field, the problem is sometimes called "buying the base."[59] The "base" consists of the non-additional projects that are subsidized to get the additional projects. The cost of buying the base is the cost of the non-additional projects and reduces the cost-effectiveness of the subsidy. Buying the base, for example, was widely recognized as a problem with the Investment Tax Credit but solutions

59. *See, e.g.*, Lawrence Zelenak, *A Health Insurance Tax Credit for Uninsured Workers*, 38 Inquiry 106, 112–14 (2001).

were seen as unadministrable.[60] It would have been too complex to prove additionality, so inefficiencies were accepted as part of the program design.

Sometimes, rather than buying the base, tax subsidies for non-additional projects are described as receiving "windfalls."[61] Non-additional projects do not need a subsidy but get one anyway; hence they receive a windfall of undeserved funds. The same windfall terminology is sometimes used in the literature on environmental subsidies.[62]

In the development aid field, the problem of additionality is framed as one of "targeting."[63] The intuition is that a subsidy that goes to non-additional projects is badly targeted. Hence the literature seeks ways to improve targeting, to ensure that the money goes to those most in need.

Finally, in the industrial organization literature, the additionality problem is described as one of "price discrimination" (or more precisely, the lack of price discrimination).[64] If a business lowers the price on a good to attract an additional buyer, existing (non-additional) buyers of the good also benefit. They would have bought the good at the higher price. The industrial organization literature looks at ways that businesses try to prevent this non-additionality problem through various schemes to differentiate customers.

Notwithstanding the different terms, the problem is the same in all of these cases. Any time the government subsidizes an activity (or in the industrial organization case, a business lowers prices), it faces the problem of additionality. So why do environmentalists regard offsets as different? We think it results from framing that focuses on moral culpability, baselines, and metrics.

In the climate context, offsets are viewed as a *compliance mechanism*. Companies meet their net zero goal by purchasing offsets; therefore, lack of additionality undermines compliance. It falsely suggests emission reduction commitments by a country or business have been met. Lack of additionality seems a doubly bad act—it both harms the atmosphere and breaks a promise. The same is true for offsets in cap-and-trade systems. A non-additional offset is said to violate the integrity of the cap (and note the moral valence of the term, "integrity"). If the cap was set at 100 units of emissions, 5 units of non-additional offsets means that in fact 105 units of emissions will be released.

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60. *See, e.g.*, Laurence H. Meyer et al., *Designing an Effective Investment Tax Credit*, 7 J. Econ. Perspectives 189, 195 (1993); Jane Gravelle, *What Can Private Investment Incentives Accomplish? The Case of the Investment Tax Credit*, 46 Nat'l Tax J. 275, 282–84 (1993).
61. *See, e.g.*, Stanford G. Ross, *Tax Policy for Energy Investments – Where We Should Be*, 67 Proc. of the Ann. Conf. on Tax'n Held Under the Auspices of the Nat'l Tax Ass'n-Tax Inst. of Am. 513, 516 (1974).
62. *See, e.g.*, Carmen Arguedas & Daan P. van Soest, *On Reducing Windfall Profits in Environmental Subsidy Programs*, 58 J. Env't Econ. & Mgmt. 192, 200 (2009).
63. *See, e.g.*, Sarah Blodgett Bermeo, *Aid Allocation and Target Development in an Increasingly Connected World*, 71 Int'l Org. 735, 746–49 (2017).
64. *See, e.g.*, Hal R. Varian, *Chapter 10: Price Discrimination*, *in* 1 Handbook of Indus. Org., 597, 597 (1989).

In the eyes of the environmental law professors with whom we spoke, those using offsets are morally bad actors. They are polluters who should be regulated directly because they are actively harming the world. Their purchase of offsets promises to redeem them. If the offsets lack additionality, though, the results are doubly bad. The actors are both polluters and promise breakers. The atmosphere has more greenhouse gases and the polluter is "getting away with it" thanks to the fig leaf of ineffective offsets.

By contrast, it appears that lack of additionality for most subsidies means merely that a policy goal is not met efficiently. Paying for medical care for individuals who would otherwise have purchased it, as in the case of Medicare, may waste money but it is not viewed as undermining the integrity of the program, harming people, or letting bad actors continue their bad behavior. Low-income housing tax credits reduce the cost of housing, even if they do so inefficiently by not ensuring all credits generate new housing. Developers who build non-additional units are not necessarily bad actors harming the world. These and other programs suffer from lack of additionality, but unlike with polluters using carbon offsets, there is not an obviously bad actor. We can always just spend more on health care, housing, food, or other policies to meet our goals. Put another way, non-additionality in carbon offsets creates moral culpability that is not present when talking about subsidies more generally.

This argument, however, while attractive at first glance, does not meaningfully distinguish most subsidy programs from carbon offsets. To start, while there surely are bad actors, it is not obvious that all 5,200 companies and the 33 nations making net zero promises are morally culpable. Moreover, there are likely bad actors in many subsidy programs. To illustrate, while the morality of gentrification is complex and we take no position on it here, many view developers gentrifying poor neighborhoods as bad actors.[65] If they build non-additional low-income housing, subsidized by the LIHTC, they may claim that they have "offset" the gentrification because they have not reduced the number of low-income units on the market. If the units are non-additional, however, they have done no such thing. The problem is precisely the same as the bad carbon polluter who buys carbon offsets. Many subsidy programs can present similar problems with moral dimensions.

More importantly, the central goal for climate policy is reducing emissions. Most subsidy programs have similar types of goals, such as providing healthcare, housing, or nutrition for people who cannot otherwise afford these items. In all these cases, climate change and other policy areas, the goal is to get more of a good or less of a bad. We want fewer emissions of greenhouse gases, but also fewer food-insecure people, fewer people without access to housing or health care. Money "wasted" on actions or services that would have occurred anyway could have gone much farther to prevent harm to society if the funds

65. *See* Victor Couture et al., *Income Growth and the Distribution Effects of Urban Spatial Sorting*, Rev. Econ. Stud. (forthcoming 2023).

had been better directed to ensure additional good services and actions. For example, if school lunches are non-additional, the reduction in childhood food insecurity is not as large as we might have hoped in the same way that if offsets are non-additional, emissions of carbon dioxide do not go down by the amount promised.

The second framing that seems to distinguish between offsets and other policies focuses on baselines. Emissions reductions systems are about preventing a bad. They prevent actors from harming others. Non-additional offsets means we are allowing, or at least failing to prevent, individuals to harm others. Most subsidies, such as the LIHTC and various health-related problems, are about providing a good. They give people housing, healthcare, food, and similar items. Non-additional subsidies mean we fail to provide these goods, at least to the extent we thought we were providing them, but they do not permit actors to continue harm-causing behavior.

The law frequently treats preventing a bad differently than providing a good. For example, tort liability imposes an affirmative duty not to harm others but provides only very narrow duties to help them.[66] For similar reasons, we might think different about non-additional offsets than non-additional subsidies.

All of these cases, however, can equally be framed as preventing bads or providing goods. The LIHTC can be framed as preventing homeless and housing insecurity (preventing a bad) or as providing housing (providing a good). Health subsidies can be framed as preventing bad health outcomes or as providing medical care. Similarly, offsets can be framed as preventing or slowing climate change (preventing a bad) or as reducing emissions (providing a good).

To be sure, one framing or the other might seem more natural in various cases. Reducing emissions seems best framed as preventing a bad because it preserves or at least helps preserve the status quo climate. We think of the pre-industrial concentration of CO_2 as the environment we should be living in, as the appropriate status quo. The goal of climate policy is to prevent bad deviations from this status quo.

Housing subsidies might seem more like providing a good because the status quo includes a high level of homelessness and housing insecurity. SNAP provides a good because the status quo has a high level of food insecurity. But, as we know, that framing is largely arbitrary because it depends on a specification of baseline duties. If we, for example, view homelessness and hunger as intolerable, providing housing and food is more naturally framed as preventing a bad.[67]

The third framing that separates offsets and other policies turns on metrics. Offsets are usually linked to numerical targets while subsidy programs

66. *See, e.g.*, Marin Roger Scordato, *Understanding the Absence of a Duty to Reasonably Rescue in American Tort Law*, 82 Tul. L. Rev. 1447 (2008).

67. Moreover, the reasons the law often embraces the action/inaction decision are not present here. For example, one reason there is no, or only limited, duty to rescue in the common law is that imposing affirmative duties through the tort system would quickly become infeasible.

often do not use specific quantitative targets as measures of success. They are "price-based" rather than "quantity-based."[68] Returning to the example of offsets above, the offset was part of a cap-and-trade system with a target of 100 units of CO_2. If the offset is non-additional, the target is not met. Similarly offsets that are part of net zero promises mean that the target of net zero emissions is not met. Subsidies, such as Medicare, Social Security, the LIHTC, or the clean-energy subsidies in the Inflation Reduction Act, lower costs but do not aim for a particular quantity. For example, the production tax credit in the Inflation Reduction Act provides a subsidy of 0.3 cents per kilowatt hour regardless of how much electricity is produced.

This distinction breaks down, though, because all of these cases can equally be framed as a promise to meet a fixed target.[69] The Inflation Reduction Act, for example, eliminated the 200,000 vehicle/manufacturer quantity limit for the electric vehicle (EV) credit, turning it into a pure price-based system. At the same time, it imposed a phase-out of the clean energy credit when emissions reductions from the power sector are at 75% of the 2022 level, turning a price-based subsidy into a quantity target. Similarly, we can, and sometimes do, promise to reduce some other bad—lack of healthcare, housing, food, or something else—by a fixed amount. We might, for example, promise to provide universal health insurance, ensure that everyone has access to shelter, or to eliminate food insecurity—all quantity targets. A lack of additionality may cause the promise not to be met fully just as a lack of additionality means an emissions reduction target is not met.

In sum, lack of additionality with offsets are regarded as quite different than lack of additionality in other settings because of framings based on moral, baseline, and metrics considerations. Through these vantages, offsets can seem a very different beast. Once one steps back and considers social welfare, however, it becomes evident that the additionality problems facing offsets are, indeed, very similar and sometimes identical to those faced by many other policies.

To make these considerations more concrete, consider again the LIHTC program described in Part II. While considered a subsidy, in terms of additionality concerns it is very similar to carbon offsets. Both are programs designed to subsidize a fixed quantity of a socially valuable activity: housing for low-income individuals and emissions reductions. Both are created through the interaction of private actors with some sort of oversight. For the LIHTC, developers and

68. Note that offsets need not be quantity based. Offsets could be incorporated into a carbon tax by providing tax credits for emissions reductions outside of the tax system.

69. There is a large literature on similarities and differences between price-based and quantity-based systems. *See, e.g.*, Martin Weitzman, *Prices vs Quantities*, 41 Rev. Econ. Stud. 477 (1974). One of us has argued that there are no significant differences between the two and the choice is simply one of implementation. David Weisbach, *Instrument Choice is Instrument Design*, *in* U.S. Energy Tax Policy 113 (Gilbert E. Metcalf ed., 2011).

investors build or rehabilitate a housing unit to generate a credit, with the state housing agency and the federal government supervising the activity to ensure compliance with the rules for qualifying. For offsets, a polluter and an offset provider (such as the owner of a plot of land) create the credit, and their activities are supervised by either a government program such as California's cap-and-trade or a private program such as Verra.

In both cases, the credits can be traded. The LIHTC does not formally allow trading, but the credits are almost always sold through a syndication to raise funds to finance the housing project. Offsets that are a part of a cap-and-trade system can be sold within that program. That is, the market system in both cases is used to create the credits and to allocate the credits.

In both cases, there is a quantity cap. The LIHTC cap is determined by the formula that allocates credits to the states based on population. Each year, that number, and only that number, of credits are issued. Offsets within cap-and-trade systems work, or are supposed to work, to help the system meet its targeted emissions cap. Voluntary offsets, such as with corporate net zero promises, are supposed to help corporations meet their emission quantity goal.

Finally, although this language is not typically used, we could say that the lack of additionality undermines the integrity of the low-income housing program. The goal of the housing program is to create new low-income housing, to provide shelter for individuals and families who would otherwise lack shelter (or pay an undue portion of their income to obtain shelter). If the tax-credit finances units that are not additional, this goal has not been met, violating the integrity of the program. A fixed amount of money is dedicated to the program every year. Because there are a limited number of credits and some lack of additionality, less low-income housing is built than would have been built with complete additionality. Some individuals and families that really needed the units will not get them because fewer non-additional units have been built.

Similarly, the goal of emissions reductions programs such as cap-and-trade systems or net zero promises is to reduce emissions. If offsets are not additional, this goal is not met, undermining the integrity of the program. We might say that the net zero promise has been broken or that the cap in a cap-and-trade system has been violated or breached, but these are just different ways of saying that we have not gotten the emissions reductions we hoped to achieve.

In short, the LIHTC suffers from an additionality problem that is effectively very similar to the problem in the offsets world. In both cases, lack of additionality results in harm—unavailability of low-income housing for those in need or increased greenhouse gas emissions.

V. Managing Additionality

A. Six Approaches

If most subsidies suffer from the problem of additionality and if they rarely attempt to address the problem with the same stringent requirements for proof as in the carbon offsets world, then how do they manage the problem? In this Part, we set out the six different approaches that are used to address additionality. By examining how additionality is addressed across government programs, we can learn how to better address it in the carbon offsets world. Table 2 provides a summary of these approaches.

Table 2: Approaches to Managing Additionality

Approach	**Example**
Acceptance	Investment Tax Credit
Embrace lack of additionality	Social Security
Proxies	Medicaid
Ratios	Wetlands Mitigation Banking
Adjust size of the program	Infrastructure law EV charger subsidy
Proof of additionality	Unemployment Insurance

The first strategy to ensure additionality is one of simple *acceptance*. Some of the subsidy will go to non-additional activities, and there is no effort to limit the subsidy in any particular way. Non-additional subsidies under this approach are simply a cost of the program.

The now-expired investment tax credit (ITC) is an example of this approach. The investment tax credit, first introduced in 1962, provided a tax credit equal to a specified percentage of qualifying investment. For example, the ITC in 1962 allowed businesses to claim a tax credit equal to 7 percent of their gross investment in business equipment.[70] The goal was to stimulate investment. It was raised, lowered, repealed, and reinstated in various forms over the years. It does not exist today.[71]

Policy designers and academics recognized the problem of additionality with the investment tax credit early on. The concern was that tax credits could

70. *See* Laurence H. Meyer et al., *Policy Watch: Designing an Effective Investment Tax Credit*, 7 J. Econ. Perspectives 189, 189 (1993).

71. There is currently something called the investment tax credit, but it is not a general investment credit of the sort enacted in 1962.

go to investments that would have been made without the credit.[72] To that extent, the credit would not stimulate additional investment. Valuable resources would have been spent on non-additional activities. In fact, because so much investment happens each year in the ordinary course, it is possible that a very large fraction of the investment credit would be non-additional.

Policymakers and academics considered a number of ways to reduce the problems with additionality. One widely discussed method, eventually proposed in legislation by the Clinton administration in 1993, was to make the tax credit incremental.[73] An incremental credit in its purest form would only allow credits for investments that firms can prove would not have happened without the credit, an approach that resembles the approach taken for carbon offsets.

In practice, the incremental credit would have been for investments that exceeded an average of investments made in the past. Even this, however, was viewed as too hard to implement. The benefits of this additionality proxy were not thought to be worth the added complexity.[74] As a result, the investment tax credit, as enacted, never included provisions to address additionality. The problem of additionality was accepted as a cost of offering the credit.

A second strategy is to *embrace* non-additional subsidies, viewing them as a benefit rather than an unfortunate cost, as a feature rather than a bug, so no additional measures are warranted. The classic examples of this strategy are Medicare and Social Security. Neither program includes any provisions to address additionality, and, as a result, it is likely that a large fraction of the funds these programs distribute are non-additional. For example, many people over 65 would be able to afford their own health insurance even without Medicare, and many would have adequate retirement savings even without Social Security.

Supporters of these programs, however, view these non-additional payments as a benefit, not a cost. The reason is that providing payments to a broad cross-section of the population builds political support for the program. Theda Skocpol famously made this argument, noting that programs that are universal, that "benefit a broad, cross-class constituency", attract lasting political support.[75]

If instead, the program was limited to non-additional recipients, many people might not be willing to support the program because they do not receive the benefit. The saying, "programs for poor people are poor programs" reflects

72. Jane G. Gravelle, *What Can Private Investment Incentives Accomplish? The Case of the Investment Tax Credit*, 46 Nat'l Tax J. 275, 282 (1993).

73. For a discussion, *see id*. at 276–77, 281–84.

74. A related credit, the Research and Development (R&D) credit, took this path. The credit was allowed for 25 percent of the excess of current qualified R&D expenses over a company-specific and time-specific baseline. This was widely criticized as complex and as often discouraging rather than encouraging investment. *See* Robert Eisner et al., *The New Incremental Tax Credit for R&D: Incentive or Disincentive?*, 37 Nat'l Tax J. 171, 171 (1984).

75. Theda Skocpol, The Missing Middle: Working Families and the Future of American Social Policy 39 (2000).

this logic.[76] If programs like Medicare and Social Security were limited to non-additional recipients, they would likely be restricted to the poor. In that case, however, they would lack the broad political support that they currently enjoy, and, therefore, would likely be starved of resources.

A third approach is to use *proxies* for additionality. A proxy is a more easily measurable attribute that correlates with additionality. The most common proxy in subsidy programs is income. The underlying theory is that the lower your income, the less likely you could have purchased the subsidized item absent the subsidy. Therefore, income cut-offs serve as a proxy for additionality.

Medicaid, for example, uses an income proxy. It provides health care for individuals below an income threshold. The thresholds vary by state, but for states that have accepted Obamacare, the threshold is typically 138% of the poverty line.[77] There is no guarantee that everyone below that threshold would be unable to afford healthcare without Medicaid, which means that there are likely some non-additional recipients. The income cutoff, however, makes it likely that most recipients would not have otherwise been able to obtain healthcare and, therefore, are additional. Using the language of program design, the income threshold helps target the program to those most in need. Using the language of offsets, the income threshold helps prevent significant percentages of non-additional recipients.

The LIHTC uses an income proxy but only indirectly. There are no income limits on who may receive the credit. Instead, there are income limits on the renters in credit-subsidized housing and limits on the percent of their income that can be charged as rent. These income and rent limits make it less likely that the housing would have been built in the first place because if rents must be sufficiently low, the builder would have a hard time making a profit.

The old electric vehicle credit, now replaced by the IRA with a different credit, used a quantity limit rather than an income limit as an additionality proxy. (The current EV credit has an income limit.) The credit for each manufacturer was limited to, approximately, the first 200,000 vehicles sold by that manufacturer.[78] This can be seen as a proxy: the first vehicles a manufacturer sells might be less profitable because they rely on new technology and supply chains and, therefore, may not have been built absent the subsidy. Once a manufacturer has sold 200,000 vehicles, it likely will have sorted out technology and supply chain issues and no longer need the subsidy. Vehicles beyond the first 200,000 are likely to be non-additional.

A fourth approach uses simple mathematical formulas that adjust for the presence of non-additional activities. One version of this is to use what are

76. Ann Marie Marciarille, *The Medicaid Gamble*, 17 J. Health Care L. & Pol'y 55, 73 (2014).

77. *Status of State Medicaid Expansion Decisions: Interactive Map*, Kaiser Fam. Found. (Feb. 16, 2023), https://perma.cc/R265-LPNA.

78. It was not precisely the first 200,000 vehicles because of the way the limit was implemented if the threshold was met during the middle of the year.

sometimes called *ratios* or coefficients. A system that uses ratios requires more than one unit of emissions reduction offsite to offset one unit within the system. For example, a cap-and-trade system could require 1.5 units of offsets to generate 1 credit. Similarly, a corporation with a net zero promise could discount its offsets, so that more than one ton of emissions offsite are needed to account for one ton when estimating the corporation's net emissions.

Ratios have been used in non-climate change cap-and-trade systems, such as in wetlands mitigation banks. Under the Clean Water Act, parties that wish to dredge and fill navigable waters must apply for a permit.[79] One of the "404 permit" requirements is that a developer must mitigate for the harm caused. Over time, a large wetland mitigation banking industry has evolved that creates new wetlands (usually from former farm fields) and sells credits to the developers to compensate for the filled wetlands. In some respects, the mitigated wetlands serve as offsets for the lost wetlands. Because the created wetlands may fail at some point after the credits are released, though, regulators often require a ratio as added insurance. For example, a developer filling 10 acres of wetlands may be required to purchase credits for 20 or 30 acres in a wetlands mitigation bank. That is, a ratio of 2 or 3 is factored into the mitigation.[80]

A fifth, related approach is to *adjust the size* of the program. Like ratios, adjusting the size of the program allows the program to account for additionality without attempting to test for additionality on a case-by-case basis. To illustrate, suppose the goal of a subsidy is to create an additional 100 low-income housing units, but estimates show that 33 percent of the units created by the subsidy are likely to be non-additional. To achieve the 100 unit goal, we can create a subsidy that nominally pays for 150 units. If we do that, the policy will create 100 non-additional units.

While we are not aware of policies where this approach is made explicit, it seems implicit in the design of many policies, particularly those with quantity targets. For example, the 2022 Infrastructure Investment Jobs Act provided funding with the goal of installing 500,000 additional EV chargers by 2030.[81] It is almost a certainty, however, that some fraction of these would have been installed without the federal subsidy and, moreover, that the designers of the subsidy would have known this.[82] As a result, their true target for additional

79. For a thorough description of the mitigation permit process, *see* J.B. Ruhl & James Salzman, *No Net Loss? The Past, Present, and Future of Wetlands Mitigation Banking*, 73 Case W. Rsrv. L. Rev. 411, 415 (2022).

80. For an illustrative table of ratios used by the Army Corps of Engineers, *see* USACE, Ratios for Compensatory Mitigation 1 (2014), https://perma.cc/4B4Q-LGZD.

81. Surface Transportation Reauthorization Act of 2021, Pub. L. 117–58, § 11401, 135 Stat. 547 (2022).

82. For example, Fitch Ratings, summarizing the plan, noted that "[it] is unclear how many projects that may have proceeded with private funds will now benefit from federal grants." *Federal Spending to Rapidly Expand EV Infrastructure*, Fitch Ratings (Nov. 22, 2022), https://perma.cc/H5TK-SD4D.

EV chargers would have been lower. By setting the goal at 500,000 EV chargers, they would have known that they were actually adding, say, 200,000 extra chargers compared to what would have been built without the subsidy.

The sixth and last approach used outside of the carbon offsets setting is to use the same approach as offsets, requiring case-by-case *proof of additionality*. The federal unemployment insurance program takes this approach. It requires recipients to show that they are actively searching for work, which means that if they are unemployed, they are unable to find work.[83] This requirement is, in effect, an additionality requirement. Temporary Assistant for Needy Families (TANF) and disability insurance have similar requirements to show additionality.

Note, however, that the approach taken by TANF, disability insurance, and unemployment insurance has been widely criticized as burdensome and intrusive.[84] There is a substantial movement to shift away from these sorts of showings of need to a simpler universal system, such as a universal basic income (UBI).[85] A UBI would mean that most recipients are not additional, in the sense that they do not need the money. The rationale is, in part, based on the theory that testing for additionality is too difficult and burdensome.

B. Explaining the Differences

If the sixth approach, requiring proof of additionality, is the most likely to ensure additionality, why is it used so infrequently? We suspect that the following factors play important roles in the reluctance to require proof of additionality.

A primary factor is the likelihood of non-additionality in a particular program. That is, what is the ratio of non-additional projects to additional ones? If there are likely to be few non-additional projects, it is not worth the cost to use complex measurement systems to weed out the non-additional projects. Instead, it may be simpler and cheaper to simply accept that even if some projects will be non-additional the program goals can still be met. Conversely, if there is a large number of non-additional projects for each additional project, it may be desirable to attempt to weed out the non-additional projects.

For example, there may be only a small number of non-additional low-income housing projects. Developers are not waiting in the wings to build housing for poor people. As a result, lack of an additionality test (beyond the income proxy for tenants) for the LIHTC may not cause great harm. The potential pool of non-additional carbon offsets, however, may be almost infinite. Every forest and every farm could potentially claim to store carbon in the plants or soils. As a result, it may be infeasible to have no additionality test at all in the climate context.

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83. *Work Search Requirements*, Nat'l Emp. L. Project (Oct. 2, 2022), https://perma.cc/ED5B-YD2W.
84. *See* Bagley, *supra* note 55.
85. *See* Howard, *supra* note 56.

A second related issue is whether it is feasible to measure additionality and what the costs of doing so are. If it is expensive or infeasible to measure additionality, doing so will often not be worth the cost. Equally, if measurement costs are not unduly high, imposing stringent additionality requirements may be desirable.

Consider, for example, distribution of subsidies after natural disasters or a pandemic. When there is an urgent need for action, government leans toward the "simple acceptance" end of the spectrum and might just issue every citizen a check (as happened with COVID-19).[86] During a sharp recession, when it is of paramount importance to get money circulating through the economy, some of the subsidy ending up in bank accounts of people who are wealthy enough to save it rather than spend it back into stimulus is an accepted inefficiency. This is viewed as a small price to pay for the urgent stimulus needed.[87]

Third, all of the choices for additionality considered above generate incentives. The stringent tests for additionality used by unemployment insurance and disability insurance, for example, are motivated by concerns about perverse incentives. Without a stringent test, some argue, people will simply claim these benefits rather than looking for gainful work. Moreover, people will not have incentives to gain skills and develop human capital because they can rely on these programs.[88]

Crude proxies for additionality also have the potential to create bad incentives. For example, many of the programs we have highlighted use income as a proxy for additionality. This proxy, however, creates an incentive to reduce income, for example, by working less.[89]

There is likely no way to design a system to get incentives perfectly right. The challenge in designing a system to address additionality is to understand the incentives it creates and to try to minimize the bad incentives.

Finally, the choice of tests for additionality will affect the political support for the programs. As noted, universal safety net programs may be universal to generate political support for the programs. We also suspect that the stringent additionality tests for TANF, unemployment insurance, and disability insurance are needed to ensure political support for these programs. If they were seen as benefiting non-additional individuals, support would drop.

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86. *See generally A Guide to COVID-19 Economic Stimulus Relief*, Consumer Fin. Prot. Bureau (July 7, 2020), https://perma.cc/9QNE-T4WV.

87. *See, e.g.*, Lorie Konish, *How Effective Were Those Stimulus Checks? Some Argue the Money May Have Fueled Inflation*, CNBC (June 11, 2022), https://perma.cc/39ES-5UBK.

88. Rick Newman, *Unemployment: How the Lazy Are Hurting the Needy*, U.S. News & World Rep. (Apr. 3, 2012), https://perma.cc/QB2T-NALB.

89. *See, e.g.*, Eric Morath, *Coronavirus Relief Often Pays Workers More Than Work*, Wall St. J., (Apr. 28, 2020) (explaining how workers getting COVID support checks earned more from income support than from going back to work).

C. Putting the Toolkit to Work

An examination of how subsidies address the problem of additionality suggests a number of lessons.

To start, neither of the first two approaches—*acceptance* or *embracing lack of additionality* are likely to work in the context of carbon offsets because the base of non-additional carbon offsets is too large. Without any additionality test, non-additional offsets would swamp the market. Lack of additionality for carbon offsets is an important concern. We should not turn a blind eye or simply shrug to the possibility of bogus offsets, happily paying parties for actions that would have occurred anyway.

Most subsidy programs tolerate some degree of non-additionality in a way that does not seem to be the case for offsets. The difference seems to be the way that the programs are framed. Most subsidies are framed as an attempt to improve social welfare, such as by providing healthcare, housing, or nutrition. That some of the subsidy is imperfectly targeted is viewed as a cost, but not a fatal flaw. The framing of offsets as part of a promise makes the same non-additionality seem worse. Thus a second lesson is that changing the framing of the problem may open the space for a broader set of solutions.

There is some movement to reframe offsets more similarly to the way subsidies are framed. Offsets are increasingly viewed as contributions to the environment rather than iron-clad promises to meet an emissions goal.[90] This movement away from offsets as a mechanism to achieve net zero goals would lessen concerns over imperfect measurement of additionality while the offsets market develops.

The most common approach to additionality for subsidies is to use broad-based proxy measures, with the understanding that the proxies will not be perfect and that some offsets will not be additional but that enough will be to make the program worthwhile. A third lesson is that this approach may have promise for carbon offsets.

For example, forestry projects can be targeted to specific regions where deforestation is a serious risk.[91] Agricultural offsets can be targeted to places where agricultural practices are the least climate friendly. Crude proxies will mean that some offsets are not additional. John Oliver will still be able to find, and giggle at, offsets credits that go to forests that were never going to be logged. To be sure, using proxies means that some projects that would have actually

90. *Carbon offsetting vs. Climate contribution,* ClimateSeed (Oct. 2, 2020), https://perma.cc/D286-LYQP.

91. *See, e.g.*, Sven Wunder et al., *Payments for Environmental Services: Past Performance and Pending Potentials,* 12 Ann. Rev. Res. Econ. 209 (2020) (calling for better spatial targeting to ensure site selection for payments is in high threat areas); Arthur van Benthem & Suzi Kerr, *Scale and transfers in international emissions offset programs*, 107 J. Pub. Econ., 31 (2013) (finding the use of broad baselines improves offset efficiency).

been additional may not be eligible for offsets but that is no different than other government programs.[92]

The goal in developing a proxy is to find a measure that correlates with additionality but is easily observable and not easily manipulated. The best proxies will likely vary by the type of offset and perhaps also with the location of the offset. We see this in the subsidy world: as discussed, income is a common proxy for additionality but other proxies, such as the prior year's activities, are used for some subsidies. The same will likely be true for carbon offsets, and in fact the offsets world has started moving in this direction.[93]

The crudeness or error rate of the proxy should depend on the base of non-additional projects. If the number of non-additional projects is limited, a crude proxy may work because it will not induce a large number of non-additional offsets. If, however, the supply of non-additional projects is large, the proxy may need to be more refined. For example, there is a large volume of carbon stored in the world's existing forests, which means that the supply of non-additional forestry projects is large. Forest offsets, as a result, need a relatively accurate proxy for additionality to avoid being swamped with non-additional offsets. For example, a proxy might need to take into account both past-year's activities (e.g., recent trends in deforestation in a jurisdiction) as well as economic conditions that might alter those trends in order to have a sufficiently precise prediction of deforestation in the hypothetical world without offsets.

Proxies must also account for manipulation and adverse selection. In particular, the offset supplier and purchaser should not be able to influence the proxy. Verra's use of existing regulatory requirements is flawed for this reason: relying on a lack of regulatory requirements as a test of additionality simply invites less regulation. Similarly, proxies must prevent offset suppliers from selecting into a proxy only when it produces favorable results. Simple trends, such as trends in deforestation, may allow offset suppliers to choose years when economic forces would have reduced deforestation without offsets.

Proxies also need to be dynamic. Subsidy programs that use proxies often require the use of recent information, such as the prior year's income or recent trends in investments. Offsets should similarly use recent information. One approach for ensuring that offsets are based on recent information is to compare an activity subject to an offset, such as forestry in a given area, to current trends in a closely related but unaffected area, as in a horse race. The trends in the

92. For example, California has moved in this direction, using a standardized system for measuring additionality instead of individual, tailored measurements. For a discussion of California's approach, *see* Barbara Haya et al., *Managing uncertainty in carbon offsets: insights from California's standardized approach*, 20 Climate Pol'y 1112 (2020).

93. In particular, investment credits sometimes allow a credit only to the extent investments exceed the prior year's investment.

unaffected area act as a proxy for what the deforestation would have been in the area subject to the offset in real time.[94]

Finally, additionality measurements should consider using formulas, such as ratios, to account for the inevitability of non-additionality. If, for example, we expect 50% of a type of offset to be non-additional, the offset might require two tons of CO_2 to be stored in order to generate one ton of credits.[95] Alternatively, a company with a net zero promise can revise its target to be net negative. Complying with the net negative target would cost more, just as paying for non-additional Medicare recipients costs more, but the savings in administrative expense and the benefits of honesty about the problem may be worth it.

It is important to note that science will be integral to all these approaches. In particular, developing workable proxies for additionality for nature-based offsets will require making predictions of future behavior based on observations of prior behavior or on the current behavior of comparables. This will require broadly accepted and inexpensive techniques for measuring the carbon stored in forests and soils as well as data-science techniques to develop workable proxy formulas.

Conclusion

In a perfect world, we should not pay parties for actions that would have occurred on their own. But our world is an imperfect one, increasingly imperiled by the threat of climate change.

The central goal of this article is to show that the problem of additionality is ubiquitous. Other programs, programs with far more money at stake and a much longer history of policy development have developed a full toolkit to manage the additionality problem. We should look to the six strategies set out in Part IV and consider whether they can help restore carbon offset credibility.

The one option that should *not* be on the table is rejection of offsets as fatally flawed. The LIHTC and a wide range of established government programs suffer the same flaw, and they are not tossed with scorn on the sacrificial pyre. The assumption in the carbon offsets world that lack of additionality represents a fatal flaw should be rejected. Much work needs to be done to ensure credible offsets. The additionality toolkit developed for subsidies provides an important guide that we should follow.

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94. In effect, this approach uses the difference-in-differences method of estimating effects in economics as a policy rather than simply a method of empirical estimation.

95. For a discussion of ratios, *see* Ben Groom & Frank Venmans, *The Social Value of Offsets*, 619 Nature 768 (2023); *see also* Arthur van Benthem & Suzi Kerr, *Scale and transfers in international emissions offset programs*, 107 J. Pub. Econ. 31 (2013) (considering "discounting" of offsets). A similar approach has been proposed for carbon cap-and-trade programs. Brian Murray et al., *Designing Cap-and-trade to Correct for "Imperfect" Offsets* (Nicholas Inst. for Env't Pol. Sols., Working Paper EE 10–03 V2, 2012).

APPENDIX

Examples of Federal Subsidies with Additionality Problems

Safety Net Programs (FY 2023 costs)[96]	**Additionality Problem**	**Additionality Filters**
Medicare ($1.2 trillion)		
Provides health insurance to people over 65 with an eligible work history. Coverage includes hospital (Part A), outpatient care (Part B) and prescription drug costs (Part D).	Pays for people who would otherwise have purchased health insurance.	None
Social Security ($1.1 trillion)		
Provides retirement benefits to eligible individuals (for the most part, people over age 65). About 70 million people receive Social Security each year.	Pays benefits to people who have sufficient retirement savings.	None
Social Security Disability Benefits ($24 billion)		
Provides payments for individuals unable to work due to a disability.	Might pay disability benefits for people who are not disabled.	Have to show you are unable to work.
Medicaid and CHIP (Medicare: $640 billion, CHIP: $19 billion)		
Provides health insurance to poor adults and children. Covers 72.5 million individuals.	Families might have been able to purchase health care without Medicaid or CHIP.	Income as a proxy.
TANF ($16.7 billion)		
Income support for families and children in poverty.	Might provide support for families that otherwise do not need it.	Income plus job search rules. Administered at the state level, so rules vary by state.

96. USA Spending, https://perma.cc/65HJ-EZKU.

SNAP ($121 billion in 2022)		
Vouchers for food purchases by low-income families. Cost varies with the economy. 2022 cost was $121 billion. 2019 cost was $64 billion.	Might provide food for people who would or could otherwise buy food.	Income and asset tests as proxy: Household income must be at or below 130 percent of the poverty line. Plus asset tests.
Child nutrition programs ($37 billion)		
Provides nutrition for low-income children such as school lunches.	Might provide nutrition for children who would otherwise be able to get it.	Income eligibility tests, such as family income at or below 130 percent of poverty line.
Unemployment insurance (Federal cost: $125 billion)		
Payments for individuals who recently lost jobs. State implemented. Most states provide up to 26 weeks of payments, replacing 30-50 percent of wages.	Might provide wage substitutes for people who can otherwise work.	Active search for work requirement plus time cut-off.
Selected Tax Programs (2023 costs)[97]	**Additionality Problem**	**Additionality Filters**
General Business Tax Credit (§ 38), made up of 35 different credits, including:		
Low-income housing tax credit (§ 42) ($10.5 billion): tax subsidy to developers to build housing for low-income renters.	Might pay for housing that would otherwise be built.	Income and rental tests for renters as a proxy.
Research and development credit (§ 41) ($22 billion): 20% tax subsidy for activities related to the development, design, or improvement of products or processes.	Might pay for research that would have been done anyway.	Incremental: credit only applies for expenses above a base amount.

97. U.S. Dep't of the Treasury Off. Of Tax Analysis, Tax Expenditures 22 tbl.1 (2023).

New Markets Tax Credit (§ 45D) ($1.2 billion): tax subsidy for investments in investment in low-income communities. Competitively allocated to intermediates that select investment projects.	Might pay for projects that would otherwise have been built.	Use of intermediaries that might be able to use local knowledge to invest only in additional projects.
Orphan drug credit (§ 45C) ($2.8 billion): 25% subsidy for research into cures for certain rare diseases. Two part test: (i) disease affects fewer than 200,000 people in the US or (ii) more than 200,000 but no reasonable expectation that costs will be recovered.	Might pay for research that would have otherwise occurred.	Core idea is that little of this research would otherwise be done. Second test looks like an additionality test.
Personal credits		
Tax credits for postsecondary education (§ 25A) ($14 billion): made up of the American opportunity tax credit and the lifetime learning credit. Subsidizes tuition for eligible students.	Eligible students might otherwise have been able to pay for tuition.	Income limits.
Child credit (§ 24)($67.5 billion): $2,000/child credit. Increased during the pandemic and made refundable, but these changes expired. One goal is to reduce childhood poverty.	Poor targeting: many children and households do not need the credit.	Income limits.
Earned income tax credit (§ 32) ($2.7 billion): provides subsidy for low earners. Tries to combine low-income support with work incentives. Have to have earned income to be eligible.	Might subsidize people who would otherwise work.	Earned income phase in so only workers get it and income phase out.

Bonus Depreciation (§ 168) ($31 billion)		
100% expensing on qualified property placed in service before 1/1/23. Phases out by 2027. Qualified property is generally property with a life of less than 20 years. Goal is to promote investment.	The investment might have otherwise been made.	None
Exclusion of employer health insurance ($225 billion/year)		
Health insurance provided by employers is not taxed. The purpose is unclear.	Employers might provide health insurance even if it were taxed.	None
Charitable contribution deduction (§ 170) ($79 billion/year)		
Deduction for contributions to 501(c)(3) organizations.	Contributions might have been made without the deduction.	None
Inflation Reduction Act (10 year estimates)[98]	**Additionality Problem**	**Additionality Filters**
Clean energy production credit (§ 45Y) $51 billion)		
Subsidy per kilowatt hour for electricity produced at qualified facilities. Domestic content requirement.	Might subsidize facilities that would otherwise have been built.	None
Clean energy investment credit (§ 45E) ($51 billion)		
Provides a credit based on the costs of a qualified facility. Domestic content requirement.	Might subsidize facilities that would otherwise have been built.	None
Advanced manufacturing production credit ($31 billion)		
Tax credit for domestic production and sale of qualifying solar and wind components. The credits vary by the particular technology (e.g., thin film photovoltaic cells compared to photovoltaic wafers).	Credit might not be needed.	None. Possible that the credit rates for each technology were chosen to fill profitability gaps.

98. Cost estimates are from the revenue estimates. Note that these are 10-year costs, while the rest of the table uses 1-year costs.

Zero-emission nuclear power production credit ($30 billion)		
Tax credit for existing nuclear power plants, with the goal of keeping them in operation.	Some might have stayed open without the credit.	None
Residential energy efficient property credit ($22 billion)		
Extends and increases the existing tax credit for residential energy efficient property, such as solar electric property.	Property owners might have installed energy efficient items anyway.	None
Electric vehicle credits ($14 billion)		
$7,500 credit for the purchase of EVs. Domestic content requirement.	Might have been purchased anyway.	Income limits.