Economics 134 L12. Environmental offsets

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Environmental offsets
- Definition and rationale
- Monitoring quality
- Adverse selection

California forest offsets
- California carbon market
- Empirical strategy
- Results

Environmental offsets

Today we continue our study of environmental markets.

Sometimes, activities can be undertaken to **offset** environmental destruction.

We call these activities "**environmental offsets**."

Useful to distinguish between two kinds of environmental offsets:

- **voluntary —** e.g., buying "carbon offsets" to offset the emissions from flying
- **mandated —** e.g., offsetting activities mandated by an environmental impact assessment during a land use permitting processes

Both of these are types of environmental markets.

Should we encourage environmental offsets?

For us, two key economic questions:

1. how costly are offsets relative to "direct" environmental protection (or allowing the environmental destruction to proceed)?
2. are offsets "good substitutes" for direct environmental protection?

The first question is the same we asked about environmental markets

- if some people or firms can supply environmental protection at lower cost, then it is **efficient** to incentivize them to do so!

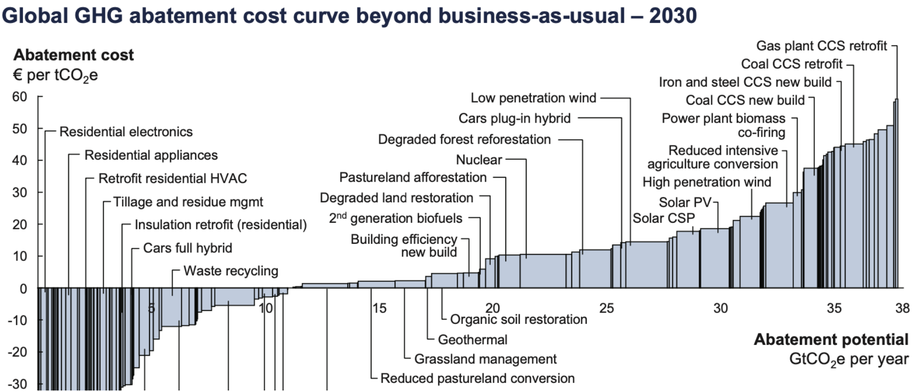
The second is a new concern

- key problem: the quality of offsets is often difficult to verify and monitor
- the **certification system** for offsets becomes crucially important

1. How costly are offsets?

Usually much less costly.

McKinsey's marginal abatement cost curve



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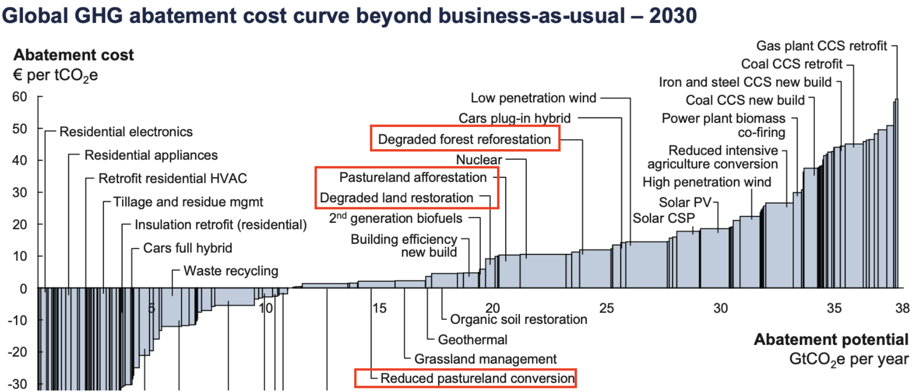

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WSJ

Turning Brazilian Farmland Back Into Forest Gains Some Traction

Microsoft says it will buy 8 million tons of carbon offsets in a top agro-state to transform farm acreage into forest. The investment comes as credits to protect existing forests have lost credibility.

By Paulo Trevisani

June 18, 2024 at 6:55 am ET | WSJ PRO

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The project, in the major grain- and beef-producing state of Mato Grosso do Sul, aims to buy up farm and pasture and cover it once again with trees. Half the terrain will go to dozens of native species such as ipê and jatobá, and the rest to trees for timber, mostly eucalyptus.

BTG TIG is a timber organization owned by Brazilian investment platform BTG Pactual. A dollar amount for the Microsoft deal wasn't disclosed.

"There have been two stories of carbon markets," said Mark Wishnie, chief sustainability officer at BTG TIG. "One is a much-reported criticism of specific carbon projects ... that has battered the markets to a certain degree."

The other story, however, concerns "high-

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dioxide from the air, he said, but also regenerate habitat for animals and other organisms to thrive while providing extra income to local communities.

Four-month-old eucalyptus trees planted in rows alongside naturally regenerating greenery in Brazil's Cerrado region. PHOTO: TIG

Microsoft's investment is part of a plan by BTG TIG, in partnership with nonprofit Conservation International, to gather $1 billion to buy, lease or otherwise invest in more than 135,000 hectares (333,592 acres) of farmland, an area nearly 23 times the size of Manhattan, over a five-year period ending in 2027 and return it to forest.

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2. Monitoring offsets

Are offsets "good substitutes" for direct environmental protection?

Depends on

1. what type of environmental **benefit** the offset creates
2. the **counterfactual**: what would have happened if the offset were not bought

1. **Benefit**. Need to monitor
   - future outcomes—e.g., if the offset is a forest to reduce carbon emissions, then it matters whether the forest is cut down in five years or if the forest is (eternally) sustained with new trees as old trees die
   - displacement—saving a forest might induce greater deforestation elsewhere

2. Ideal counterfactual: offset project would not have taken place
   - difficult to assess
   - often assumes a "**baseline scenario**" that is untestable

Monitoring quality

Example. Suppose that

- the marginal social cost of one ton of carbon is \$10/ton
- we can capture one ton of carbon by planting trees, for costs that range between \$5–\$20/ton

Solution: We should plant all trees that cost \$10/ton or less.

- we can implement this with a **subsidy** of \$10/ton for tree carbon capture
  - all trees that cost no more than \$10/ton to plant will be planted
  - the more expensive trees will not be planted!
- this is just the Pigouvian tax, which happens to take on a negative value

Monitoring quality, cont'd

Example, cont'd. Continue to suppose that

- the marginal social cost of one ton of carbon is \$10/ton

Now also suppose that

- each tree will successfully grow with probability $p = 0.9$ and fail otherwise

Solution: We should plant all trees that cost \$9/ton or less.

- Why? Because we should subsidize them for their **expected** externality:

$$0.1 \cdot 0 + 0.9 \cdot \$10/\text{ton} = \$9/\text{ton}$$

Discussion

- when offsets have uncertain quality, we should take this into account in the design of our economic policies
- here, need to **adjust** the Pigouvian tax (subsidy) to account for the probability that the offset does not always work perfectly
- an assumption in the above example: the unknown quality of the offset project did not depend on its cost
- we will now see what happens when this is not the case $\hookrightarrow$

Monitoring quality, cont'd'd

Example, cont'd. Now suppose that

- the marginal social cost of one ton of carbon is \$10/ton
- all trees cost less than \$10/ton, but every third tree costs \$0 to plant (and was going to be planted regardless!)

Solution:

- we do **not** want to subsidize the trees that would be planted no matter what
- why? they trap carbon, but the **marginal** social value of subsidizing these trees is zero because the subsidy does not affect whether the tree is planted
- if we can observe which trees are inevitable, then we subsidize the rest
- if we cannot observe this, it becomes more complicated
  - if we subsidize with the "average" marginal social value, $\frac{2}{3} \cdot 10$, then some trees that cost more than \$6.67/ton will not be planted...
  - this is not efficient

Monitoring quality with adverse selection

Another example. Suppose that each potential offset project i

- has environmental quality (positive environmental externality) worth v_i
- v_i is distributed uniformly on $[0, 1]$.

Then the **average** quality, $\mathbb{E}[v_i]$, is $1/2$.

$\hookrightarrow$ while some projects are worth more than $1/2$, without additional information, society on average obtains only $1/2$ for a project drawn at random from $[0, 1]$.

Finally, suppose that the cost of undertaking a project is c_i, and that it **correlates** with quality so that

$$c_i = \frac{2}{3} v_i.$$

That is, higher-quality projects cost more.

Monitoring quality with adverse selection

Suppose we use the policy from before, where we reward each project with a subsidy s equal to its expected value,

$$s = \mathbb{E}[v_i] = 1/2.$$

What happens?

- each offset project i with $c_i \leq s$ will be undertaken
- offset projects with $c_i > s$ will not be undertaken.

Adverse selection, cont'd

Consider the set of offset projects that are undertaken ($c_i \leq s$).

Since $c_i = \frac{2}{3}v_i$, we know that $c_i \leq s$ is the same as

$$\frac{2}{3}v_i \leq s.$$

When $s = 1/2$, we obtain $\frac{2}{3}v_i \leq \frac{1}{2}$, or

$$v_i \leq \frac{3}{4}.$$

This is the **selection** problem: the offsets undertaken are only those with $v_i \leq \frac{3}{4}$, as opposed to all $v_i \in [0, 1]$.

In particular, since $v_i \sim \text{Unif}(0, 1)$, the average value of subsidized offsets is only

$$\mathbb{E}\left[v_i \,\middle|\, v_i \leq \frac{3}{4}\right] = \frac{3}{8},$$

which is **less** than $1/2$!

Discussion

- when the uncertain environmental benefit correlates with the project's cost, then how we incentivize offsets can affect their average environmental benefit
- here, when higher-quality projects are also more expensive, we get what is known as **adverse selection**
  - lower-cost projects select into the offset regime
  - because lower-cost projects have lower quality, this lowers the average quality
- need to **condition** on how the policy itself will affect the expected value of the offsets

Brief detour involving a philosopher

So far, two arguments "against" using offsets

1. may not actually deliver true quality
2. policies may lead to adverse selection

Sometimes also argued that offsets can **undercut** other pro-environmental actions. . .

Brief detour involving a philosopher

Michael Sandel (1997), Harvard philosophy professor:

> *Despite the efficiency of international emissions trading, such a system is objectionable for [several] reasons.*
>
> *[...]*
>
> *[T]urning pollution into a commodity to be bought and sold removes the moral stigma that is properly associated with it.*
>
> *[...]*
>
> *A[nother] objection to emission trading among countries is that it may undermine the sense of shared responsibility that increased global cooperation requires.*

California's carbon cap-and-trade (AB 32)

California has a cap-and-trade that covers 75% of the state's carbon emissions

- offsets can be used by polluting firms to comply with their legal obligations

Prospective offset projects follow detailed rules from the California Air Resources Board (CARB)

- projects submit an application to CARB
- CARB evaluates applications, decides how many offsets to award, if any
- projects then can sell credits to firms

By September 2020, **193 million offsets** (each 1 tCO_2), valued at $2.6 billion at market prices ($13.67/credit).

More than 80% are for "improved forest management." $\hookrightarrow$

Forest offsets

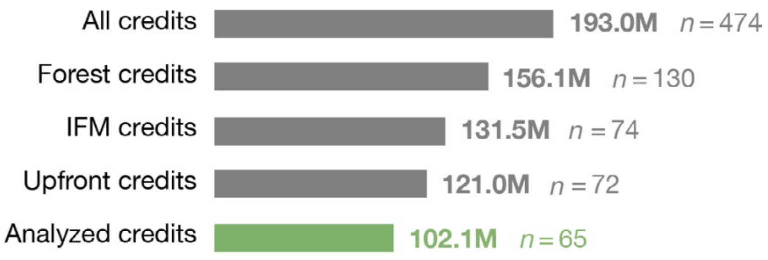


FIGURE 1 California's carbon offsets program. As of our study cutoff date of September 2020, the California Air Resources Board had issued 193 million offset credits, each worth 1 tCO_2e, to 474 projects.

Source. Badgley et al. 2022, Figure 1

How California approves offsets

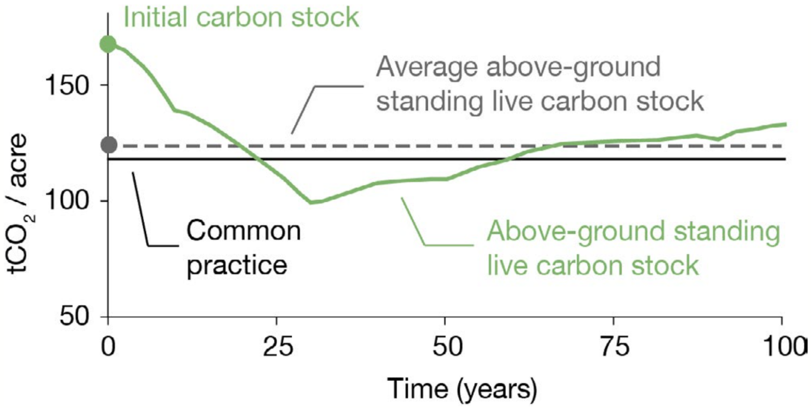
Offset credits are rewarded for improved forest management that increases carbon above modeled **baseline** scenarios

- give credits to landowners who claim that, without the credit, they would cut down the forests according to a baseline scenario
- landowners can only claim scenarios above the regional average prediction for the next 100 years

Then, they obtain credits equal to the difference between

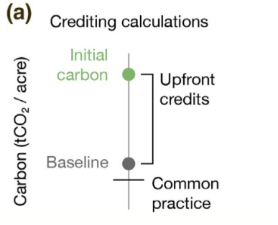
- **initial** carbon stock (observed)
- the **long-run counterfactual stock** (baseline)

Carbon offsets for forest management



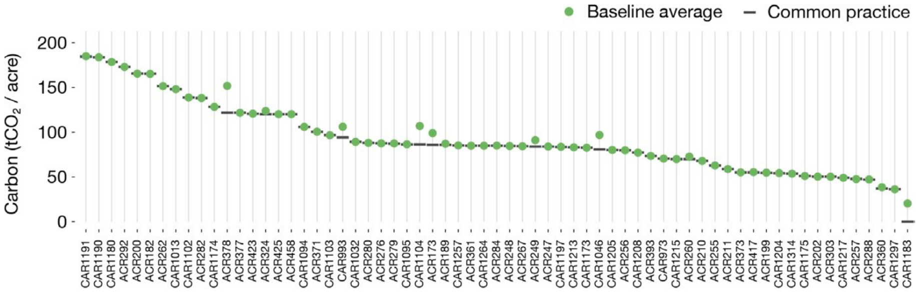
- **Solid green line** is the counterfactual "baseline" — when the landowner claims the forest will be cut down without offset payments
- implies a **long-run baseline average** (grey dashed line)
- if this is above the regional average (**black** line), proposal is approved

Assigning offset credits to projects



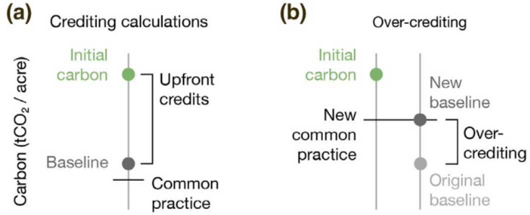
Source. Badgley et al. 2022, Figure 4

Virtually all projects max out on credits



Source. Badgley et al. 2022, Figure 3

"Over-crediting" if the baseline is overly pessimistic



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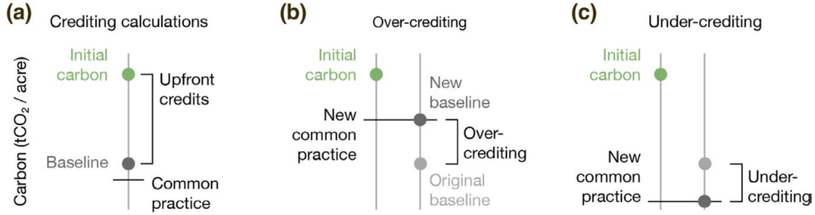


Source. Badgley et al. 2022, Figure 4

Recalculating the baselines

Recent work evaluating the 100-year predictions:

- Badgley et al. (2022) "Systematic over-crediting in California's forest carbon offsets program," Global Change Biology, **28**:1433–1445.

Research design:

- replicate California's method for predicting 100-year classifications based on geographic regions ($R^2 = 0.97$)
- develop an alternative, more "ecologically robust" definition controlling for different species of trees
  - e.g., Douglas Fir and tanoak (more carbon-dense, 122.5, 192.5 tCO_2/acre) versus ponderosa pine (60.4 tCO_2/acre)
- use classification algorithm to predict forest types to recalculate more appropriate baseline

Adverse selection

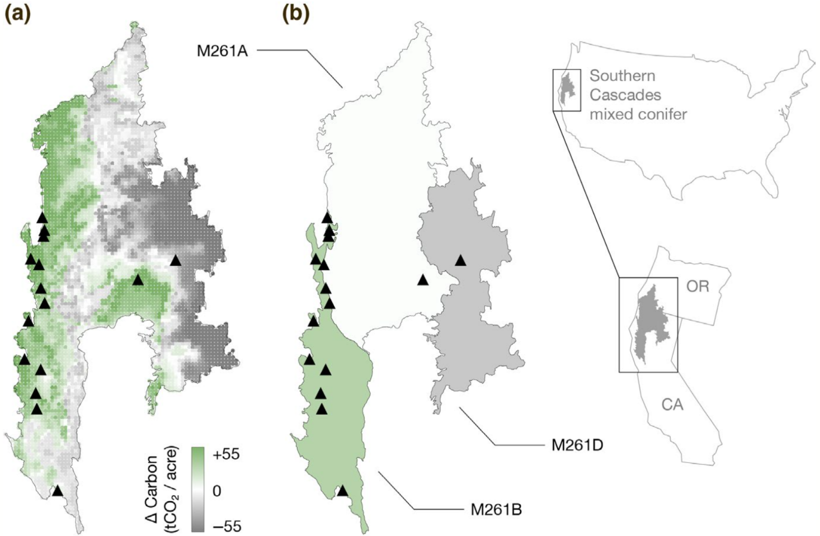
Example: Southern Cascades

- Ecosystem M261B, carbon-dense: 150.5 tCO_2/acre
- Ecosystem M261A, M261D, less dense: 120.6, 100.6 tCO_2/acre

Average for all is 121.8 tCO_2/acre.

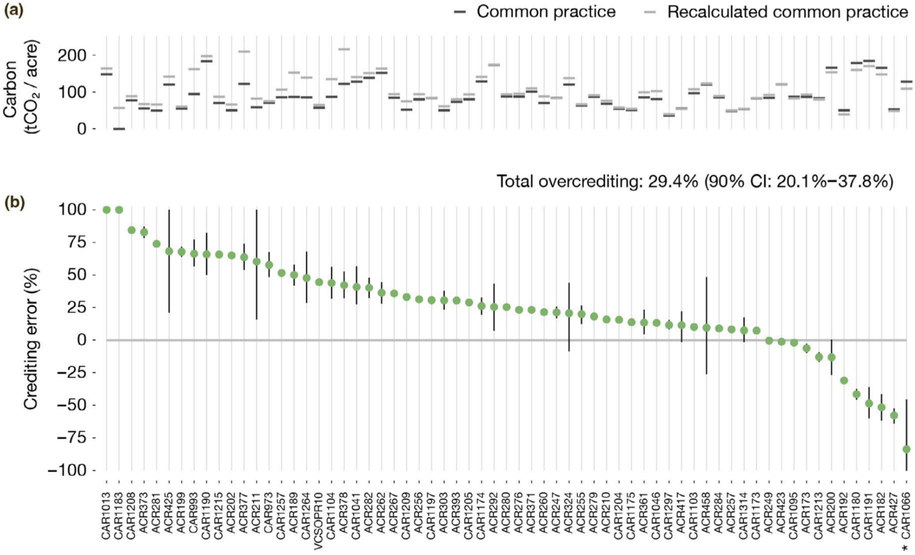
-19% less than the M261B average!

Adverse selection



Mixed conifer assessment area in the Southern Cascades (Badgley et al. 2022, Figure 6).

Estimated crediting error by project



Source. Badgley et al. 2022, Figure 5

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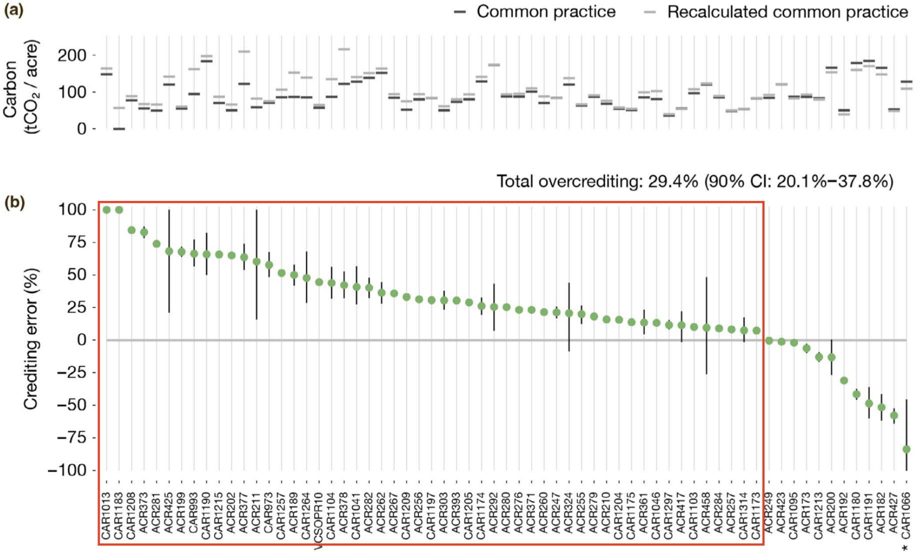

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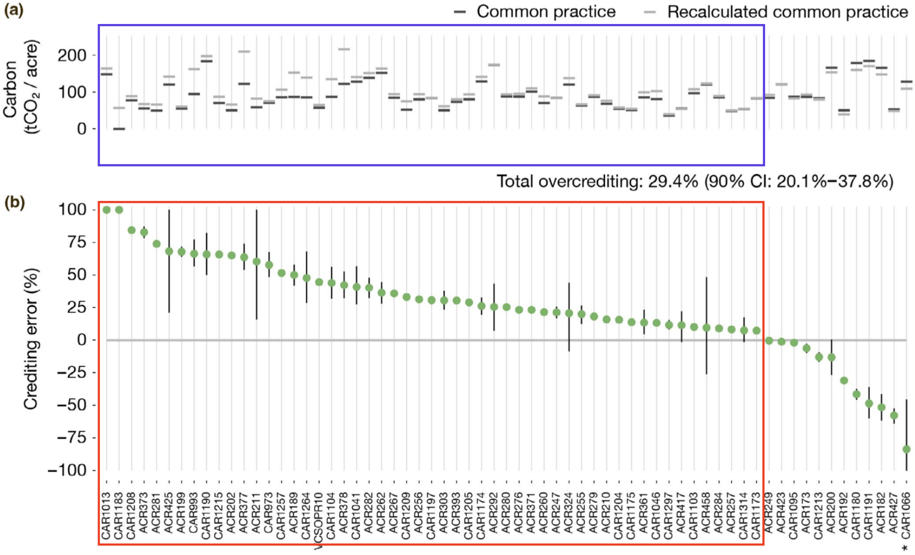

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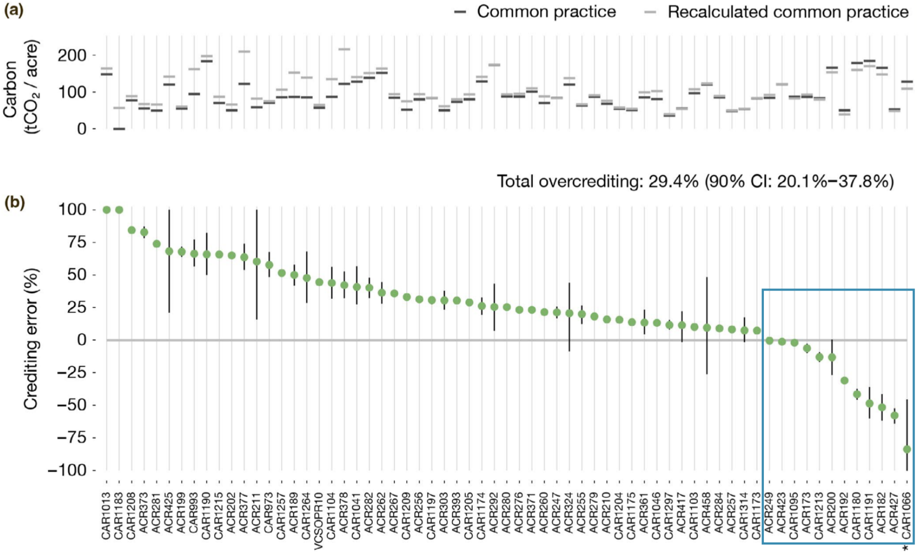

Source. Badgley et al. 2022, Figure 5

Discussion

Badgley et al. (2022) find evidence of substantial over-crediting:

- Calculate over-crediting due to inflated baseline of 30.0 million tCO_2 (90% CI: 20.5–38.6 million tCO_2).
- 29.4% of credits analyzed (90% CI: 20.1%–37.8%)
- at market prices ($13.67/offset), these excess credits are worth **$410 million** (90% CI: $280–$528 million)

Next time

We have a midterm, in-class:

- cumulative but emphasis on Lectures 6–11 and material from Problem Set 2
- **two** pages of notes allowed (8.5" $\times$11", front and back okay)
- can bring regular or scientific calculator if you want, but should not be needed