RESEARCH BRIEF • JULY 2023

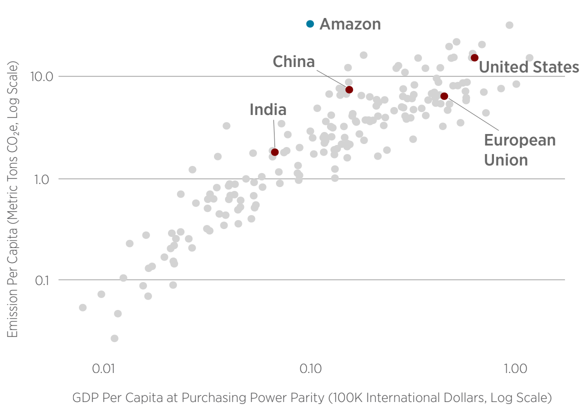
Carbon Prices and Forest preservation Over Space and Time in the Brazilian Amazon

Based on BFI Working Paper No. 2023-86, "Carbon Prices and Forest preservation Over Space and Time in the Brazilian Amazon," Juliano Assunção, Climate Policy Initiative and PUC-Rio; Lars Peter Hansen, University of Chicago; Todd Munson, Argonne National Laboratories; and José A. Scheinkman, Columbia University

With modest transfers per ton of net CO_2, Brazil would find it optimal to choose policies that produce substantial capture of greenhouse gasses in the next 30 years, suggesting that the management of tropical forests could play an important role on climate change mitigation in the near future.

Much of the current discussion about reducing the effects of climate change entails decreasing the amount of CO_2 released into the atmosphere. Other efforts revolve around technologies that capture CO_2 in the atmosphere and safely store it, often underground. Related to this carbon capture option is a natural alternative—the world's existing trees—which absorb carbon from the air and store it within a tree's structure in what scientists call a "carbon sink."

Figure 1 • Emissions Per Capita vs GDP Per Capita for Countries, the European Union, and Brazilian Amazon in 2018



Notes: As described in the accompanying text, deforestation of the Brazilian Amazon forest has resulted in high emissions, setting the Brazilian Amazon as a substantial outlier in a plot of countries' emissions per-capita vs. GDP per-capita. Each dot in this figure represents a country in 2018, except for the European Union and the Brazilian Amazon. Sources: World Bank Data, downloaded on March 2021; Fatos da Amazônia 2021 (www.amazonia2030.org).

This natural carbon sink raises an intuitive question: Can we plant our way out of climate change? The short answer is "No," as it would require too many trees and too much time. It takes dozens of years for trees to mature and to absorb maximum amounts of carbon; and mature forests will not absorb net carbon. In other words, reliance on natural carbon sinks via the world's forests will not resolve climate change.[1]

However, that does not mean that trees, including existing forests, are ineffective in ameliorating climate change. Indeed, the Amazon forest contains over 100 billion tons of captured carbon, roughly equivalent to the total US emissions of carbon dioxide from 1990 to 2010.[2]

[1] MIT Climate Portal (June 16, 2022). "How many new trees would we need to off-set our carbon emissions?" climate.mit.edu/ask-mit/how-many-new-trees-would-we-need-offset-our-carbon-emissions

[2] Abouelnaga, Mahmoud (May 2021). "Carbon Dioxide Removal: Pathways and Policy Needs." Center for Climate and Energy Solutions, 2. c2es.org/wp-content/uploads/2021/06/carbon-dioxide-removal-pathways-and-policy-needs.pdf.

The Brazilian Amazon, the subject of this innovative analysis, occupies 60 percent of the 2.7 million square miles that comprise the Amazon forest. And that section is shrinking: Roughly 17 percent of the Brazilian Amazon has disappeared over the last 50 years due to deforestation. From 1985 to 2021 alone, the area cleared for agriculture increased from 68.6 to 240.5 thousand square miles, an area about the size of Texas. (See accompanying Figure.)

The reason deforestation is occurring in the Amazon forest is that land is potentially more valuable to a developer as a source of agriculture—most commonly, cattle ranching—than it is as a carbon sink. In other words, a developer has the option of cutting down part of the Amazon forest and raising cattle on the land, or that developer can receive a subsidy to preserve the forest. If no subsidy exists, or if the subsidy is too low, the developer has less incentive to preserve the forest. The effects of that developer's decision extend beyond the local market and accrue to the rest of the world in the form of higher CO_2 levels in the atmosphere. Economists call these phenomena externalities, and in this case, the release of CO_2 through deforestation results in a negative externality. This negative externality, which is not priced into the local land market, is an example of market failure.

The contribution of this work is that it offers a framework for policymakers to assess how externally set carbon prices can affect the nexus between agriculture and forest. Importantly, the authors offer a model that captures the tradeoff between agricultural production and forest preservation (or regeneration) across space and time, while also incorporating uncertainty based on fluctuating beef prices and forest carbon measures. That is, not only are certain sections of land more/less valuable as grazeland or as carbon sinks than others, but that value changes over time and we have imprecise knowledge of this value. By incorporating the dynamic value of land over time along imprecise information about productivities, the authors model the optimal allocation of land over time and space in the presence of uncertainty as a function of the price of carbon.

To do this, the authors compose a unique dataset that incorporates cross-sectional variability in cattle farming productivity and in the potential absorption of carbon in the Brazilian Amazon. They divide the Amazon region into various subregions, from 1,059 sites measuring 67.5km x 67.5 km, to 81 sites measuring 270km x 270km. They first attempt to derive the price of carbon implicit in the deforestation that occurred from 1995, the first year with reliable cattle price data, through 2008, which marks the beginning of the Amazon Fund, a pay-for-performance scheme financed primarily by the Norwegian and German governments. The authors show that this implicit price was only around \$6 per ton of CO_2e , and use this price of CO_2e as a "shadow price" to produce simulations when they assume that no transfers to the Brazilian government prevails.

The authors then study the impact of adding outside payments for net capture of CO_2 in the Amazon over a series of steps (incorporating the space and time parameters discussed above), to determine whether and by how much Brazil would gain if the country signed an agreement for a set of hypothetical dollar transfers per **net** unit of CO_2. In doing so, they reveal both the social gains to preserving or enhancing Brazil's Amazon forest and to reallocating production. The authors also incorporate uncertainty into the mix, providing benchmarks for a social planner to compare outcomes of alternative ad hoc policies, and suggesting improvements over current policies.

So, what is the price (or what are the prices) to optimize the utility of the Brazilian Amazon forest? The authors do not say, as that is the purview of policymakers and governments charged with weighing the benefits and costs of various uses of the land. However, they do offer suggestive guidelines. For example, according to existing research, deforestation in the Amazon will likely cross a tipping point of 20-25% if the carbon price is equal to the shadow emission price of $6 per ton of CO_2e, with no additional payments. To counter this effect, the authors' model reveals that additional payments of at least $15/ton would not only safeguard against reaching the tipping point, but would also trigger reforestation on a large scale. Among other examples, this work also suggests that if treansfers per ton exceeded $20, optimal management of the Brazilian Amazon forest alone could deliver in excess of 39 billion tons reduction in atmosphreric CO_2e over the next 30 years from restoration, avoided land conversion, and other forestry practices a substantial contribution for the goal of having a 50% chance of not exceeding 1.5 degrees of warming.

Bottom line: By offering a dynamic approach that accounts for expected future prices of agricultural goods, as well as carbon emissions from deforestation and carbon capture from forest regeneration, and which also incorporates uncertainties surrounding measures of agricultural goods and forest carbon, the authors offer a timely framework for better decision-making on an issue of global importance.

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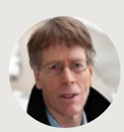

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