Greenhouse gas property:

An adaptable climate policy for an uncertain world

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June 2007

Submission for the Dennis J. O'Brien USAEE Best Student Paper Award

Abstract

I propose a new climate policy whereby we treat greenhouse gases (GHGs) from fossil fuel combustion as private property. A GHG property scheme provides an adaptable, long-term framework for climate policy that better matches the science and economics of climate change. The initial extractor or importer of the fuel would own carbon property that would become carbon dioxide (CO_2) property upon combustion. This property could be bought and sold, and the CO_2 property would be taxed for as long as it affects the atmosphere. The prices of fossil fuels would rise to account for the expected tax liability, leading to emissions reductions as with a carbon emission tax, and the ongoing property taxation would provide an incentive to develop and deploy air capture technologies that could remove CO_2 from the atmosphere. Because the government could adjust the tax rate on previously and contemporarily emitted property from year to year, this property policy uses new information about climate change in ways that other climate policies cannot. Finally, to avoid a property policy being undermined by firms insufficiently valuing future taxes, we could combine a property scheme with a cap-and-trade program to create a capped property policy.

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INTRODUCTION

Commonly proposed climate policies regulate the emission of greenhouse gases (GHGs) through market-based schemes such as emission taxes or tradeable emission permits or through regulatory approaches such as efficiency standards. However, none of these approaches consider the property relations underlying the emission of GHGs. A greenhouse gas property policy makes emitted GHGs the property of private actors and taxes this GHG property for as long as it remains in the atmosphere. Uniquely, this policy provides incentives both to reduce GHG emissions and to remove accumulated GHGs from the atmosphere. Most climate policies regulate the emission of GHGs, but it is the accumulation of GHGs in the atmosphere that drives climate change. Taking a property rights approach to climate policy can better construct incentives that fit the science of climate change and can provide the adaptable, long-term framework needed to guide energy sector investments.

This paper introduces the idea of GHG property. I first explain how the regulatory focus of common climate policies fails to match the science of climate change and how a GHG property policy is different. I then elaborate on two economic advantages of GHG property: it better uses future learning about climate change impacts, and it provides long-term incentives for the development and deployment of carbon dioxide air capture technologies. I conclude by addressing the problems posed by bankruptcy, questionable governmental commitment, and firms' myopia and by describing how a property policy could be combined with a cap-and-trade policy.

MATCHING CLIMATE POLICY TO CLIMATE SCIENCE

As GHGs accumulate in the atmosphere, they absorb radiation coming from the earth towards space and re-emit some of it back towards the earth. The earth and the atmosphere thereby absorb more energy and their temperatures rise accordingly. These rising temperatures have pruned glaciers, diminished Arctic sea ice, increased sea levels, shifted the ranges and behaviors of animal and plant species, and, perhaps, brought more extreme weather events (IPCC 2007a). Further warming will change weather patterns, temperatures, and sea levels and will challenge ecosystems and societies (IPCC 2007b).

The atmospheric stock of GHGs is the total quantity of GHGs present in the atmosphere, and this stock is increased when the flow of emissions from human and natural activities is greater than the flow of GHGs out of the atmosphere through chemical reactions or uptake by vegetation and oceans.[1] The actual flow of emissions affects the climate only insofar as it affects the total quantity of GHGs in the atmosphere. Carbon dioxide (CO_2) is the most important GHG because it is long-lived, it is steadily increasing in atmospheric concentration, and it is a byproduct of nearly all combustion processes.[2] Because a large proportion of anthropogenic climate change may be traced to the combustion of fossil fuels and the subsequent release of CO_2 (IPCC 2001: 37, 204), climate change policies often focus upon reducing CO_2 emissions from the energy sector.

[1] If GHG emissions are like water flowing into a tub, then the atmospheric stock of GHGs is the water standing in the tub. This water is getting deeper because the tub's drain does not let as much water out as is flowing in, and, in this case, it is the amount of water standing in the tub, and not the rate of water flowing into the tub, that affects the climate of the room.

[2] The time it takes for altered CO_2 concentrations to return to equilibrium is somewhere between 5 and 200 years (IPCC 2001: 38). Parts per million by volume (ppm_v) is the number of moles of a gas per million moles of air. In 2005, the atmospheric CO_2 concentration was 379.1 ppm_v, an increase of 35% from the relatively constant pre-industrial level of 280 ppm_v, and it has increased at an average rate of 1.9 ppm_v per year over the last ten years (WMO 2006).

Market-based proposals for comprehensive climate policies have centered around cap-and-trade programs and carbon taxes. GHG cap-and-trade programs are in development or in operation in the European Union, in California, and in the northeastern U.S. states of the Regional Greenhouse Gas Initiative. In these programs, the government decides on the total emissions that will be allowed in a year and then either auctions off or gives away this number of permits to emitters. Because private parties may then trade these permits among themselves, the firms that can reduce their emissions most cheaply do so, and total emissions come down to the capped level. Carbon taxes, in contrast, involve the government placing a levy upon emissions, and aggregate emissions then respond to this price signal. To avoid confusion with a tax on atmospheric carbon dioxide property, I will henceforth use "carbon emission tax" to refer to a traditional carbon tax. In theory, a cap-and-trade program reaches a given emissions level at the lowest cost and a carbon emission tax produces the lowest emissions level for a given cost. Cap-and-trade programs provide certainty about the quantity of emissions, and carbon emission taxes provide certainty about the cost of emissions.

Both of these climate policies regulate GHG emissions, not the GHG stocks that drive climate change. Cap-and-trade programs have been used with success in the U.S. to reduce acid rain by controlling sulfur dioxide emissions, but the science of acid rain is quite different from the science of climate change. While acid rain is driven by contemporary emissions, climate change is driven not by any year's emissions but by accumulated historical emissions. Furthermore, any one year's GHG emissions are but a small percentage of the GHGs from past years that have accumulated in the atmosphere. Regulating current emissions is important for addressing climate change because our current emissions are indeed adding to atmospheric GHG stocks, but such regulation can only control how fast stocks increase. It does not provide incentives to find ways to decrease these stocks.

A GHG property policy would shift the focus of climate policy from annual emissions to the atmospheric gases that actually drive climate change. A GHG property policy says that somebody owns the GHGs emitted to the atmosphere and that the owner will pay taxes for as long as the property remains in the atmosphere. This is like an atmospheric storage fee. When a company owns coal and burns it to make electricity, our concept of property is fluid enough to work through the thermodynamic transformations and say that the company also owns the electricity output. We do not, however, currently say that the company owns the gas molecules it releases to the atmosphere. Because these gas molecules have no productive value, the company does not claim them as its property, and nobody forces the company to recognize them as its property. In a sense, these molecules revert to a state of nature. If we consistently apply our ideas of private property to the bad outcomes as well as to the good, then the GHGs released from the coal's combustion are owned by some agent that is responsible for the effects of its property.

This property system would be most readily established for energy sector CO_2 emissions. Indeed, some regions already have GHG registries that track these emissions, and it would not be especially difficult to convert them to property-tracking registries. Because carbon is conserved, we can think of agents as owning carbon property in fossil fuels that becomes CO_2 property upon combustion, and because the atmosphere is well-mixed and CO_2 is homogenous, we can treat all of the CO_2 emissions in a year as identical. However, while energy sector CO_2 emissions are important for climate change, they are not the sole contributor. Other CO_2 sources and other GHGs play key roles, but some of these sources may be too diffuse to establish ownership. Many of these other CO_2 sources and other GHGs may require their own policies that are tailored to their physical, economic, and technological specifics. Like cap-and-trade programs and carbon emission taxes, a GHG property policy is tailored for CO_2 emissions from the energy sector.

When implementing a GHG property policy, we need to decide where property ownership begins in the fossil fuel product chain. Carbon property becomes taxable CO_2 property upon combustion, but who first owns the carbon property? We should initially assign the property so as to minimize transaction costs and make ownership comport with control. Combusting fossil fuels releases carbon that would otherwise have remained locked in the coal, gas, or oil. Moving down the fossil fuel product chain from extractors to refiners to consumers involves more parties and uses. Because extractors are situated at the least differentiated level of the fossil fuel product chain, and because they are directly responsible for liberating the carbon from its geological sequestration, it makes sense from an efficiency perspective initially to assign carbon property to them. On a sub-global level, it is the extractor of fossil fuels and the importer of fossil fuels who initially own the carbon property in their fuels.

Carbon property and CO_2 property can be bought and sold. Carbon property could be transferred by contract along with the fossil fuel, and fuels which come with carbon property would be cheaper than fuels that do not. This is because buyers of the fuels that come with carbon property would assume property tax liability while the fuels that do not come with carbon property leave the tax liability with the seller. In this latter case, the seller would want to raise the sale price to cover the expected tax liability. Since fossil fuels that are not combusted would not produce GHG property, owners of carbon property might offer rebates to encourage such alternate uses. This could segment the market for fossil fuels: for example, the petroleum carbon that is destined to be locked away in plastics would be cheaper than the petroleum carbon destined for combustion and release to the atmosphere. Most market-based climate policies aim to make the act of emitting more costly, but a property policy aims to make the ownership of GHGs more costly. Just as society wants to reduce atmospheric GHG concentrations and one way to do this is by reducing emissions, firms would want to reduce their ownership of GHGs and one way they would do this is by reducing emissions.

BRINGING FUTURE LEARNING INTO CLIMATE POLICY

The economic advantages of a property policy relative to other market-based climate policies come from the treatment of GHGs after the time of emission. Under a cap-and-trade program or a carbon emission tax, a power plant must turn in a permit for or pay a tax on the CO_2 it releases to the atmosphere. It is then no longer associated with or responsible for that CO_2. However, the CO_2 will affect the atmosphere for many decades, and over that time we will refine our judgments regarding its effects. If in 10 years we learn that the effects of climate change will be more severe than we had expected and that the CO_2 therefore should have been more costly that it in fact was, there is nothing we can do about the past emissions from within a cap-and-trade or carbon emission tax policy. Through these policies, we can affect contemporary emissions, but the previously emitted CO_2 that causes climate change damages is nobody's responsibility. We would either need to adopt new policies to remove these GHGs from the atmosphere or we would need to penalize contemporary emitters for regulators' past miscalculations.

A GHG property policy is more robust because it recognizes that we learn about climate change over time and so does not demand knowledge we do not have.[3] Because CO_2 emitted under a property policy is associated with a private actor even after the time of emission, future learning can affect decisions about the CO_2. Now when a power plant emits the CO_2, it profits from the sale of electricity in the first year and pays a tax for storing CO_2 in the atmosphere, and because its CO_2 is still in the atmosphere the next year and the years after that, it pays a tax in those years as well. The property would endure in the atmosphere for a predetermined length of time that should correspond to the time for which emitted GHGs affect the atmosphere.[4] Importantly, the government can adjust the tax rate from year to year to account for new information about damages from climate change. Each year, the regulator can form its best estimate of the marginal damage from GHG emissions and set the tax rate accordingly. Future tax rate revisions will affect the cost of today's emissions because the property could reside in the atmosphere for quite some time. When assessing the cost of potential emissions, firms must now consider whether and in what way the tax rate is likely to change as we learn about damages.[5] Because current uncertainty and future learning are so crucial to climate change economics, one of the main advantages of a GHG property policy is that it allows

[3] See Lemoine (2007b) for a formal exposition and for a discussion of the optimal property tax rate.
[4] As already noted, this can be between 5 and 200 years for CO_2 (IPCC 2001: 38). The property could either survive intact for some defined time or decay at some defined rate.
[5] Firms' uncertainty about future tax rates creates another advantage for a GHG property policy: it promises to internalize the option value associated with the irreversibility of emissions. See Fisher and Narain (2003) and Lemoine (2007a) for more on option value in climate change economics, and see Lemoine (2007a) for models of option value in a property policy.

future learning to affect the cost of today's emissions. It recognizes that even the most diligent regulator may not be anywhere near omniscient when it comes to the costs of climate change.

INCENTIVIZING AIR CAPTURE TECHNOLOGIES

In a GHG property policy, firms not only have an incentive to reduce their emissions, but if the tax rate ends up high enough, they may actually pay to take their CO_2 out of the air so as to avoid paying future taxes. This incentive to remove previously emitted GHGs from the atmosphere has been absent in other climate policies.

There are two ways of quickly reducing the atmospheric stock of CO_2: biological sequestration and air capture.[6] Biological sequestration involves cultivating organisms that take in CO_2 via photosynthesis and then keeping the carbon locked in the biomass.[7] This often means planting and protecting forests, but it also includes proposals to scatter iron over the oceans to promote the growth of phytoplankton that would lock up their embodied carbon as they die and fall to the seafloor. Air capture takes CO_2 from the air and permanently sequesters it away from the atmosphere.[8] CO_2 air capture would likely be either biomass-based or chemically-based. Biomass-based air capture involves burning biomass to produce electricity or fermenting it to produce biofuels and then capturing the CO_2 from the resulting waste gas stream. Chemically-based air capture

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[6] Eliminating all CO_2 emissions would reduce atmospheric stocks only slowly.
[7] Biological sequestration generally suffers from an inability to clearly sequester large quantities of carbon for long periods of time. A property system could actually make biological sequestration more effective than could the current system of emission offsets because if a sequestration forest is cut and burned, then under a GHG property policy the carbon property owner now owns CO_2 property like it did prior to planting the forest. Maintaining property chains creates incentives to ensure sequestration. Similar arguments hold for carbon sequestered in geological formations as a result of air capture or carbon capture and storage.
[8] Air capture processes only remove those gases that we choose to target, not the air in general.

relies upon a chemical, called a sorbent, that forms a solution with CO_2 from the air. The solution dissociates upon heating, and the CO_2 can then be captured and the sorbent can be recycled.[9] While no full-scale chemically-based CO_2 air capture facilities have been built, many of the individual steps are already widely used for other purposes, the chemicals involved may be both cheap and benign, and at least one prototype has been constructed (Stolaroff 2006). With either type of air capture, the captured CO_2 may be sent to some economic use or, more likely, sequestered in old petroleum formations, in saline aquifers, or along the seafloor.[10]

Sequestration is also often proposed, and has been undertaken, for CO_2 captured from power plant emissions. This process is known as carbon capture and storage (CCS) and is most likely to be used with new coal-fired power plants. CCS is cheaper than air capture but is also more limited in potential: by taking the molecules straight from the air, CO_2 air capture technologies avoid the need for costly power plant retrofits, enable capture at the sequestration site, benefit from economies of scale, and permit the abatement of historic emissions and of emissions from sectors other than electricity. First, CCS can certainly reduce emissions from new coal-fired power plants, but we may also need to reduce emissions from the world's existing stock of coal-fired power plants. While it may be too costly to use CCS with these old plants, air capture does not require specific retrofits of existing plants. Second, transporting CO_2 from a power plant using CCS to a sequestration site will have some cost. However, because an air capture facility is not constrained by power plant locations, it could be built at the sequestration site. Third, while chemically-based air capture's cost per abated ton of carbon may fall with

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[9] See Keith et al. (2006) for more on air capture technologies.
[10] For more on the risks of geological sequestration of CO_2, see IPCC (2005) and Damen et al. (2006).

Table 1. The economic and energetic costs of air capture.

	Cost [i] ($/tC)	Energy Requirements (GJ/tC)	Source
Biomass-Based	300 [ii]		Azar et al. (2006)
	< 200 [iii]		Keith et al. (2006)
	150 [iv]		Rhodes and Keith (2005)
Chemically-Based	> 240 [v], < 500	> 1.6 [vi] (for capture) > 4 (for capture and sequestration)	Keith et al. (2006)
		44-62 (for capture and compression)	Baciocchi et al. (2006)
		208-250 [vii] (for capture)	Nikulshina et al. (2006)

[i] Costs are difficult to assess because current technologies and designs are not optimized and because, for biomass-based air capture, the tons of carbon avoided depend upon the type of electricity generation replaced.
[ii] Does not include the value of the electricity produced.
[iii] Generates electricity.
[iv] Models a specific electricity generating system.
[v] The lower bound cost estimate holds unless we find a new sorbent or recovery mechanism.
[vi] The energy requirement for capture is a thermodynamic minimum.
[vii] Uses concentrated solar power.

increasing facility size, CCS can never capture any more carbon than is emitted by a power plant. Fourth, CCS will not abate emissions from transportation unless we shift to fuels such as coal-derived electricity. In contrast, air capture could easily abate the diffuse emissions from liquid-fueled transportation by taking the corresponding quantity of CO_2 out of the atmosphere. Finally, air capture uniquely offers the valuable possibility of taking our “old” emissions out of the atmosphere, allowing us to reduce atmospheric CO_2 concentrations if we should need to.

Estimates of the economic and energetic costs of CO_2 air capture summarized in Table 1 suggest that while there are currently many cheaper abatement options in the form of emissions reductions, air capture could be useful if costs fall with economic incentives and effort or if chemically-based air capture is paired with a low carbon energy source. Expected air capture costs may be about ten times higher than many estimates of the marginal damage from CO_2 emissions (summarized in Tol 2005), but many technologies achieve comparable price declines once subjected to intensive development and deployment. Substantial cost reductions for air capture could come from new recovery mechanisms and sorbents (Stolaroff 2006). Further, chemically-based air capture may be a good application for renewable energy sources that may otherwise remain unused because of their remoteness and intermittency, and it may work especially well with wind power since capture sites require sufficient wind to bring new CO_2 molecules into contact with the sorbent.

Even if air capture seems expensive, our climate policies should recognize it as a backstop option, and it is important that we provide incentives to develop the technology in case we end up needing to reduce temperature increases or ocean acidification more quickly than natural processes allow. Yet apart from Richard Branson's recently announced prize for the air capture of CO_2 (Kanter 2007), there has been scarce public discussion of this technology. This is partly because there has been little economic incentive to develop it, partly because there are cheaper initial opportunities in climate change abatement such as reducing emissions, and partly because scientists and environmental groups have been reluctant to discuss such options for fear of diminishing the drive to reduce GHG emissions (e.g., Parson 2006). An important component of a policy solution to climate change would be to provide incentives for the development and adoption of air capture without compromising emissions reductions. While prizes and government-funded research may push initial development, further refinement and actual adoption may require long-term incentives to assure profitable use.

Air capture could be incentivized within a cap-and-trade program by allowing it as an emission offset as is currently done for biological sequestration. This would provide a clear incentive to develop and deploy the technology since doing so would create a stream of emission credits that could be sold in cap-and-trade systems, but the incentives are weaker and the possible gains lower than they could be. Under a cap-and-trade program, emission offsets should not affect the total quantity of emissions or total GHG concentrations; instead, they enable annual emissions to reach the cap at lower cost. Total net emissions would remain at the capped level, and removing GHGs from the atmosphere just allows more GHGs to be emitted. This restricts the application of air capture technologies to merely allowing more contemporary emissions when the great promise of air capture is that it could help us to achieve reductions in GHG concentrations. It would be better to provide incentives to use air capture technologies to reduce atmospheric GHG stocks rather than restrict air capture only to enabling increased emissions.

Cap-and-trade programs and carbon emission taxes focus only upon the release of GHGs to the atmosphere, but a property regime would make atmospheric stocks the unit of taxation and, by extension, the focus of firms' cost minimization through emissions reductions and sequestration. Taxing GHG property annually would make property owners bear a cost as long as their property resides in the atmosphere. This would provide a direct incentive to reduce emissions now, and it would also provide a direct incentive to develop technologies to reduce atmospheric stocks of GHGs, since removing

GHGs from the atmosphere would avoid future tax payments. If such removal benefits from economies of scale, companies could arise that specialize in abating GHG property: they would accumulate property from owners for a fee and profit by removing it from the atmosphere at lower cost. Air capture could then be used not just to offset contemporary emissions but to offset any emissions produced between the establishment of the property regime and the development of economical large-scale air capture technologies.

THE PROBLEM OF FIRMS INSUFFICIENTLY VALUING FUTURE TAXES

Because so much of the cost of emissions occurs in the form of property taxes paid in the future, the greatest threat to the success of a GHG property policy is that firms might not deem their emissions appropriately costly. This would lead them to emit more than is socially optimal. Firms may undervalue emissions for three reasons: they may plan to escape future high taxes through bankruptcy, they may not believe that the government will maintain the tax rate, or they may be overly myopic because of institutional structures or competitive pressures.

First, if GHG property is no longer taxed when its owner goes bankrupt, we may see the rise of holding companies that own a lot of GHG property but have few recoverable assets. When the tax rate gets high enough or the holding company accumulates enough property, it could declare bankruptcy and its assets might be insufficient to cover the tax liability. The original property owners would know that their property would not be taxed as much as it should be and so they may not raise their fuel prices as much as they would have, and these lower fuel prices produce more GHG emissions.

We could solve this problem of faltering tax collection by stipulating that if a property owner cannot pay current and future property taxes even after bankruptcy proceedings, then the property reverts to the one who sold it to the insolvent party. This makes the current property owner responsible for ensuring the creditworthiness of potential trading partners. Property owners will not want to transfer property to individuals or firms that may ultimately leave them responsible for property they had paid to get rid of. In all probability, this property transfer rule will lead the market to evolve ways of assuring property transactions (such as insurance against downstream default, certification schemes, contractual clauses, or reliance on credit ratings). By mitigating the risk that property will end up back with those who had paid to get rid of it, these mechanisms also mitigate the risk that the government will not be able to collect property taxes.

Firms may also undervalue future taxes and emissions if they doubt that the government will fail to maintain the tax rate at an appropriate level. If the government can credibly commit to maintain the tax rate, then the incentives to reduce emissions should be at least as strong as those produced by the corresponding carbon emission tax, but if property owners doubt the government’s commitment, they will not deem emissions appropriately costly. Because of the long-term nature of the investments required, this problem of governmental commitment is important in all climate policies (e.g., Helm et al. 2003), but it is especially highlighted in this property proposal. This property tax system depends upon a long-lived tax-setting institution that will adjust rates in response to new information about climate change impacts.

We already have GHG registries and carbon markets that could be readily adapted to track GHG property, but we have no example of an institution for finely tuning tax rates on an annual basis in response to complex scientific and economic information. Developing such an institution is the most difficult and most important step in the implementation of the property tax proposal. The tax-setting institution may need to resemble the independent committees used in many countries to set monetary policy. [11] Also like monetary policy by committee, a GHG property policy may only be suitable for countries with institutional environments that enable governmental commitment (cf. Gilardi 2007), and international arrangements could become valuable commitment devices where suitable institutional environments are lacking (cf. Stasavage and Guillaume 2002). Finally, as one threat to governmental commitment comes from the possibility of a tradeoff between the GHG property tax rate and economic growth, the government could mitigate this tradeoff and so reduce its chances of reneging if it returned all GHG property tax revenue to the citizenry. This revenue recycling would have the side benefits of reducing the policy's distributional impacts and of giving the broader electorate a financial stake in the system's success.

The third threat to a property policy is that firms will fail to adequately consider or value future tax rates because firms are not suited to managing long-term social problems (due to high discount rates or short time horizons) or because short-run competitive pressures favor those firms that ignore these future costs. If firms are intrinsically unlikely to value future costs at socially optimal levels, then the property tax payments would need to cluster together in the near term like a carbon emission tax.

[11] See Lemoine (2007a) for a formal illustration of the government's time inconsistency problem and for more details on institutional solutions.

However, this would mitigate the advantages of a property policy with regard to air capture and future learning. A better way to solve the problem is to combine a cap-and-trade program with a property scheme.

A CAPPED PROPERTY POLICY

A GHG property policy could be combined with a cap-and-trade program by capping the GHG property created in any one year. If the property-creation permits (i.e., emission permits) are auctioned off, their cost could count as a credit towards future property taxes. If the permits are freely allocated, the average market permit price could count as a credit towards future tax payments. This would still make future learning relevant to decisions about contemporary emissions and would preserve the incentives to remove GHGs from the atmosphere. And because emissions would not rise above the cap, a capped property policy would also protect against firms failing to adequately consider future tax payments when making their emission decisions.

Some argue that those with the most past emissions should bear the greatest current and future climate obligations (e.g., Baer et al. 2000). A capped property policy provides two ways of bringing international equity concerns into a property scheme. First, the level of the cap could reflect the equity demands created by past emissions. Second, equity considerations could determine which countries party to a climate change treaty adopt a capped property policy and which adopt just a cap. Indeed, those countries with the best institutional environments to implement a property policy are probably also those that bear the most climatic responsibility because of historic emissions. Equity considerations therefore could lead to some emission caps being stricter than others and could lead some states to allocate responsibility for GHGs even beyond the time of emission. States with fewer past emissions would not concern themselves with the eventual abatement of their current emissions.

CONCLUSION

A GHG property policy offers three advantages that neither cap-and-trade programs nor carbon emission taxes provide: it regulates atmospheric stocks of GHGs rather than just the emission of GHGs, it allows future learning to affect contemporary emissions, and it incentivizes the development of air capture technologies that can remove previously emitted CO_2 from the atmosphere. A capped property policy can obtain these advantages while ensuring that contemporary emissions remain within acceptable limits.

Making companies assume the evolving costs of climate change would push the whole market to adapt. A GHG property tax could raise the cost of emissions as with a carbon emission tax. Futures markets could develop for global temperature or property tax rates, and tax liability insurance could affect the price of fuels. If GHG property management benefits from economies of scale, new businesses could arise that assume GHG property for a price. Under current rules, a GHG property tax would probably trigger changes in publicly held companies' treatment of GHGs in their financial statements (see Hancock 2005), and the U.S. Securities and Exchange Commission could further formalize disclosures of GHG liability by requiring the reporting of carbon and CO_2 property owned, carbon and CO_2 property acquired in the financial year, forecasted tax rates and damages from climate change, and steps taken to reduce exposure. Property-owning companies would have to decide to what extent it is worth raising product prices, paying other firms to assume the property and liability, or removing GHG property from the atmosphere. Prices of fossil fuels should rise as if with a carbon emission tax corresponding to the present value of expected tax rates, but the tax rate would continually adapt to new information and knowledge and the unit of the tax would be CO_2 stocks, not emissions.

Cap-and-trade programs and carbon emission taxes do not adequately address the science of climate change. Climate change is driven by atmospheric stocks of GHGs, but these policies provide a framework only for slowing the increase in long-lived atmospheric GHG stocks. A GHG property policy, on the other hand, provides a framework for the ultimate total abatement of all emissions dating back to the time of the policy's establishment. This may be important if the public is willing to pay to mitigate climate change but not to undertake emissions cuts of questionable effectiveness. A property policy provides an adaptable long-term framework for climate policy that can guide energy sector investments and spur technologies that can both reduce future emissions and compensate for past and present emissions from sunk investments.

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