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Inter-trading permanent emissions credits and rented temporary carbon emissions offsets: some issues and alternatives

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Abstract

Permit trading among polluting parties is now firmly established as a policy tool in a range of environmental policy areas. The Kyoto Protocol accepts the principle that sequestration of carbon in the terrestrial biosphere can be used to offset emissions of carbon from fossil fuel combustion and outlines mechanisms. Although the lack of guaranteed permanence of biological offsets is often viewed as a defect, this paper argues that the absence of guaranteed permanence need not be a fundamental problem. We view carbon emissions as a liability issue. One purpose of an emissions credit system is to provide the emitter with a means to satisfy the carbon liability associated with her firm's (or country's) release of carbon into the atmosphere. We have developed and here expand on a rental approach, in which sequestered carbon is explicitly treated as temporary: the emitter temporarily satisfies his liability by temporarily "parking" his liability, for a fee, in a terrestrial carbon reservoir, or "sink," such as a forest or agricultural soil. Finally, the paper relates the value of permanent and temporary sequestration and argues that both instruments are tradable and have a high degree of substitutability that allows them to interact in markets.

Keywords: Inter-trading; Kyoto Protocol; Carbon emission

1. Introduction

Permit trading among polluting parties is now firmly established as a policy tool in a range of environmental policy areas. Carbon emissions credits, as proposed for carbon dioxide emissions from the energy sector, are based on the idea that a prevented emission is prevented forever. Trading of carbon emissions credits among parties has been widely considered. The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC, 1998) accepts the principle that sequestration of carbon in the terrestrial biosphere can be used to offset emissions of carbon from fossil fuel combustion (Articles

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3.3 and 3.4) and introduces three processes for cross-country transactions—joint implementation (JI, Article 6), the clean development mechanism (CDM, Article 12), and emissions trading (Article 17). The possibility of using carbon sequestration in the terrestrial biosphere has been recognized as a potentially powerful yet relatively low cost tool to offset carbon emissions (Kauppi et al., 2001).

A purpose of carbon emissions credits is to eliminate the liability associated with a firm's (or country's) release of carbon into the atmosphere. An issue for carbon sequestration is the extent to which a carbon offset can be a substitute, perfect or imperfect, for an emissions credit. If carbon offsets are guaranteed as permanent, an offset is a perfect substitute for an emissions credit. To the extent that offsets lack permanence or require higher monitoring and transaction costs, their substitutability becomes less perfect.

As prescribed in the Kyoto Protocol, there are at least two sets of activities through which the terrestrial biosphere can be used to offset emissions of carbon from fossil fuel combustion. These are stated in Article 3.3; which specifically mentions afforestation, reforestation, and deforestation; and Article 3.4, which suggests that other activities might also be considered. Negotiations subsequent to the initial 1997 drafting of the Kyoto Protocol now accept that revegetation, forest management, cropland management, and grazing land management could be used under Article 3.4, within prescribed limits, to generate offsets for carbon emissions (UNFCCC, 2002).

Both the IPCC *Special Report on Land Use, Land Use Change and Forestry* (IPCC, 2000) and the IPCC Third Assessment Report (Kauppi et al., 2001) suggest that the potential of biological sinks for sequestering carbon is substantial. Kauppi et al. estimate that the biological sink may reach a cumulative 100 Gt (C) over the next 50–100 years, most of it in forest systems. This implies the potential to capture 10–20% of the anticipated net fossil fuel emissions between now and 2050.

Carbon sequestered in the terrestrial biosphere, however, may lack permanence. Carbon that is conserved in existing biological pools or captured in vegetation or soils or forest ecosystems is not necessarily permanently removed from the atmosphere. Forests may be harvested for timber and used to produce short-lived products or cleared for other purposes. Wild fires can release large amounts of sequestered carbon. Farmers may return to carbon-depleting agricultural practices, thereby releasing carbon that had previously been captive.

However, carbon sequestration, even if temporary, has important climate benefits. Sequestration reduces the amount of greenhouse gases currently in the atmosphere. In some cases sequestration can be long-lived and approximate permanence. At a minimum, temporary carbon storage can buy time until effective, efficient, or less expensive permanent emissions reduction alternatives can be developed. Finally, terrestrial carbon sequestration is inexpensive compared with many of the alternatives under consideration now. Marland et al. (2001) discuss further economic and environmental reasons for which it may be advantageous for some parties to acquire temporary credits and for others to provide temporary credits for carbon sequestration, even when it is understood that sequestration is not likely to be permanent.

Nonetheless, permanence is the fundamental issue unique to biological sequestration. How might tradable carbon offset credits be created and maintained if some of the credits are temporary and, furthermore, their duration is unknown? Additionally, how would such a trading system for temporary carbon credits be integrated with broader national or international tradable permit schemes? Measurement, monitoring, and verification raise interesting questions, but on close examination do not seem to provide compelling issues unique to land use change and forestry activities (e.g. Sedjo and Toman, 2001). The same is true for leakage and the establishment of baselines against which net emissions reductions are measured.

We note that Herzog et al. (2003) approach the permanence of carbon sequestration with the vision that even emissions reductions do not represent a permanent change in the cumulative flux of CO_2 to the atmosphere. Ultimately this distinction depends on the extent to which the full terrestrial store of fossil fuels will be oxidized. If all fossil fuels will eventually be burned to release CO_2, then current emissions reductions represent simply a delay in the time at which the emissions will occur and this differs only in degree from slowing the flow of fossil fuel carbon to the atmosphere by the use of temporary storage in the biosphere. Our view point (also see IPCC, 2000, p. 85) is that the resource of fossil fuels is very large and that reductions in emissions now will result in a smaller integrated total of emissions over all time frames of interest to humans, i.e. that reductions in fossil fuel emissions are, for all intents and purposes, permanent reductions in cumulative flows to the atmosphere.

The absence of certain permanence of carbon sequestration, this paper argues, is not a fundamental defect of carbon sequestration. Furthermore, we note that although any individual project may be temporary, the effect of economic incentives for carbon sequestration will be to increase aggregate sequestration on a permanent basis. That is, wherever and whenever there are incentives (payments) for carbon sequestration services, we would expect more sequestration than if no payments were being made.

To address carbon sequestration under a cap-and-trade system, Marland et al. (2001) have suggested a rental approach whereby sequestered carbon could be treated as temporary and rental payments could be made on that basis. This paper further develops some of the accounting and trading concepts of that earlier paper. It also develops the relationship between the market for temporary offsets and the market for tradable, permanent emissions credits. We discuss how such a system might work in the context of the Kyoto Protocol. There is no need, however, to limit its application to that particular agreement; it could apply to any national or international carbon cap-and-trade system. Although the Kyoto Protocol has yet to be ratified by enough countries to enter into force, at this writing it appears likely that it will soon achieve a sufficient number of ratifications. Whereas the US has indicated that it does not intend to ratify the Kyoto Protocol, it is moving in the direction of undertaking biologic sequestration activities to meet its own objectives.

The Kyoto Protocol includes many elements that have been widely agreed to and could take effect as part of this or some subsequent international accord or national program. These elements include the trading of emissions permits where the trading partners have unequal liability or where one partner is unwilling or unable to accept long-term liability for managing a stored pollutant. Such trading would take place in an environment where at least some parties either tax emissions or ration emissions permits—that is, where there is an established cap on or penalty for emissions. Rental of emissions permits or emissions offsets provides an opportunity for reducing total emissions in this environment.

The basic question is whether it is appropriate to treat carbon sequestration in the biosphere as the negative of emissions to the atmosphere if we cannot guarantee that the carbon, once sequestered, will remain sequestered. In an ideal accounting system it would be possible to treat carbon flows into and out of the biosphere like flows from fossil fuels: flows toward the atmosphere would be emissions and represented with a positive sign, and flows from the atmosphere would be treated symmetrically and have a negative sign. Such an accounting system would allow carbon offsets to enter into a trading system. We agree that if emissions reductions are clearly permanent (e.g. fossil fuel is not burned), then emissions credits might be bought and sold. If emissions reductions are not clearly permanent (e.g. carbon is sequestered in a forest), then, we argue, emissions credits might better be “rented.” We argue that this proposed system can readily be integrated with the more conventional types of national tradable emissions permit schemes.

2. Liability

Under a market trading system for emissions permits, carbon emissions in excess of the level allocated under a cap-and-trade arrangement would be liabilities. The entity generating these emissions could meet this liability by purchasing additional emissions permits (or credits). These would typically be available from an entity that had lower emissions than its allocated amount, and thus had surplus credits. In this case the surplus emissions could be traded (sold) to entities that had fewer credits than emissions, thereby enhancing efficiency in meeting the emissions targets.

In general, emissions credits would be generated within the energy sector. For example, a plant that can reduce emissions below its allocation by switching from coal power to natural gas would have surplus credits that could be sold. These fossil fuel emissions credits are forever. A plant that has a 1 t emissions liability could be absolved of that liability by purchasing a 1 t carbon emissions credit. Credits from biosphere sinks, however, are quite different from energy emissions reductions. Any system of emissions or offset credits must establish carbon release liability—that is, it must identify who is responsible if and when the CO_2 from temporary sequestration is released to the atmosphere.

Liability is the essential issue for permanence. The Kyoto Protocol envisions a system whereby credits against emissions could be achieved by reducing emissions, purchasing emissions permits, or generating offset credits for sequestering carbon. Under an emissions cap, a carbon liability would be created when a firm or country emits carbon into the atmosphere. The purpose of an emissions credit would be to eliminate the carbon liability associated with that release of carbon. An emissions credit of, for example, 1 t of carbon would eliminate in-perpetuity the liability for the release of 1 t of carbon into the atmosphere. Biological carbon sequestration, however, is a reversible process, and the Kyoto Protocol does not fully prescribe who is responsible if the sequestered carbon is subsequently released and the basis for the offset credit thereby lost. If credit is given when carbon is sequestered, who then assumes the liability if the sequestered carbon is lost?

3. A rental alternative

A traditional system for limited-term use of a capital asset or piece of real estate involves a rental contract, and rental contracts seem ideally suited to satisfy and transfer carbon liability if permanence is either not guaranteed or not desired. A rental contract can allow the buyer–renter to enjoy the limited-term benefits of the asset while the seller–host retains long-term discretion over the asset.

A principal feature of a rental system is that it behaves like a direct credit–debit system for the renter of credits. Credit is assigned when carbon is sequestered and debits accrue when carbon is emitted. The credits and debits are symmetric and instantaneous. The difference is that credit is leased for a finite term, during which someone else accepts responsibility for emissions, and at the end of that term the renter incurs a debit unless the carbon remains sequestered and the lease is renewed. At the end of the rental period, the renter will have received some of the benefits and can either renew the lease or incur the emissions debit and replace the credit with one from another activity.

In the energy area, where credits are given for the permanent exclusion of a tonnes of carbon from the atmosphere, the single payment mechanism would appear appropriate. However, for temporary (or potentially temporary) exclusions of carbon from the atmosphere, a periodic payment for temporary carbon removal services would seem to be more workable. This can be viewed as a payment for borrowing a temporary place to store emissions, or as a way to borrow time.

In a world where carbon emissions credits were commonly traded, the market would determine the value of a permanent carbon credit (the asset value). This value would provide a base price from which the market could determine the annual rental values for carbon sequestration services. The market would consider the additional costs associated with any extra monitoring (some monitoring is necessary for sequestration projects, whether temporary or permanent). Thus, the market could arrange rental contracts using information on the price of permanent carbon credits, the discount rate, and costs unique to quasi-temporary projects.

With the rental approach, as with other investments, one would not expect indefinite sequestration or full payment before the services were rendered. Contracts could be made for periodic payments, say a payment each year based on the carbon serviced, perhaps with a provision for renewal. If longer contracts were desired, the evaluation of future values would probably be discounted, reflecting both the discount rate and the market's assessment of risk. Most of the advantages of temporary credits (such as credit for delaying emissions) rely on the credits' being available early in the project life—at the time of actual sequestration.

Additionally, a rental system would provide symmetry. Debits and credits would both be accounted for on a periodic (perhaps annual) basis and be counted in the time interval during which the loss or gain of carbon occurred.

A rental-like approach for dealing with sequestration that cannot be considered permanent has been introduced into negotiations on the Kyoto Protocol by the government of Colombia (Colombia, 2000), which envisioned expiring emissions credits. The European Community has subsequently expanded this into a concept for temporary "certified emissions reductions" (Denmark, 2002). The European Community approach envisions that certified emissions reductions (created under Article 12 of the Kyoto Protocol) could be issued during one commitment period and would expire during the subsequent commitment period unless specifically renewed. The concept is similar to that described here except we suggest that traditional rental concepts are sufficient to bring temporary credits into the trading regime without the additional strictures and time constraints of the EC proposal.

The European Community proposal (Denmark, 2002) suggests temporary credits with a fixed term of 5 years. Recognizing that liability needs to be clearly defined and attributed, the EC suggests that (with a 5-year contract) temporary credits gained during one commitment period under the Kyoto Protocol would expire during the subsequent commitment period. Expiring credits would become current liabilities. If the carbon remained sequestered a new, 5-year, temporary credit would be issued to cover the current liability. If additional carbon had been sequestered the new credits could be greater in number than the expiring credits.

The EC proposal does not make a strong argument for 5-year expiring credits, as opposed to rental credits whose duration would be established by contract between the parties, except that it would mandate a 5-year review and verification that the carbon was indeed still in place and merited issuance of new credits. In essence it would appear to treat sequestration credits differently depending on whether they were held and used by a single party or traded between parties. Presumably a single party would be responsible for increases or decreases in carbon sequestration at the time they occurred while credits traded between parties would be subject to periodic (5-year) expiration and re-issue.

The EC suggests that their proposal avoids the "need for specific provisions for purchaser liability, or project owner or seller liability", because carbon, once sequestered, is entitled to a 5-year credit regardless of its duration of storage. In essence, of course, the purchaser would retain the liability because it is he who would accept that liability at expiration of the temporary credits. What the fixed-time credit does is to establish that no-one is liable if the carbon is lost during the credit's life time. This creates a potentially interesting quandary for secondary transactions or bundling of credits. Consider that a purchaser of a temporary credit could sell that credit in a secondary market at the end of, say, 2 years. The secondary buyer of that temporary credit could use the credit for the remaining 3 years of its lifetime, even if the sequestered carbon on which it was issued had already been released back to the atmosphere prior to his purchase.

Generally, a system that includes temporary credits allows for a portfolio of carbon credits of different types and different maturities, and greater flexibility in meeting carbon liabilities.

4. Insurance

There are a variety of ways that insurance programs might be used to provide reasonable expectation of permanent sequestration. However, with the rental system suggested here, the role of insurance would be substantially less critical, and investors would have incentives to pay market rates for credits to protect their flow of future annual payments. Any insurance would be for defined contract periods and with an improved assessment of risk. In this context, a major role for insurance might be to cover damages—for example, to assume the carbon liability should the buyer–renter go out of business.

Even when permanent sequestration is not certain, it is possible to devise approaches to improve the likelihood that impermanent sequestration becomes a permanent net reduction in emissions. Since the payments for carbon services are made on a periodic basis, continuing the carbon services would result in continuing periodic payments for carbon sequestered earlier. Continuing payments provide a financial incentive for the sequestration service provider. Thus, although there is no initial commitment that the project be permanent, the investor has reason to extend the period of sequestration. Permanence in a forest, for example, might be accomplished by establishing a steady-state forest on a previously unforested site. Once the steady-state biomass (and carbon) is attained, the investor has a financial incentive to maintain the steady-state function, since the rent flow will be lost if the carbon parking service is discontinued. Van Kooten et al. (1995) have shown that at certain relative prices of timber and carbon, the maximum value of the timber asset would be attained by focusing solely on carbon sequestration and ignoring timber harvests entirely. Permanence might also be accomplished through a reserve of extra credits.

5. Market relationship between permanent and temporary credits

Offset credits are clearly a substitute, albeit imperfect, for more permanent emissions credits. Offset credits involve periodic payments for services rendered—that is, the temporary removal of carbon from the atmosphere. Under the rental approach, financial markets would allocate values to emissions credits according to the time during which carbon is sequestered, and there is no need to define a numerical equivalence between tonnes-years and permanent-in-perpetuity tonnes (Marland et al., 2001). A payment for a limited period can be viewed as a rental payment for using the physical space to provide the service (or interest payment on the use of capital). The rental payment for 1 t for 1 year would be Eq. (1):

$$R = P_p \times r^* \quad (1)$$

where R is the rental price for 1 t-year of carbon offset credit where 1 t-year = 1 t sequestered for 1 year, P_p the price of a permanent emissions reduction credit, and r^* the discount rate (adjusted for differential risk, uncertainty, and transaction costs).

The price of a permanent emissions credit, P_p, would be determined in the market for tradable emissions credits. Since trading in one market in no way precludes trading in the other, the price in the presumably smaller offset market would be influenced importantly by the price of permanent emissions credits.

The mix of types of credits in one's portfolio is likely to vary through time. Indeed, there are circumstances when offsets might be an acceptable alternative to a permanent emissions credit, or even preferable (as when it is believed that a "technological fix" will obviate or reduce the need for credits in a relatively short time). With functioning markets, the relative prices of the two types of credits would be determined by considerations that include the current and expected future value of a permanent carbon credit, the discount rate, and adjustments for expectations of additional monitoring and transaction costs associated with the biological offsets.

In concept this problem can be cast in terms of either stocks or flows. Why treat temporary biological sequestration as a stock when it can be better treated as a temporary flow? In fact, questions relating stocks to flows are routinely dealt with in finance and economics. An in-perpetuity flow of benefits or costs can be represented as a single financial value, which is referred to as a discounted present value, where future costs or benefits are discounted by an appropriate interest rate. It can also be represented as an infinite stream of periodic payments.

Related to the idea of providing incentives for delaying CO_2 emissions, ultimately, is the temporal issue—whether current emissions reductions have the same value as future emissions reductions, and thus whether zero is the appropriate discount rate for treating emissions reductions over time or the temporary storage of carbon.[2] Might conditions change such that emissions in the future cause more damage than the same quantity of emissions now? Temporal issues are discussed in the context of carbon sequestration by Fearnside et al. (2000), Richards (1997), Marland et al. (1997), Van Kooten et al. (1997), and Meinshausen and Hare (2000), and are not discussed further in this paper. Here we do not discount future carbon, although we do discount carbon's future costs and/or prices. Thus we acknowledge that markets for trading carbon credits will adopt appropriate discount rates for the value of carbon emissions credits.

6. Seemingly similar approaches

Several alternative approaches to terrestrial carbon sequestration have been suggested. *Land Use, Land-Use Change, and Forestry*, a special report prepared by the IPCC (IPCC, 2000), describes the tonnes-year approach for dealing with the lack of permanence of sequestered carbon (see also Fearnside et al., 2000; Moura Costa and Wilson, 2000; Tipper and de Jong, 1998). In a tonnes-year system, credit would be awarded for the number of tons of carbon held out of the atmosphere for a given number of years, and some equivalency factor would equate a specific number of tonnes-years with 1 t of permanent

[2] Discount rates apply to values, not to physical units. Thus the discounting of future carbon volumes can best be viewed as a proxy for discounting future values on the *assumption that carbon prices* (*or costs*) *are constant through the relevant period*. In such a case, treating a long, say 50-year sequestration project as permanent will only modestly change the present values. However, to the extent that carbon prices (damages) rise through time, as posited, for example, by Nordhaus and Boyer (2000), the equivalence deteriorates.

sequestration. Some of the problems with tonnes-year approaches have been elaborated by Marland et al. (2001) and Korhonen et al. (2002). We agree with Chomitz (2000) that there is no unique way to determine a conversion rate between tonnes-years and permanent tons and that the choice among justifiable possibilities is thus a policy decision. This paper argues that it is unnecessary to make such a choice.

As noted above, the government of Colombia has suggested a system of "expiring emission reduction credits". This system, in different words and with less elaboration, is very similar to our concept of renting carbon credits and has been introduced by the government of Colombia (2000) and elaborated by Blanco and Forner (2000). Colombia envisions the proposal as a "simple liability scheme" that addresses the concerns of countries "preoccupied about the sovereignty issue." Colombia proposes placing an expiration data on emissions credits from sequestration activities so that emissions credits would eventually have to be replaced by permanent credits or additional expiring credits. Lands on which carbon is sequestered would be released from any further obligation when the credits expired. Colombia recognizes that the owner of a project might choose to extend the lifetime of a project and thus the lifetime of expiring credits. The EC proposal discussed above introduces the term "temporary certified emission reduction" (tCER).

Our proposal differs from the Colombia and EC proposals in that it involves no automatic expiration date. Expiration would occur when it occurred, and the rent payments would then cease. The duration of rental contracts could be left to the discretion of the contracting parties. Thinking in terms of rental contracts also tends to make clear the opportunities for secondary transactions, a concept not addressed by the Colombia and EC proposals. Describing the approach in terms of rentals helps bring the proposal into familiar financial terms and concepts.

Another alternative is a system that would treat carbon offsets as permanent for the purposes of trading in some markets. A system like this has been considered for Canada but appears not to have been fully developed (Hull and Lempriere, 2002). Under this system the liability of certified sequestration projects would be assumed and guaranteed by the government. The government would be the sole purchaser of the offset rights, which it would in turn make available to domestic industry as a substitute for emissions permits. The emissions permits would be required because the governments limited industrial sector emissions to some fraction of its earlier emissions. Individuals and the market could view the offsets as permanent, since they would permanently release offset holders from future emissions liability. In essence, the carbon offsets would become *perfect* substitutes for the usual permanent emissions credits, within the domestic market; and they would supplement the stock of emissions permits. However, since the carbon offset liability would be assumed by the government, the government would become responsible to the international community for ensuring that offset sequestration permanency was achieved.

This later type of proposal raises the more general question about credits involving the long-term commitments of corporations or other non-governmental organizations that engage in rental agreements for carbon emissions credits. These entities would essentially accept long-term, unsecured obligations for carbon releases potentially many years after the use of the credits, and there is no assurance of their existence and responsibility by the time the rental contracts expire. In fact, it is governments that will likely be bound by international obligations, whether taxes or rations on emissions, and they must ultimately determine the extent to which they will choose to include rented credits as part of their reporting and long-term obligations. Individual countries may choose to limit the extent to which individual investors can use rented credits to help meet the national commitment.

7. Conclusions

The creation of a market for the renting, rather than permanent sale, of carbon emissions offset credits provides advantages to certain users and addresses concerns about the possible absence of permanence and liability. Such a system recognizes that stocks and flows can be alternative descriptions of the same phenomenon, and that a flow need not exist in-perpetuity to have an equivalent stock. Hence, this approach is conceptually more complete and likely to be more feasible operationally than alternative proposals for dealing with temporary sequestration.

A market for renting offset emissions credits would complement the market for buying and selling permanent emissions credits. Short-term credits provide a flexibility not found in longer-term instruments. Furthermore, the relative prices determined by the markets would indicate the degree of substitution between these two types of credits. Presumably, carbon emissions offsets would rent at a discount to the rental equivalent of permanent credits by virtue of the higher transaction costs, namely periodic transitions and additional monitoring.

The voluntary rental of carbon emissions offset credits should benefit both renter and host. The attraction of rented credits for the renter would presumably be financial. Those in need of credits could rent temporary credits as well as buy permanent credits or borrow to purchase permanent credits. Rented credits would provide revenue to the host and perhaps also bring a flow of development and environmental values. They would not, however, obligate the host beyond the negotiated rental contract, a matter of considerable concern to potential host countries. Such a system could be used in conjunction with a market system of permanent tradable emissions permits, providing flexibility in addressing carbon liability issues under the Kyoto Protocol or under similar regulatory regimes within countries.

Finally, we note that the effect of renting carbon on an individual project basis should increase total global carbon sequestration. Although any individual project may be temporary, the aggregate effect of economic incentives for carbon sequestration will be to increase aggregate sequestration on a permanent basis. Whenever and wherever there are incentives (payments) for carbon sequestration services, we would expect more sequestration than if no payments were being made.

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