Potential for Carbon Forest Plantations in Marginal Timber Forests: The Case of Patagonia, Argentina

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Abstract

With the advent of the Kyoto Protocol and its recognition of the use of forestry activities and carbon sinks as acceptable tools for addressing the issue of the build-up of atmospheric carbon, the potential role of planted forests as a vehicle for carbon sequestration has taken on a new significance. Additionally, the emergence of tradable emission permits and now tradable carbon offsets provides a vehicle for financially capturing the benefits of carbon emission reductions and carbon offsetting activities. In a world where carbon sequestration has monetary value, investments in planted forests can be made with an eye to revenues to (at least two) joint outputs: timber and the carbon sequestration services.

The first section of this paper examines the Patagonia region of Argentina, as an example of an area where carbon sequestration values combined with timber values create financial incentives for creating planted forests, which could not be justified on the bases of timber values alone. The paper uses a present value approach to evaluate the costs and benefits of plantation forestry in a "representative" site in Patagonia. A basic timber harvest scenario is developed and then a number of alternative scenarios are examined. These introduce carbon as an additional product to be produced "jointly" with timber. The scenarios include alternative rotation periods, alternative prices for carbon offsets, and a brief examination of the effect of undertaking a specific silvicultural activity.

In the second section of the paper the results of this analysis are considered in the context of a discussion of the various types of institutional arrangements that might be required to provide a market for the carbon sequestration services provided by the planted forests. The paper identifies, examines and discusses a number of potential institutional arrangements that exist or are under discussion for marketing carbon sequestration services. A number of problems that may arise with offset credits and some of the innovative institutions that may be created are identified and discussed.

Key Words: carbon sequestration, forest plantations, carbon offsets, present value, Kyoto Protocol, Argentina, developing countries

JEL Classification Numbers: Q15, Q20, Q23

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SECTION I. PATAGONIAN FOREST MODELS

Introduction

Forests have long been recognized as generating a suite of desirable outputs. In addition to timber, outputs include water quality, flood control, wildlife habitat, outdoor recreation, and so forth. In many cases, however, these outputs are not traded in markets and thus do not contribute financial returns. Often these outputs have been referred to as external effects or "externalities." Thus, for a planted forest, the timber market values typically must cover the costs of forest establishment, management and protection. In many regions of the world, however, the economics of timber production do not justify planted forests, as the value of the timber harvests do not adequately cover the costs.

Recently, carbon sequestration has come to be recognized as an important output of forests. As with many other nontimber outputs, the carbon sequestration values of the forest have generally not been capturable by forest owners or in markets. This situation appears to be changing. With the advent of the Kyoto Protocol and its recognition of the use of forestry activities and carbon sinks as acceptable tools for addressing the issue of the build-up of atmospheric carbon, the potential role of planted forests as a vehicle for carbon sequestration has taken on a new significance. Additionally, the emergence of tradable emission permits and now tradable carbon offsets provides a vehicle for financially capturing the benefits of carbon emission reductions and carbon offsetting activities. In a world where carbon sequestration has monetary value, investments in planted forests can be made with an eye to revenues to (at least two) joint outputs: timber and the carbon sequestration services. It should be noted that almost all of the studies thus far have focused on the cost of carbon sequestration as a single output, rather than as a joint output with timber (e.g., see Sedjo et al. 1995, Stavins 1999).

The first section of this paper examines the Patagonia region of Argentina, as an example of an area where carbon sequestration values combined with timber values create financial incentives for creating planted forests, which could not be justified on the bases of timber values alone. After discussing Argentine experience, the paper uses a present value approach to evaluate the costs and benefits of plantation forestry in a "representative" site in Patagonia. The data are presented in spreadsheet form in the appendix. The basic unit of analysis is a planted hectare. However, the hectare is then examined within the context of a

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multiple-hectare forest system. For convenience, the concept of a regulated forest is developed, but the basic results are more general.

A basic timber harvest scenario is developed and then a number of alternative scenarios are examined. These introduce carbon as an additional product to be produced "jointly" with timber. The scenarios include alternative rotation periods, alternative prices for carbon offsets, and a brief examination of the effect of undertaking a specific silvicultural activity. Additional scenarios can easily be examined if desired. The results of the forest model financial analysis are summarized and implications developed.

In the second section of the paper the results of this analysis are considered in the context of a discussion of the various types of institutional arrangements that might be required to provide a market for the carbon sequestration services provided by the planted forests. This paper recognizes that markets for carbon credits are not well developed. The second section of this paper identifies, examines and discusses a number of potential institutional arrangements that exist or are under discussion for marketing carbon sequestration services. A number of problems that may arise with offset credits and some of the innovative institutions that may be created are identified and discussed. At this time most of these institutions are in their fledgling stages, and further refinements are likely to be required if they are to be effective in facilitating various market and market-like activities and transactions.

The Argentine Experience

Argentina has a substantial history of planting trees, including commercial plantations. Over the years the Government has had a number of different plantation policies, including periods during which major subsidies were provided and other periods during which they were withdrawn. In recent years Argentina has become a significant producer of industrial wood from forest plantations, mostly in the Mesopotamian region in northeast Argentina. This region has the conditions for rapid growth rates and relatively short rotations and planted forests are probably justified on the bases of the expectation of future prices at timber harvest (Sedjo and Ley, 1995).

As it became well known that forests and forest ecosystems sequester large volumes of carbon and preliminary studies indicate that forestry has the potential of capturing large amounts of carbon at a low cost, the interest of Argentina in carbon plantations is focused largely on Patagonia. The interest probably reflects the recognition that Patagonian plantations, for timber alone, are very marginal at best.

Earlier work has suggested that the economic returns to plantations in Patagonia for the production of industrial wood are usually not justified by normal economic and financial criteria. The problems are of two types. First, although some areas along the eastern side of the Andes have adequate soils and rainfall to provide good forest growth, the major markets in Argentina are at a considerable distance; thus the transport cost to the major domestic markets is high. Additionally, major ports are some distance therefore making it difficult to be an efficient exporter. Second, although growth rates are significant, the species that do well in Patagonia's soils and climate, commonly introduced from North America, tend to have slow initial growth, with the more rapid growth coming many years out. This results in a relatively long rotation period, in the neighborhood of 27-35 years. The result of the long rotation period is a relatively low rate of financial return.

However, producing both timber and carbon, forest plantation appear to offer potential to promote the economic development of a lagging region. The government has been mostly concerned with the development of small-scale forest plantations, as the subsidies for establishment are often limited to only 300 ha of planting annually. However, if a market for carbon sequestration services were to develop, the financial returns to Patagonia plantations could improve substantially and, at a sufficiently high carbon payment, the subsidy could be withdrawn without serious reductions in plantation starts. As mentioned earlier, the Patagonia planted forest has longer rotations than many plantations, with more growth in the latter period. Although this is a financial disadvantage in timber production, this characteristic could be positive in that the increased growth could occur in a later period when the carbon sequestration services may become the more valuable.

The recent Kyoto Protocol has reinforced this interest by indicating that certain types of carbon sinks, and particularly forestry, may have the potential to capture carbon and that this sequestered carbon can be counted by Annex 1 countries in meeting their carbon obligations. Furthermore, forestry is particularly attractive due to the development of a Joint Implementation (JI) mechanism, which allows carbon projects be undertaken jointly between countries with the credits directed to the country needing the credits and revenues directed to the country in which the project is undertaken. This type of arrangement will probably also apply for the Clean Development Mechanism (CDM) currently under development.

Prior Studies

A series of preliminary studies looking at aspects of the possibility of establishing planted forests in Patagonia had been undertaken by SAGyP (1993), Crossen et al. (1994), and Sedjo and Ley (1995). This paper extends some of that earlier work, particularly that of Sedjo and Ley for the World Bank.

Prior work by Sedjo and Ley examined the cost potential of plantations of different types in alternative locations in Argentina, including Patagonia. These results were consistent with earlier studies by SGCyP, which found that the rate of return to timber plantations in Patagonia was well below the 10 percent target level of the Argentine Government, generally in the range of 4-7 percent. This return is roughly the same return as alternative uses, primarily extensive grazing. This early work supported the contention that without substantial subsidies, generally in the range of a contribution of about $500 or one-half of the plantation establishment costs of $1000 per ha, the private sector would not have the financial incentives to establish forest plantations in Patagonia.

In addition, the Sedjo and Ley study estimated the costs of capturing carbon via planted forests in Patagonia. For Argentina, the cost estimates ranged from $1.72 to $21.95 per tonne of carbon permanently sequestered, and between $5.36 and $21.95 per tonne in Patagonia. However, that analysis did not consider the value of timber. The study estimated the present value of costs required to capture carbon at a future date. It did not, however, discount future carbon sequestered (see van Kotten et al. 1997 for a discussion of the issue of discounting future physical volumes of carbon). The discounting of future payments for future carbon sequestration becomes important, however, when developing market institutions to adequately compensate investors for projects that generate revenues from carbon sequestered at some far distant time. Future carbon values are discounted in this paper.

This paper expands the earlier work by developing a prototype financial approach for examining the economic potential of the region to produce jointly both industrial wood and carbon sequestration services, in place of the largely pastoral economy that now exists. As with the timber outputs, the financial approach explicitly considers the time at which the carbon is sequestered. It assumes the grower can be compensated for capturing carbon with a market price that will exist at that time, thereby generating financial benefits to the grower. The analysis discounts the financial payments, where appropriate, to provide an estimated present value of the carbon benefits, which are added to the timber benefits. The general findings for an individual hectare are expanded to adapt to the desired size of the operation and alternative scenarios are examined. Finally, the implications of these findings are examined in the context of alternative organizational structures and financing arrangements that might be considered for Patagonia.

The Representative Situation

The study begins with a "typical" or representative hectare of land that is being considered for conversion into plantation forest. The representative hectare of land is now in grass or grass and scrubs and is used as pasture for cattle or sheep. It is found in a north-south strip of land running along the east side of the Andes mountains in Argentina from roughly 36 to 46 degrees south latitude with an elevation of about 1500 meters or perhaps slightly higher. The areas appropriate for forest plantations have suitable soils for forestry and precipitation ranging from 400 mm on the eastern edge to 1000 mm and above along the western edge. This land area is found in the western parts of the Patagonia provinces of Neuquen, Rio Negro and Chubut. The area suitable for forestry encompasses about 3 million ha or perhaps more. The tree species most suitable for this area is probably Ponderosa pine. The expected biological rotation is 36 years with a financial rotation of about 27 years.

Ponderosa pine, and indeed most species that would be suitable to this area, is expected to grow relatively slowly for most of the first two decades before its growth accelerates in the latter part of the second decade and continues into the third decade. This growth pattern is reflected in the data of Urzua (no date), used in the spreadsheet figures of the appendix, as adjusted to provide for data missing for various intervening years.

Land values in this area are $50-$150 per ha. As noted, the alternative land use is largely extensive cattle and sheep grazing. The forest plantation establishment and operational costs are estimated at a present value of about $1000 per hectare, including land cost. Most of the actual cost occurs in the first year. Subsequent operation and maintenance costs are very modest with the possible exception of thinning.

The results of the base case and other financial analysis are reported in Table 1, which is drawn from the various spreadsheets. As noted, a number of studies have suggested that the financial rates of return are in the range of 4-7 percent per annum. Our estimate of the expected present value of our base case for the discounted present value (DPV) of timber production alone is $354 for the biological rotation of 36 years, and $581 for the financial rotation of 27 years, assuming a stumpage price of $15 per m3, which is about the current price. Of course, given an initial present value of costs of $1000, the net present values are -$419 and -$546 respectively. Thus, neither option provides anything near a positive net present value with a discount rate of 10 percent for the production of timber under conditions prevailing today. Once again the earlier assessments are confirmed.

Table 1. Plantation Forests: Present Value Timber Product and Carbon

	Biological Rotation	Financial Rotation
Rotation Period	36 years	27 years
Price Stumpage/m3	$15	$15
PV Timber Harvest	$354	$581
PV Plantation Costs	$1000	$1000
Net PV	**- $546**	**- $419**
Price Carbon/tonne	$10	$10
PV Carbon @ $10	$340	$304
NPV Timber&Carbon ($10)	**- $206**	**- $115**
Price Carbon/tonne	$20	$20
PV Carbon @ $20/tonne	$694	$614
NPV Timber&Carbon ($20)	**$48**	**$99**

Source: Developed from various spreadsheets.

The next step involves introducing the carbon sequestration into the analysis as a joint product with timber. Using the timber yield function of a ha of planted ponderosa, two adjustments are made. The first converts the estimate of industrial wood volume, as provided in the yield function, to an estimate of total tree biomass. The timber yield function provides an estimate of the industrial wood volume per ha, i.e., the industrial wood in the stems of the trees on a ha of planted ponderosa forest, exclusive of the volume in the branches, tops, stump and roots. Provision for the wood volume in these parts of the tree is made with a commonly used adjustment factor of 1.4 (i.e., biomass units per unit of industrial wood). Although this factor will vary somewhat depending on species and other conditions, this value is a useful average. Thus, for example, 100 m3 of industrial wood is associated with 140 m3 of total tree biomass. The second adjustment is to estimate the tonnes of carbon in the forest biomass. The factor used is 0.26 tonnes carbon per tonne of biomass. Again, this value will vary depending on the density of the tree and so forth, but this again is a commonly used and useful average. The data are also modified to provide the annual incremental carbon yield (rather than the cumulative yield as in a typical yield function). Finally, additional carbon that may be associated with the newly created forest "ecosystem" includes grown litter (detritus), understory vegetation and newly created soil carbon. These effects are likely to be small or offsetting, e.g., as with soil carbon that is released upon harvest but increases modestly with forest vegetation. In this study these sources of carbon are assumed to be negligible.

The estimates of the annual incremental additions to carbon sequestered per ha of planted forest are monetized assuming alternative carbon prices in Table 1. At a price of $10 per tonne for permanently sequestered carbon, the PV of the carbon is estimated at $340 for the longer biological rotation and the PV of carbon is $304 for the shorter financial rotation. Assuming a price of $20 per tonne for permanently sequestered carbon, the PV of the carbon is $694 for the longer rotation and $614 for the shorter financial rotation.

At a carbon price of $20 per permanent tonne and above, the forest plantations provide benefits (revenues) adequate to financially justify their costs. The longer biological rotation generates a PV of total benefits, timber harvest plus carbon benefits of $1048 and the shorter financial rotation provides a PV of total benefits of $1099. Both of these PVs of benefits exceed the $1000 PV of costs. Thus, net present value is positive at carbon prices about $20 per permanent tonne and higher.

It is seen in Table 1 that as we move from a solely timber operation to a timber and carbon operation and as the price of carbon rises, the advantage of the shorter financial rotation diminishes as the increased volumes of carbon in the later periods begin to offset the advantage of the earlier harvest. Conceptually, we can think of the optimum financial rotation as lengthening when the value of carbon rises. Van Kotten (1995) has shown that if the price of carbon is sufficiently high, it will never pay financially to harvest and thus the rotation becomes infinite.

We also examine, very briefly and crudely, the effects of thinning management (the removal of some portion of the trees throughout the stand). Thinning is something that is often recommended by foresters for a number of reasons. Evidence shows that thinning results in more volume on fewer trees. This is valuable if larger logs sell at a premium, however, it results in some loss in final harvest volume. Thinning can also improve the cash flow with the receipt of some revenues before final harvest. Often, thinning is part of a strategy of dense planting with the intent to remove weaker trees to improve the vigor of the remaining stand. However, thinning in the early part of a rotation often generates net costs.

In our representative case (Table 2A in the Appendix), the financial benefits of thinning to timber returns are very modest, even when there are no carbon effects. If we assume revenues are generated both in the early initial thinning and in the later thinning, the PV of thinning is only $20, and the negative effects on carbon and carbon revenues have not been assessed. It is clear, however, that where carbon has a value, thinning will diminish the carbon in the forest not only in the year of the thinning but in subsequent years also by lowering biomass and carbon in subsequent periods also.

Overall, it appears the effects of thinning on our analysis are very small and likely to be negative when significant carbon values are considered. Additionally, we have no idea of what, if any, price premium for thinning may be today, to say nothing of what it will be in 36 years. Thus, for purposes of most of this study, our analysis assumes no thinning occurs.

After Timber Harvests: What Next?

The above analysis carried the process of forest growth through one rotation from the planting of bare ground to the timber harvest some three decades later. What happens after the timber harvest? There are a number of ways to address this question. Let us look at two sources for perspective: the recent Kyoto Protocol and from a more general conceptual view.

First, according to the Kyoto Protocol, carbon credit is to be given for carbon sequestered through afforestation activities. However, credit can be lost for Annex 1 countries for deforestation. Hence, following Kyoto, if the harvested plantation is established on an area not in forests, as is expected for Patagonia, the activity is clearly eligible for carbon credits. However, if the forest is harvested and not regenerated, then this would constitute deforestation and carbon debits should occur for Annex 1 countries. However, if the harvested area is reforested, then the area remains in forest and there appears to be no carbon debit. (This is the most common interpretation of the Kyoto Protocol, but it remains somewhat unclear on this point and clarification may be forthcoming from the international negotiations.) Thus, debits would not be forthcoming if replanting takes place after the harvest. However, since the replanting of the newly established forest is not on a previously unplanted area, **the second rotation would not be eligible for carbon sequestration credits.**

<u>The Steady-State Forest</u>

From a conceptual perceptive, we can think of Patagonia as establishing a "regulated" or steady-state forest of some desired size, e.g., a million ha, with a rotation of perhaps 30 years (longer than the financial rotation reflecting the carbon effect on the rotation length) and a planting rate of 33,333 ha per year, enough to plant 1 million ha in thirty years. Thus, at year 30 Patagonia will have completed the planting of the one million ha forest. There will be 30 age cohorts of 33,333 ha, and the first harvest will be undertaken on the 30-year-old cohort.

From that time on, the forest can be viewed as a regulated forest. It would be capable of generating a harvest from one-thirtieth of its area and volume. If this harvested area were replanted, the stock of biomass and carbon of the system would remain constant, despite annual harvests. Therefore, the forest system would not release any net carbon even though there were annual harvests. Also, there would be no carbon debits generated. However, as noted with Kyoto, using the steady-state concept, **the second rotation would not be eligible**

for carbon sequestration credits. Hence, both the conceptual view and the Kyoto Protocol give the same results with respect to credits and debits.

Some Problems

One conceptual concern with both the steady-state forest and also with the Kyoto system, the afforestation provision as commonly interpreted could generate a payment schedule that would exceed the actual carbon sequestered. This is because, at any point in time, a regulated forest consists of all the age groups and some will have a carbon content that is the average of these ages. However, the regulated forest, by definition, is only some portion of its maximum since it always has most of the forest at less than maturity. But, if each separate ha receives compensation for the cumulative carbon sequestered in its growing life, the payment to the regulated forest would be as if it were entirely at its harvest age. Thus, with this approach the steady-state system, as the Kyoto system, would provide compensation based on the maximum carbon per ha at harvest and not what exists in the regulated forests with its varying ages. This is payment for more carbon than is stored in the steady state.

This result occurs in the regulated forest system because one the oldest cohorts begin to be harvested, the harvest from the oldest cohort equal the total annual forest growth of all the younger cohorts. The forest system is in regulated steady state, any first rotation ha that is not old enough to be harvested will continue to receive carbon credits until harvested. But, no new carbon is being sequestered in the regulated system; rather the sequestration of the young ha is simply offsetting the releases of the harvested ha. Thus, the regulated system as described and the Kyoto Protocol both appear to have the potential to provide more compensation than is justified from the actual amount of carbon sequestered. However, since this problem does not occur for the first several decades, it may be that its resolution can be deferred and this issue is not addressed further in this paper.

Implications

The forest model confirms the results of earlier studies which indicate that, for forest plantation in Patagonia, the financial returns to timber alone are unlikely to generate anything close to the revenues needed to generate a positive net present value at a 10 percent discount rate. If planted forests jointly produce both timber and carbon, the carbon price needs to be $20 per permanent tonne or higher to provide a positive net present value. Also, management activities such as thinning probably add little value, and can generate negative value if the carbon values are large. Finally, the higher the price of carbon, the less important the value of the timber, and also the less importance given to associated timber quality enhancing activities.

On a larger scale, we can view the annual establishment of plantations as moving toward the establishment of a large regulated forest. Hence, at some future date when the forest system stops expanding, it can be viewed as producing an in-perpetuity flow of timber and maintaining a permanent stock of carbon and carbon credits. However, additional carbon credits will not be created in the second rotation. The results in terms of carbon credits and debits for afforestation and deforestation are the same as those coming from the forest carbon guidelines of the Kyoto Protocol.

SECTION II. POLICY ISSUES AND INSTITUTIONS

Background

Without some mechanism to capture the carbon sequestration rights, the sequestration function of the forests is simply another externality, the returns to which cannot be captured by the forest owner. Therefore, investors will not consider the positive benefits of the forest sequestration function. However, an institutional mechanism that is under development to allow the externality to be internalized is the "carbon offset." Carbon offsets, sometimes called a certified tradable offset (CTO), would be designed to neutralize or "offset" the carbon emissions of various activities, usually emissions from fossil fuels use to generate power see the discussion of UFCMP below), but also possible associated with land use changes. Carbon offsets, together with tradable emission permits, would offer power utilities a way to expand emissions without increasing the total carbon in the atmosphere. A carbon offset would be eligible since it represents a given amount of newly sequestered carbon. An emission permit, by contrast, does not represent new sequestration. Rather, for a system with a cap (limit) on releases, it represents the transfer of releases from one party to another and involves a redistribution of releases. For example, in a system with some maximum allowable emissions, a company that has reduced its emissions, e.g., due to a plant closure or new technology, could sell a permit to emit to someone else. The new emission would be in place of those that were not forthcoming due to the plant closure or new technology. Thus, with offset and emission permits, new emissions are allowed only if they are neutralized by either an equal amount of carbon being sequestered somewhere else (an offset) or where the new emission is a replacement for a reduced emission somewhere else (an emission permit).

Some Confusions

When speaking about the price of carbon offsets, there appears to be some confusion as to the period covered by the offset. Is the offset valid for one year after which time it must be renewed? Or, is an offset of a permanent or unlimited duration? Most of the work estimating the cost of sequestering carbon is dealing with permanent offsets (for example see Sedjo et al., 1995). This was also the case for the GEF/WB 1995 study of forestry carbon costs in Argentina. Thus, to do the task intended carbon offsets must be essentially permanent. However, there appear to be cases where offsets are available for short periods, perhaps a year. One might make the case that since carbon offsets are reversible, they ought to be created for a limited time period, e.g., one year, and renewable only upon assurance that the offset, e.g., the forest, is still in effect.

Future Prices and the Forestry Model Findings

The earlier section of this report detailed the findings of the simple joint product forestry model. To summarize, our analysis used alternative assumptions regarding future prices of permanent carbon offsets. At some sufficiently high future price, the benefits will cover the timber production costs, assumed to have a present value of about $1000 per ha, mostly associated with the plantation establishment. However, at many possible future prices the financial criteria will not be met. In our analysis we examined the implications of an assumed a price of $10 and $20 per tonne of carbon for a permanent offset. At the $10 price the discounted benefits (revenues) of the carbon and the timber were about equal, but none of the plantation projects examined was economically justified. All scenario projections had benefits substantially less than costs at the 10 percent level. At the $20 per tonne of carbon price of a permanent carbon offset, however, the value of the carbon benefits double and the total discounted present value of the benefits from carbon offset and timber receipts approximately equal the cost. This indicates that the project has an internal rate of return of about 10 percent, the target level.

These results provide both promise and concern for countries like Argentina. A well-formed world market for carbon offsets has not yet been developed. Hence, we have little market information as to the likely near-term prices and even less regarding the long-run market price of offsets. However, a number of studies suggests prices ranging considerably higher from twenty to sixty dollars per ton (Sedjo et al., 1995; Stavins, 1999).

Some real world experience is available at the Costa Rican Office of Joint Implementation (OCIC) which is said to generally price carbon offsets at about $10 per tonne. However, the period for which the offset is valid is somewhat unclear and appears to be variable. In some cases these appear to be for a single year, in other cases for several years up to perhaps 20 years. A price of $10 per tonne per year can be viewed as equivalent to a $100 value for a permanent offset (using a 10 percent discount rate). Additionally, some types of alternative energy technologies and carbon capturing technologies involve substantially higher likely costs. For example, solar collectors for hot water are estimated to cost $30 per tonne and photovoltacics $185.7 per tonne of carbon abated. If those prices are representative, forest carbon offers a low-cost alternative that is likely to be utilized. Demand for carbon offsets could produce high, attractive payments for offsets. Of course, in the longer term technology may well find low-cost alternatives to fossil fuel energy or develop means of "scrubbing" or "capturing" the carbon from fossil fuels. Thus, there is a huge degree of uncertainty about the long-term future value of carbon offsets and their likely future prices.

Many believe that prices are likely to rise in the longer term as concerns increase and companies need to make required adjustments. Thus, it may be sensible for an intermediating institution to collect offsets today, when prices are low to be released in the market if and when prices rise. To some extent this service is being provided by the members of the Utility Forest Carbon Management Program (UCMTP) in the US and by the OCIC in Costa Rica (see below).

Some Existing Institutional Arrangements for Carbon Credits

Markets for carbon credits are not well developed, in part because the international community has not fully agreed as to what needs to be done nor precisely what will be the role of carbon offset credits. However, the concept of carbon emission activities in one country being used by other countries as credits is well recognized.

Institutions are being developed to allow these multi-country activities and transactions to be made. Joint Implementation, for example, allows one country to purchase carbon credits by undertaking carbon-reducing activities in another country. Also, the newly developed Clean Development Mechanism (CDM), coming out of Kyoto, may allow the same general types of multi-country activities, purchases and trades.

<u>Buyers' Side</u>

From the side of potential buyers of carbon offsets, the US provides some interesting examples of arrangements that can be made. The development of a serious carbon offset program has been encouraged by the State of New York's power authority's requirement that electric power facilities that want to receive a license to increase their power generation capacity must demonstrate that they have provided for any increased carbon emissions resulting from the expansion. In an early case a major power company made arrangements for tree planting activities in Guatemala, thereby demonstrating to the State of New York authorities that the new carbon emissions would be offset. Other power companies have met these obligations in a similar way.

Also, in the US, the electrical power industry, through the Edison Electric Institute (EEI), an association of private electrical power companies, has formed a Utility Carbon Management Tree Program whereby the various member companies invest monies into a UFCMP project fund. In this case the buyer is working directly with the carbon producers. Proposals for various tree-planting projects that will sequester carbon are solicited from potential contractors. The UFCMP then selects which proposals will be funded, with the rights to the carbon offset credits going to UFCMP. The carbon offsets are distributed, as with a mutual fund, to the utilities in proportion to their investment levels. Currently the UFCMP is a prototype operation "experimenting" with different types of projects and arrangements. However, it has invested about $5 million in over 20 projects in several different countries including Russia, Belize and Malaysia, as well as the US. This is the type of operation that could become a major investor worldwide, particularly if the US seriously moves to control carbon emissions and places increasingly stringent constraints on emissions by electrical utilities.

<u>Producers' Side</u>

While the buyers need to identify needs and potential sources of secure and acceptable offsets, the producers of carbon offsets need to find ways to create and certify new offsets. This needs to be done in a context where buyers have offsets that are recognized and honored, probably via some creditable third-party certification.

Perhaps the most well developed system for collecting and marketing carbon offsets from the producers' side today is that of Costa Rica. The system is approximately as follows: A joint governmental/NGO organization, FONAFIFO, has the responsibility for collecting Certifiable Tradable Offsets (CTO) by undertaking projects, some may be Joint Implementation projects, in Costa Rica. These projects may be conservation, management or reforestation. (We might note that currently it is uncertain whether carbon credits will be awarded for conservation or management under the newly concluded Kyoto Protocol. Presently, Kyoto seems to provide no credits for forest protection, although Annex 1 countries receive carbon debits for deforestation.) For reforestation, farmers are paid for over 5 years for the first 5 years of carbon sequestration, with over 90 percent of the monies coming in the first 3 years, whereas most of the carbon is accumulated in years 4 and 5. The actual existence of successful carbon sequestration is certified by a third party. For Costa Rica the certifier is SGS UK Ltd., Forestry Services, a member of the Societe Generale Surveillance of Switzerland.

FONAFIFO now has rights to this carbon for 20 years. The marketing rights to the carbon are transferred to the Costa Rican Office on Joint Implementation (OCIC) that has responsibility for marketing those rights as CTOs. Investments come into the system in two ways. First, one-third of the fuel tax collected in Costa Rica is directed to FONAFIFO to provide them with funds to purchase carbon offsets from the farmers based on their forestry activities. Second, investors may provide monies to OCIC for Joint Implementation projects. Additionally, funds may be received by the sale of CTOs in the market.

It will be noted that there are two "subsidies" provided to the farmer in this system. First, the fuel tax revenues that are directed to FONAFIFO are a subsidy to its operation find their way to the farmer to promote his forestry activities. Second, the farmer is paid most of the monies before the carbon is actually accumulated. This can be viewed as an interest free (subsidized) loan by FONAFIFO to the farmer.

In Costa Rica, there is involvement by the central government, NGOs and quasi-governmental groups as well as by the international community. Additionally, they are utilizing international mechanisms that exist; e.g., Joint Implementation, and they are providing creditable third-party certification.

The model of Costa Rica is described, not because we believe that it should necessarily be adopted by other countries, but rather because it provides an idea of what types of arrangements can be made and perhaps some of the questions that need to be addressed, e.g., timing of payments, appropriate role of government.

Another producer side issue to mention is that of adequate compensation. At least two of the UFCMP projects have had difficulties getting participation due to concerns about whether the compensation was adequate. One project in Oregon is having difficulty getting landowners' cooperation to allow tree-plantings on their lands. This is, in part, because the compensation, which is three-fourths of the establishment costs, does not appear sufficient for giving up the right to future carbon credits. This suggests that producers may be quite sensitive to the level of compensation and restrictions. It also suggests that owners may behave strategically--withholding commitments for the future if the current compensation is modest. This may provide an argument that the carbon compensation should vary with future prices thereby eliminating any incentives for landowners to wait for more favorable prices.

Institutional Arrangements for a Country Like Argentina: Some Thoughts

There are a number of likely participants in any future carbon sequestering and marketing system in a country like Argentina. These are private owners with lands suitable for plantations, provincial governments, and the central government. In addition, foreign investors, offset buyers and independent certifiers also need to be considered. In the following section we will suggest some possible arrangements.

The lead on such an arrangement, in principle, could be taken by a variety of groups. Obviously, the central, or perhaps the provincial governments could take the lead in such activities. Costa Rica is an example of where the central government took the lead but with large involvement by other groups, private, NGO and foreign. By contrast, the UFCMP is strictly a private sector initiative, and working with a host of largely, but not entirely, private landowners. Both of these groups have the possibility of working through a formal JI group, but they can also work outside of that formal structure.

One possibility, for example, is that the private sector takes the lead and establishes an organization to promote investments in forest carbon in Patagonia or similar regions in other countries. However, as our forest model analysis shows, without some types of subsidies it will be difficult to attract owners to forestry unless they expect carbon offsets to sell for $20 per permanent tonne. Thus, the financial risk to the private landowner or private sector promoters of forest carbon could be large and thus discourage serious investments in carbon offsets unless and until high prices are actually experienced in the market.

1. <u>A Carbon Offset Collection Program</u>

One role for an organization would be to collect carbon offset credits in the next few years with the view to selling them in the long-term future. This might be a role that government could play in Argentina. The government is already subsidizing plantations in Patagonia. In fact, the provincial government of Neuquen has a major additional subsidy program and could easily become involved in a offset collection program. The government could create a formal carbon offset program whereby they receive rights to the offsets that are being created through the subsidy program. By creating a formal program today they avoid any future argument that the credit should not count since they were generated without thought of carbon. The government might, for example, hold some portion of the rights for themselves, to pay back the subsidies, and some portion in trust for the producer, who would receive some fraction of the organization's proceeds when the offset were sold. Thus, with the subsidy the government would be purchasing the offset rights. The extra effort involved would include record keeping of the number and ownership of the various offsets, finding some reputable certifier, and eventually developing some interactions with potential markets and some marketing expertise.

2. <u>Risk Sharing: A Role for Government</u>

The financial realities suggest that some type of risks. especially early in the program, are likely to be substantial.. There, some type of risk sharing may be desirable. Although the potential may be great, the risk of establishing plantations in the expectation of receiving large payments for carbon offsets also appears potentially great. Furthermore, the vast majority of investment, establishment costs, must be borne early, and with most of the returns delayed many years. Even carbon benefits tend to occur mostly after two decades of growth due to the slow initial growth of the species likely to do well in the region. Thus, it appears unlikely that the activities would get underway without some stronger expectation of the assurance of significant future carbon revenues or some form of government start-up support.

In recent years, most of the plantations established in Patagonia received substantial subsidies--in the range of 50 percent of the establishment costs--provided by the central government. It may be that a subsidy approach might have further justification in the guise of an "infant industry" type of argument for the region. In this way the central government would also assume some of the risk associated with carbon forest plantations in Patagonia. However, it has been observed that current subsidies provide only modest incentives to forest establishment in Patagonia as establishment levels are modest. The second part of the long-term incentives would need to come from the carbon receipts for carbon offsets. Our forest model scenario shows that at a price of $10 per permanent tonne, forestry still is not financially profitable with a 10 percent target return rate. However, with an establishment subsidy of about $500, the 10 percent target can be realized.

In the near term the government might expect to continue a subsidy program at about the present level. However, the government could agree to request repayment of the subsidies from payments the farmers received of carbon offsets. For example, 50 percent of the offset payments might go to the government until the subsidies are repaid. If offsets never come, the subsidies are a grant. If offset payments are small, the government might recapture a portion of its subsidies to the farmers. If offset payments are substantial, the government could be reimbursed for its payments with farmers still receiving most of the offset payments. (This could be done in the context of the "carbon offset collection program" discussed above.)

More generally, there could be a number of ways for the government to share the revenues from offsets. In addition to requiring payback of the establishment subsidies, these can accrue to the government through tax revenues, some of which might apply only in the case of very high carbon revenues. Provincial governments, also, have the possibility to collect some portion of any large "windfall" revenues through various tax measures.

One problem with waiting for the market to drive up the price of carbon offsets before acting is the time lag between recognizing the existence of higher prices, actual planting and the realization of significant carbon accumulations. The government may assist in preparing the way for a rapid response to the opportunity presented by a swiftly developing market for carbon credits by creating supporting institutions that will already be in place if and when the markets develop. For example, the government might arrange to develop some excess nursery capacity for desired species. There appear to have been some difficulties, even in recent years, in obtaining sufficient seedlings in Patagonia in a timely manner. Should an active well-priced market develop in offsets, it is almost certain the seedling availability would quickly become a bottleneck. The government need not establish its own nurseries, it might simply provide subsidies for local nurseries with local capacity to provide the potential to obtain high quality seedlings quickly, perhaps with an exclusive contract with a foreign provider, even in difficult times.

Other improvements in tree planting capacity of this type may also be a useful way for the central government to increase the capacity of the region to respond to opportunities. Some financing for these types of activities might be available through the development banks, foreign aid or private foundations concerned about environmental and global warming issues.

3. A Private Sector Model

A private model may be possible in Patagonia if the government is prepared to provide some support and bear some of the more serious risks. For example, the domestic power companies might wish to participate in a program similar to that of the UCMFP in the US, or, forest products companies might wish to enter the carbon credits business. Although this activity appears to be quite suited to forest companies, there appears to be some resentment to the idea from environmental groups who don't seem to want the industry to benefit from doing what environmentalist see them as doing already for financial gain. This general view seems to be reflected in the notion that small owners ought to be eligible for subsidies of plantations that grow carbon, but large firms ought not be eligible for the same subsidy, even if they too sequester carbon. In any event, the private groups that appear most interested in becoming involved in this activity are groups like the electrical power industry that have an industry interest in directly using the offsets.

Another possibility could be for a foreign external group, like the UFCMP, to choose to focus its attention on a region like Patagonia with the view to utilizing most of the carbon offsets directly by members of the group, like the US utilities. However, to have such a large involvement in one region could be seen as risky for the foreign group. Also, it would have to view the government as reliable and not likely to add additional requirements, such as export taxes for offsets, on the foreign group after it has become committed. It appears more reasonable that a local entity take the lead and work with foreign groups, recognizing that they are likely to want a host of potential offset suppliers.

A local entity might get the support, both technical and perhaps financial, of a major environmental NGO. Thus, local involvement could be mixed with foreign expertise. Again, in the Patagonia case, it is difficult to see this effort being successful without the support of the central government, at least initially if carbon offset prices are at modest levels.

Conclusions

Regions like Patagonia have the potential to sequester large amounts of the atmosphere's carbon through the establishment of large areas of plantation forests. However, for such a venture to be self-financing over the long term a number of conditions need to be met. First, there needs to be a means for converting the sequestered carbon into carbon offsets that are recognized and valued in the marketplace. Second, the market price for the offsets needs to be expected to exceed some threshold level, at least $20 per tonne in the case of Patagonia for permanent carbon offsets. To accomplish this it is almost certain that some reliable means of certification would be required as well as some type of "clearinghouse" to allow carbon offset buyers to interact with producers through offset sellers.

In concept, there are a variety of ways in which carbon offsets might be converted into money. In practice, the world is still experimenting with alternative possible institutional arrangements. Although we know how to grow trees, we know much less about simultaneously providing incentives for tree growers through creating a carbon offset vehicle that will be attractive globally. Countries, such as Argentina, should attempt to work with a variety of sources that may provide financing and expertise. This can run the spectrum from environmental groups to foundations interested in environmental issues to electrical power utility groups trying to insure that they will be able to obtain offsets in the future at a reasonable cost.

APPENDIX: SPREAD SHEETS

Table 1A: Spread Sheet 1

Timber Vol/ha (m3)	Biomass Vol./ha (m3)	Carbon (tons)	Carbon value $	discount rate DPVbio	DPVfin	timber price/m3 biological	financial
0	1.4	0.26	$10	0.1		$15	$15
1	1.4	0.364	$4			0	0
2	2.8	0.728	3.64			0	0
3	4.2	1.092	3.64			0	0
5	7	1.82	7.28			0	0
7	9.8	2.548	7.28			0	0
9	12.6	3.276	7.28			0	0
10	14	3.64	3.64			0	0
11.7	16.38	4.2588	6.188			0	0
18	25.2	6.552	22.932			0	0
25	35	9.1	25.48			0	0
33.6	47.04	12.2304	31.304			0	0
47	65.8	17.108	48.776			0	0
61	85.4	22.204	50.96			0	0
75	105	27.3	50.96			0	0
109	152.6	39.676	123.76			0	0
130	182	47.32	76.44			0	0
149.4	209.16	54.3816	70.616			0	0
190	266	69.16	147.784			0	0
230	322	83.72	145.6			0	0
247.8	346.92	90.1992	64.792			0	0
290	406	105.56	153.608			0	0
330	462	120.12	145.6			0	0
364.8	510.72	132.7872	126.672			0	0
390	546	141.96	91.728			0	0
430	602	156.52	145.6			0	0
461.7	646.38	168.0588	115.388			0	$6,925.5
480	672	174.72	66.612			0	0
510	714	185.64	109.2			0	0
540	756	196.56	109.2			0	0
560	784	203.84	72.8			0	0
580	812	211.12	72.8			0	0
600.6	840.84	218.6184	74.984			0	0
620	868	225.68	70.616			0	0
640	896	232.96	72.8			0	0
662.4	927.36	241.1136	81.536			$9,936	0
DPV				$346.97	$307.13	$353.56	$581.09

Table 2A: Spread Sheet 2

Timber Vol/ha (m3)	Biomass Vol./ha (m3)	Carbon (tons)	Carbon value $	discount rate		timber price/m3		
				DPVbio	DPVfin	biol	fina	thinng
0	1.4	0.26	$10	0.1		$15	$15	$13
1	1.4	0.364	$4			0	0	0
2	2.8	0.728	3.64			0	0	0
3	4.2	1.092	3.64			0	0	0
5	7	1.82	7.28			0	0	0
7	9.8	2.548	7.28			0	0	0
9	12.6	3.276	7.28			0	0	0
10	14	3.64	3.64			0	0	0
11.7	16.38	4.2588	6.188			0	0	0
18	25.2	6.552	22.932			0	0	0
25	35	9.1	25.48			0	0	0
33.6	47.04	12.2304	31.304			0	0	0
47	65.8	17.108	48.776			0	0	0
61	85.4	22.204	50.96			0	0	0
75	105	27.3	50.96			0	0	0
109	152.6	39.676	123.76			0	0	0
130	182	47.32	76.44			0	0	0
100	140	36.4	-109.2			0	0	50
190	266	69.16	327.6			0	0	0
230	322	83.72	145.6			0	0	0
247.8	346.92	90.1992	64.792			0	0	0
290	406	105.56	153.608			0	0	0
330	462	120.12	145.6			0	0	0
364.8	510.72	132.7872	126.672			0	0	0
390	546	141.96	91.728			0	0	0
430	602	156.52	145.6			0	0	0
461.7	646.38	168.0588	115.388			0	$6,925.5	0
480	672	174.72	66.612			0	0	0
360	504	131.04	-436.8			0	0	150
540	756	196.56	655.2			0	0	0
560	784	203.84	72.8			0	0	0
580	812	211.12	72.8			0	0	0
600.6	840.84	218.6184	74.984			0	0	0
620	868	225.68	70.616			0	0	0
640	896	232.96	72.8			0	0	0
662.4	927.36	241.1136	81.536			$9,936	0	0
DPV				$340.30	$303.89	$353.56	$581.09	$20.29

Table 3A: Spread Sheet 3

Timber Vol/ha (m3)	Biomass Vol./ha (m3)	Carbon (tons)	Carbon value $	discount rate		timber price/m3	
				DPVbio	DPVfin	biolog	financ
0	1.4	0.26	$10	0.1		$15	$15
1	1.4	0.364	$4			0	0
2	2.8	0.728	3.64			0	0
3	4.2	1.092	3.64			0	0
5	7	1.82	7.28			0	0
7	9.8	2.548	7.28			0	0
9	12.6	3.276	7.28			0	0
10	14	3.64	3.64			0	0
11.7	16.38	4.2588	6.188			0	0
18	25.2	6.552	22.932			0	0
25	35	9.1	25.48			0	0
33.6	47.04	12.2304	31.304			0	0
47	65.8	17.108	48.776			0	0
61	85.4	22.204	50.96			0	0
75	105	27.3	50.96			0	0
109	152.6	39.676	123.76			0	0
130	182	47.32	76.44			0	0
149.4	209.16	54.3816	70.616			0	0
190	266	69.16	147.784			0	0
230	322	83.72	145.6			0	0
247.8	346.92	90.1992	64.792			0	0
290	406	105.56	153.608			0	0
330	462	120.12	145.6			0	0
364.8	510.72	132.7872	126.672			0	0
390	546	141.96	91.728			0	0
430	602	156.52	145.6			0	0
461.7	646.38	168.0588	115.388			0	$6,925.5
480	672	174.72	66.612			0	0
510	714	185.64	109.2			0	0
540	756	196.56	109.2			0	0
560	784	203.84	72.8			0	0
580	812	211.12	72.8			0	0
600.6	840.84	218.6184	74.984			0	0
620	868	225.68	70.616			0	0
640	896	232.96	72.8			0	0
662.4	927.36	241.1136	81.536			$9,936	0
DPV				$346.97	$307.13	$353.56	$581.09

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