Financial Contracts and the Management of Carbon Emissions in Small Scale Plantation Forests

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Abstract

Under the New Zealand Emissions Trading Scheme, foresters can obtain carbon units as their forests sequester carbon. If they sell these units as they are earned, the units must be repurchased when the forest is harvested, exposing foresters to price risk. This paper examines the way forward markets, futures markets, and carbon lending markets could be used to manage this risk. It argues that carbon lending markets are likely to be the most convenient form for foresters, as they allow the total returns from forestry investments to be increased with minimal risk. The carbon units can be lent to industrial firms or developers of new forests to minimise the carbon risk they face if they make carbon reducing investments.

JEL codes

Q23, Q55

Keywords

carbon banking, carbon forward markets, forest sequestration

Summary Haiku

Trees fall in the woods
If lent, their carbon still works
As firms pollute less

Contents

1. Introduction

The Emissions Trading Scheme has the potential to transform forestry investment in New Zealand. For years, land-owners have contemplated long term forestry investments on their own land. These investments provide a cash income only after 25–50 years, upon harvest, reducing their attractiveness to many potential investors. The Emissions Trading Scheme enables investors to receive a different pattern of cash flows, however. As forests are growing, forest growers receive carbon units, which can be sold for cash. When forests are harvested, forest growers receive cash from the sale of trees, but have to redeem carbon units, which can be purchased using the forest proceeds. Consequently, the sale and repurchase of carbon units can transform the timing of the cash flows obtained from forestry investments, making them more attractive to some investors.

If forest growers sell the carbon units they obtain while the trees are growing, and purchase carbon units when the trees are harvested, they expose themselves to the risk that the price of carbon changes. This price risk is sufficiently large that it may deter forest growers from participating in the Emissions Trading Scheme. The potential benefits from managing this price risk are thus considerable (Manley and Maclaren, forthcoming).

This paper examines the way forward markets, futures markets, and carbon lending markets could be organised to manage this risk. The concept of using carbon forward markets, carbon futures markets, or carbon lending markets to manage carbon price risk is not new. A carbon futures market already exists in Europe and the United States, and a carbon forward market exists in New Zealand and elsewhere. Even though they do not yet exist, various forms of carbon lending markets have been discussed in the literature. As yet, however, these markets have been little utilised by the forestry industry. This paper draws on insights from the commodity finance literature to offer reasons why.

When forward markets, futures markets, and carbon lending markets are used to manage carbon price risk, they generate alternative types of risks and entail different transactions costs. The experience of the way other commodity markets are organized suggests that the transactions costs and risks associated with forward markets and futures markets make them unattractive to forest growers. However, carbon lending markets have features that are much more suited to the needs of forest growers, and, if introduced, would be able to increase the total returns from forestry investments with minimal risk. Consequently, the repackaging of future and forward contracts into carbon lending contracts may be the step needed to enhance the attractiveness of the Emissions Trading Scheme to the forestry sector.

In a carbon lending market, forest growers would lend the carbon units they earn as their forest grows, rather than selling them. As the carbon units are still owned, the forest grower avoids carbon price risk, but the interest earned increases the total return to forestry investments. For this market to exist, there have to be willing borrowers of carbon units. A key insight is that a large number of these borrowers potentially exist, as carbon debt issuance is an attractive way for investors to finance investments in carbon reducing technologies without facing carbon price risk. An investor planting a new forest, or an industrialist investing in carbon reducing technology, could borrow carbon units, sell them to finance the investment, and repay the loan using the carbon units earned in the future. With sufficiently low transactions costs, therefore, carbon lending markets could catalyse the conversion of temporarily sequestered forestry carbon into permanent emission reductions, by increasing the likelihood that investments in carbon reducing technologies take place.

The paper is structured as follows. In section 2, the paper describes the operation of New Zealand's Emissions Trading Scheme as it applies to forestry. Section 3 describes the way carbon forward, futures, and debt markets create different types of risks and transactions costs for forest growers. Section 4 describes how a carbon debt market might operate, and how it is linked to forward and futures markets. This section also explains how carbon interest rates are determined, using parallels from commodity markets. Lastly, conclusions are offered in section 5.

2. Forestry in New Zealand and the Carbon Market[1]

New Zealand's Emissions Trading Scheme was created in 2008 under the Climate Change Response Act 2002. The rules for the forestry sector largely reflect the international Kyoto Protocol rules. Under these rules, forests planted since 31 December 1989 are eligible for carbon units for increases in carbon stocks that occur after 1 January 2008. If forest growers elect to partake in the scheme, they are allocated one New Zealand Carbon Unit (equivalent to a Kyoto Unit) by the government for every tonne of carbon dioxide that is removed from the atmosphere as the forest grows, but they also must surrender units to the government if the forest is harvested or burns down. The units are held in named holding accounts in a central registry. Participation in the scheme is voluntary, and there are different rules for forests planted prior to 1990.

The basic rules governing post-1989 forests are straightforward. Land owners with forests who wish to participate register with the Ministry of Agriculture and Forestry and

[1] For more information on the treatment of forestry under the Emissions Trading Scheme in New Zealand, see Ministry of Agriculture and Forestry, 2010, or Karpas and Kerr, 2011.

periodically file a statement indicating the amount of carbon dioxide their forest has absorbed from the atmosphere. The calculation is typically done using standardised tables based on the size, age, and type of forest, although field measurements can be done. Forest owners entitled to New Zealand Carbon Units for a net increase in carbon stocks have them transferred to their holding account shortly after the statement is filed. A fee is charged for this service. If the forest owner has a net decrease in carbon stocks, usually because the forest has been harvested or has burnt down, units must be surrendered to the government, with the liability capped at the number of units that the forest has received.

Under current law, if the forest owner simply holds the units, there is no tax liability. If, however, they sell the units, the proceeds are subject to income tax in the year of the sale. If they later purchase units to surrender to the government, a tax deduction is available for the cost of the acquisition at the time the units are acquired (Climate Change Response (Emissions Trading) Amendment Act 2008).

In New Zealand, a pinus radiata forest is typically harvested at an age of 28 years. After the first ten years, a forest typically grows at 30 cubic metres per hectare per year, and absorbs approximately 35 tonnes of carbon per hectare per year. A forest grower can therefore earn 35 forest carbon units per year per hectare while the forest is growing, but is responsible for remitting 750 units per hectare at harvest.[2] At a current price of $20 per carbon unit, a hectare of forest generates approximately $700 worth of carbon units per year, while the liability at harvest is approximately $15,000 per hectare. Every $1 variation in the carbon price changes this liability by $750.

Large scale foresters can manage the risk that the price of carbon changes by having a balanced profile forest planted at different times. In this case, the amount of biomass that is harvested in any one year will be equal to the amount of biomass that is grown in the remainder of the forest; consequently, the forester will receive units equal to the number needed to be redeemed, and there is no carbon price risk. This option is less suitable to small scale forest growers, due to the lack of economies of scale in planting and harvesting.

[2] Manley and Maclaren (forthcoming). These numbers are only approximate to give the reader a guide to the magnitude of the issue. There is a minor complication because not all units earned the first time a forest is grown have to be remitted, as some of the biomass stays on site and decays slowly. A forest grows carbon equivalent to 1000 units during its first rotation, loses 750 units upon harvest and another 250 units from biomass decay during the subsequent rotation.

3. Forward, Futures, and Debt Markets

There are four types of financial contracts that enable agents to contract in the present to exchange money, goods, or services in the future: forward contracts, futures contracts, debt contracts, and option contracts. This paper focuses on the first three. These contracts are closely related, for, as explained in detail in section 3.5, any one of these contracts can be closely replicated by combining a mixture of the other contracts and spot contracts. Nonetheless, each combination may have slightly different risk characteristics and different transactions costs than the basic contract. Typically the type of contract or combination of contracts that is used is the one with the lowest transactions costs or the best risk characteristics.

3.1. Forward Markets

A forward contract is a contract to buy or sell a specified quantity of an asset for a specified price at specified time in the future. If forestry growers were to use these markets, they could sell their carbon units as they were earned, and contract to purchase carbon units at the estimated harvest date. Since no cash would change hands at the time the contract is signed, forest growers could use these contracts to alter the cash flows obtained from investments without facing the risk of an unusually high price of carbon units at the time the forest is harvested.

The price p of a forward contract made at time t_0 for delivery at time t_1 will depend not only the timing and the quantity q, but also on the identities of the seller S and the buyer B: $p(t_0, t_1, S, B, q) = F_{t_0}^{t_1} \theta(S, B, q, t_0, t_1)$ where $F_{t_0}^{t_1}$ is no-risk forward price and $\theta(S, B, q, t_0, t_1)$ is a term that reflects the counterparty risk that one or other of the parties will default on the contract at time t_1. The two parts can be considered separately.

The no-risk forward price reflects expectations at time t_0 of the price of carbon at t_1. In an efficient market, the price will incorporate information and guesses about the future supply and demand of carbon units, just as the forward market for a commodity incorporates information about the future supply and demand of the commodity. Since carbon units are internationally tradeable, the forward market prices around the world will be closely linked.

The counterparty risk depends on the identity of both parties, the quantity traded, and the horizon of the contract. A forest grower that sells carbon units when they are earned will need to buy carbon units forward, and faces the risk that the purchaser will be either unwilling or unable to sell if the price in the future is much higher than contracted forward price. This risk will be smaller if the counterparty is a major, financially strong company. Moreover, the risk will be relatively easy for a forest grower to identify and price if the counterparty specialises in the carbon trade and is well known, as the counterparty will have many other clients. For this reason, it is likely that companies that specialise in buying and selling forward contracts would emerge if a forward market in carbon units were established. The emergence of these companies would make the use of these markets relatively straightforward from the forest grower's perspective.

The counterparty selling the forward position has the opposite risk, that the forest grower is either unwilling or unable to fulfill their contract to purchase carbon units if the spot price in the future is very low. This risk means the seller will have to spend time and effort to find out about the forest grower's credit worthiness; even if the seller is a specialised company, the small size of most forestry contracts means the forest grower is likely to have to pay a considerable premium to buy carbon units on the forward market to reflect the costs incurred in establishing credit-worthiness. This premium would be qualitatively similar to the interest rate premium that a farmer pays on a loan. It is plausible that the counterparty risk may mean the contract might need to be secured by a lien on the forest grower's assets, or in some cases the counterparty risk will prevent a contract being signed at all.

Even if major companies with low counterparty risk emerge as the sellers of forward contracts, forest growers may not be able to purchase contracts with a suitable range of maturities. Because counterparty risk is difficult to ascertain for long maturity contracts, as either party could die or be bankrupted during the intervening period, only relatively short horizon forward contracts are likely to exist. Indeed, most current forward contracts are for periods less than five years, rather than the two or three decades that would be suitable for forest growers. In this case, forest growers wanting forward cover would be forced take a sequence of short term contracts, periodically rolling them over as they matured, rather than a single long maturity contract. This creates two additional issues for foresters. First, the process of selling one contract and purchasing a replacement entails transactions costs. Secondly, changes in the carbon price are "cashed out" when the contract is rolled over, exposing the forest owner with a forward contract to liquidity risk, that is the need to make a cash payment to the seller of the short maturity forward contract when it matures.[3] To offset this liquidity risk, the forest grower may wish to set aside some of the proceeds they get from the initial sale of their carbon units.

[3] Suppose, for example, a forest grower wished to purchase a forward contract to buy units in 20 years time, but could only obtain a forward contract to buy units in five years' time, at $25. Suppose they purchased this contract, and after five years the spot price and the price of the subsequent five year forward contract had both declined to $23. While at this time they could buy a new forward contract at $23, they would have to pay the counterparty $2 on the first contract. Their effective forward price is still $25, but they are required to pay part of this sum when the contract is rolled over.

3.2. Futures Markets

A futures contract is a *standardised* contract to buy or sell a specified quantity of an asset for a specified price at specified time in the future. While conceptually similar to forward contracts, futures contracts (i) cannot be customised by size as they all have the same standard volume; (ii) cannot be customised by date, as they are available only for specified future dates; (iii) are traded on an exchange and guaranteed by the exchange, so all contracts have the same counterparty risk; and (iv) are marked to market on a daily basis as the futures price changes. If a forestry grower were to use futures markets, they would sell their carbon units as they were earned, and purchase standardised futures contracts obliging them to purchase carbon units at the estimated harvest date. The process is similar to using a forward contract, except the grower would buy standard contracts from an exchange rather than negotiate with an individual institution.

For ordinary commodities, futures markets have two advantages over forward contracts; first, there is almost no counterparty risk; and secondly, they have very low transactions costs, in large part because all contracts are identical and have near zero counterparty risk and thus can be traded in volume. However, the institutional arrangements used by futures markets to create these characteristics mean they are likely to be unsuitable for trading forestry carbon units. If someone purchases a futures contract, it is necessary to open an account with a broker and place a deposit with them. No money (other than a brokerage fee) changes hands on the day the contract is purchased. Thereafter, however, the contract is "marked to market"; that is, daily changes in the future price are immediately capitalised into the value of the contract by adding or subtracting the sum to or from the brokerage account.[4] Thus from a participant's perspective, a futures market converts counterparty risk into liquidity risk. While a futures market can be used to fix the total price a forester pays to purchase carbon units at some future date, if the future price falls it will require an immediate payment to their broker, offset by a corresponding reduction in the payment made at the time the contract expires. Such payments could prove very inconvenient to a forester, and stand to negate the cash-flow advantages that stem from selling carbon units when they are earned. Indeed, it seems likely that this liquidity risk would prove sufficiently problematic that forest growers would not want to partake in this type of contract.

[4] If one has a contract to buy units in the future, for instance, and the future price rises, it is as if the initial contract is torn up and replaced by a contract to purchase in the future at a higher price; and the difference is immediately placed in the brokerage account. Conversely, if the future price decreases, a sum is immediately deducted from the brokerage account, and if the account drops too low it has to be replenished or the contract sold. This mechanism ensures that the owner of the contract always has sufficient funds to honour their contract, thus eliminating counterparty risk. In addition, future contracts are also guaranteed by the broker and the futures exchange.

3.3. Carbon Debt Markets

The third institutional form for a carbon forward market is a carbon lending or debt market. If a forestry grower were to use these markets, they would lend most of their carbon units at a carbon interest rate as they were earned, and redeem the lent units when they were repaid at the harvest date. These markets do not yet exist, although in various forms the concept has been discussed in the literature (Cronshaw and Kruse, 1996; Rubin, 1996; Kling and Rubin, 1997; Sedjo and Marland, 2003; Esuola and Weersink, 2005; Bosetti, Carraro and Massetti, 2008; Bigsby, 2009).

The links between commodity forward markets and commodity lending markets are frequently overlooked even though in many actual commodity markets the quintessential forward position is a commodity hedge, which occurs when someone simultaneously sells a commodity for spot delivery and purchases it for forward delivery. This is equivalent to simultaneously borrowing money at the money interest rate and lending the commodity at the commodity interest rate, or "own-interest rate".[5] Commodity interest rates were first noted by Sraffa (1932) and Keynes (1936), and have been subject to periodic research ever since. They are sometimes explicitly defined, as is the case with uranium, but usually are implicitly defined – if you borrow a barrel of oil, the oil interest rate (the number of oil barrels you repay) is calculated as the ratio of the spot price to the forward price, adjusted for the money interest rate. When there is an array of forward contracts maturing at different dates, there is an equivalent array of commodity interest rates, one for each maturity, just as there is an array of money interest rates for different maturities.

A carbon lending market would work as follows: an agent who obtains carbon units at one time but does not need them until another time would simply lend them out at an agreed interest rate for an agreed period of time to someone who wanted them and could expect to have surplus carbon units in the future to repay the loan. In an active market, the terms of the loan would be determined by market forces, essentially by the relative number of borrowers and lenders at any particular time. The loans would typically be brokered by specialist brokerage firms, or banks would evolve that took carbon unit deposits and made carbon unit loans. This firm or bank is quite different from the government registry. For the purposes of the following discussion, a private sector carbon bank is envisaged.[6]

[5] Williams (1986) expands on this point at length.

[6] "Carbon banking" is sometimes used to describe the process by which unused carbon units are kept at the Government registry for use at a later date. A private sector carbon lending market, where carbon units are lent to another party at interest, is quite different.

Section 4 argues that there are likely to be sufficient natural lenders and borrowers in a carbon debt market that it is reasonable to imagine one operating. Assuming one were to exist, such a market would differ from a forward market in several ways, even though the interest rate on a carbon loan would be closely related to the price for forward delivery in a forward or futures market: [7]

$$(1+r^{C}_{t_0,\, t_1\text{-}t_0}) = (1+r_{t_0,\, t_1\text{-}t_0})\left(P_{t_0} / F^{t_1}_{t_0}\right)^{1/(t_1-t_0)} \qquad (1)$$

where $r^{C}_{t_0,\, t_1\text{-}t_0}$ is the $(t_1\text{-}t_0)$ year carbon interest rate at time t_0;

$r_{t_0,\, t_1\text{-}t_0}$ is the $(t_1\text{-}t_0)$ year money interest rate at time t_0;

P_{t_0} is the spot price of carbon units at time t_0; and

$F^{t_1}_{t_0}$ is the price at time t_0 for forward delivery at time t_1.

A key difference concerns counterparty risk. When the lender makes the loan, they have to worry about counterparty risk – that the borrower will not repay – but the borrower does not have to worry about the lender. In practice, this means that a carbon bank does not need to evaluate the credit worthiness of the forest grower, any more than a money bank has to evaluate the credit risk of a depositor; for this reason, a major difference between a carbon debt market and a carbon forward market is lower transactions costs. The forest grower of course has to evaluate the risk that the carbon bank defaults, and take this risk into account when deciding whether to lend carbon units at interest rather than simply hold on to them. If the bank is a large, recognised financial organisation, this is no more difficult than the ordinary decision made when people deposit money in a normal bank.

If a range of borrowing and lending maturities terms evolve, a potential second advantage is the ability for lenders to lend carbon units on short terms near their harvest date. This would provide considerable flexibility as there would be no cash flow consequences of terminating a forward contract at a date different than the harvest date. Rather, the forester would simply borrow carbon units pledging their loan as collateral if they harvested earlier than the date the loan matured; conversely, if they were not ready to harvest at the loan maturity date, they would simply redeposit the repaid carbon units as a short term loan.

If a carbon lending market were available, and the interest rate were positive, a forester would have two basic options. First, they could lend all the units as they were earned, so that

[7] This formula was derived by Keynes (1936). See Williams (1986) for an extended discussion.

when the loan were repaid with interest at harvest they would have more units than they need, and would be able to sell the surplus at an additional profit. The size of this profit would depend on the price of carbon units at the harvest date. Secondly, they could lend a fraction of their units when earned, selling the rest. The fraction they could sell would depend on the time to maturity and the carbon interest rate; in essence, they would need to lend enough so that the accumulated amount lent, plus interest, would be sufficient to meet their remittance obligations at harvest. With a 20 year horizon and 2% carbon interest rate, they could sell a third of carbon units earned that year; with a 10 year horizon and 1% interest rate, it would only be a tenth. Nonetheless, these cashflows could prove attractive as they are available as the forest is growing without reducing the cashflow available to the forester when the wood is harvested, or without exposing him or her to the risk that the price of carbon units increases. Either way, positive carbon interest rates increase the total profit available to forest growers that participate in the Emissions Trading Scheme but do not wish to undertake carbon price risk.

3.4. Comparison of Options

Table 1 shows the various options available to a small forester who has a forest that is earning carbon units as the forest grows, and who has to remit them upon harvest.

The first option is to simply hold the units. This results in no change to the cash-flow position when the units are earned, but no risk either, as the units are available for remission upon harvest.

The second option is to the sell the units as earned. This generates a large cash-flow to the forester as the units are earned, but this money has to be deducted against the value of the forest when it is harvested, and this exposes the forester to the risk that the units are purchased at harvest at a very different price from when they were sold.

The third option is to sell the units when earned, but take a forward contract to repurchase them at a future date. This generates a large cashflow as the forest grows, which is deducted against the forest return at harvest; but in this case there is no risk surrounding the price of carbon units at harvest. This risk is converted into counterparty risk and a sizeable transactions fee: the counterparty risk is that the contracting party, assumed to be a large financial institution or bank, defaults, while the transactions costs reflect the risk facing the financial institution that the forester defaults.

<u>Table 1: Carbon Management Options</u>

Management option		**Immediate cashflow position**	**Price risk at harvest**	**Counter-party risk**	**Liquidity risk**	**Transac-tions costs**
Hold carbon units when earned		Zero	Zero	Zero	Zero	Zero
Sell carbon units when earned	No forward or future position	Large payment as units are sold	Large price risk	Zero	Zero	Zero
	Forward contract to buy at harvest	Large payment as units are sold	Little price risk	Risk bank defaults	Risk cash is needed if contracts are rolled over	Large risk margin paid to bank
	Future contract to buy at harvest	Large payment as units are sold	Little price risk	Near zero	Large risk: need cash if future price falls	Low
Lend carbon units when earned		Small payment as some units can be sold.	Little price risk	Risk bank defaults	Zero	Low

The fourth option is to sell the units when earned, but take a futures contract to repurchase them at a future date. Again, this generates a large cashflow as the forest grows, which is deducted against the forest return at harvest; and again there is no risk surrounding the price of carbon units at harvest. There is no counterparty risk and only low fees in this case, but the forester faces considerable liquidity risk as any changes in the futures prices are marked to market daily and the forester may have to make large cash payments to the futures exchange if the future price of carbon units falls.

The fifth option is to lend most of the units as they are earned, and sell the remainder for cash. This generates an additional amount of cash as the forest is growing, without reducing the value of the forest at harvest or exposing the forester to any price risk, and in this sense it is closest to the first option. The amount of additional cash depends on the carbon interest rate. The "cost" of this return is the counterparty risk that the bank defaults, similar to the default risk associated with a forward contract, but the transactions costs are significantly lower.

These options differ along two main dimensions: the timing of the cash flows, and the risk. If all of the carbon units are sold as they are earned, there is a substantial change in the cash flows associated with forestry investment, raising them considerably as the forest grows and reducing them by a similar amount at harvest. The change in the cash flows exposes the forest grower to counterparty risk, liquidity risk, or price risk depending on whether the forester takes a forward position, a futures position, or does nothing. Alternatively, the forester could lend the carbon units when earned, possibly selling some. This increases the total return and can increase the cash flows obtained as the forest grows by a small amount, without reducing them at harvest. The cost is a small amount of counterparty risk. This option could well be attractive to many forestry agents, as with relatively little risk it provides higher overall returns and improves the cash flow profile of the investment compared to the status quo option of simply holding the carbon units as they are earned.

3.5. Relationships between Forward, Futures, and Debt Markets

Carbon forward, futures, and debt markets are closely linked, as the main features of any particular contract can be replicated by a combination of the other contract forms as well as spot purchases of carbon and money debt contracts. These links mean that in wholesale commodity markets one particular contract form usually becomes dominant, and is used to recreate the other forms.

Three of these links are most important. First, a contract to lend carbon at the carbon interest rate can be recreated by (i) selling carbon units on the spot market, (ii) lending the proceeds at the money interest rate, and then (iii) contracting to buy carbon units forward on the forward or futures markets. The reverse set of contracts can be used to replicate borrowing carbon. Secondly, a contract to buy carbon forward can be replicated by (i) borrowing money at the money interest rate, (ii) buying carbon at the spot price, and then (iii) lending the carbon for the same length of time. Again, the reverse set of contracts (borrowing carbon, selling carbon, lending money) can be used to replicate selling carbon forward. Thirdly, the liquidity risk associated with a futures contract can be offset by combining a futures contract with a debt contract. In particular, a forester that sells carbon on the spot market and used the futures contracts market to buy carbon forward could invest the proceeds of the sale at the money interest rate to ensure that they always had sufficient funds to meet margin calls if the price of carbon fell. In this case, however, the proceeds of the money are not available for other purposes and the combination of a spot carbon sale, a money loan, and a futures market carbon purchase is equivalent to lending carbon at the carbon interest rate, with equivalent risk of default by the borrower.

In practice, the existence of alternative ways to replicate a particular contract means not all forms of the contract exist. Rather the form with the lowest transactions cost typically dominates. In turn, this depends on the type of the most common "natural" business for these contracts. In markets where counterparty risk is difficult to establish, futures contracts are a natural form as they sidestep the problem of default risk. In markets where the dominant concern is to sell a crop at a guaranteed price, a forward or futures market is a natural form. And in a market where most agents have differences between the time when they obtain a resource and when they use it, a debt market is a natural form.

Short term futures and forward carbon markets exist. These are not particularly practical for forest growers, who have much longer horizons. As discussed above, if foresters were to use these short term markets, they would need to periodically roll over their contracts, entailing transactions costs and liquidity risk. In contrast, a forest grower who lent carbon units would simply reinvest the proceeds, with minimal or zero transactions costs, and no liquidity risk.

4. A Carbon Debt Market

4.1. Is There a Natural Carbon Debt Market?

The above section suggests that many foresters would find a carbon lending market an attractive option, particularly if it had low fees, little counterparty risk, and high interest rates. The existence of such a market presupposes that there would be a range of agents "naturally" wishing to borrow carbon units. Without these "natural" borrowers, interest rates would be low or negative, and the market would not exist.

Is it reasonable to believe that there would be agents who would want to borrow carbon units? The answer is yes: companies considering making investments to reduce their future carbon emissions are likely candidates. These companies include forestry companies considering whether or not to plant a new plantation forest, knowing they will be entitled to carbon units in the future. To see this, consider the case of a company that is contemplating making a $1 million investment that will reduce its carbon emissions by 5,000 units a year for 15 years. The value of the investment depends on the future price of carbon. Since whether the company decides to make the investment will depend on both the expected return and the risk of these returns, whether the investment is made will depend in part on their uncertainty as to the future price of carbon.

A carbon debt market would enable a firm to manage this risk. They could initially borrow carbon units and sell them to raise the initial funds for the investment; their obligation is then to repay the carbon loan, which they will be able to do using the money saved from their reduced carbon emissions without any price risk at all. Moreover, the combination of the carbon interest rate and the initial price of carbon provides a metric as to whether the investment is likely to be profitable. Suppose, for instance the current price of carbon was $25 per unit. The firm would borrow 40,000 units and sell them to raise the million dollars to fund the investment; and given their saving of 5,000 carbon units over 15 years, the loan will be repaid so long as the carbon interest rate is less than 9.1%.[8] Note that the profitability of the investment does not depend on the future prices of carbon, for variation in the cost of purchasing carbon units to repay the loan is exactly offset by the saving made from making the investment. If the initial price of carbon was lower, say $20, more carbon would initially be borrowed to raise the necessary funds for the investment and it would be profitable only if the interest rate was lower, in this case 5.6%.

The above considerations suggest that it is plausible for a carbon debt market to exist, as it seems likely that there are both natural lenders (forest growers seeking a way of investing earned carbon units that are not needed until a later date) and natural borrowers (firms wanting to raise funds to make carbon emission reducing investments). If the market were to exist, the net gains to society – which are valued at an amount at least equal to the interest earnings on the carbon loans – stem from the risk sharing that occurs between borrowers and lenders. In particular, a carbon debt market provides firms that wish to undertake costly investments to reduce carbon emissions lower the risk of these investments by no longer making them conditional on the unknown future price of carbon, except as they affect future carbon interest rates. The more firms value this reduction in risk, the more likely it is they would wish to raise funds on carbon debt markets rather than money debt markets, and thus the higher will be carbon interest rates.

These considerations mean the potential benefits of carbon banking are large. Anecdotal evidence suggests there are many businesses not even contemplating carbon-reducing investments because of their uncertainty as to the future price of carbon, particularly as many fear the price will be zero in the event the scheme is discontinued. At the same time, there are many foresters who are not applying to join the Emissions Trading Scheme, because they see no value earning carbon units that will simply sit in the central Registry until required at harvest. A

[8] The annual payment needed each year to repay the loan is $\text{Payment} = rP(1+r)^T / [(1+r)^T - 1]$, where *r* is the carbon interest rate, *T* is the loan maturity, and *P* is the number of carbon units that are borrowed.

carbon bank has the potential to convert these unused units into carbon reducing investments. As they will earn interest on their units, forest growers currently not participating in the scheme can only be better off; and industrialists with investments that will reduce carbon emissions can undertake these investments without concern that their investments will lose money in the event the future price of carbon is very low or the Emissions Trading Scheme is scrapped. This ability to transfer risk means that, so long as transactions costs are sufficiently low, a carbon bank has the potential to generate Pareto welfare improvements.

4.2. Carbon Interest Rates

Equation (1) indicates the relationship between carbon interest rates, carbon spot and forward prices, and money interest rates. Carbon interest rates are equal to money interest rates adjusted for the long term expected change in carbon prices, and thus reflect the relative scarcity of carbon units now and in the future. If carbon units are likely to be as scarce in the future as they are now, carbon interest rates will equal money interest rates, making it profitable for forest growers to lend carbon units. If carbon units are expected to be common in the future, either because of technological developments that significantly reduce the supply of greenhouse gases or because a large number of units are made available, then the price of carbon will be expected to fall and in equilibrium carbon interest rates will be high. If carbon units are expected to be less common in the future, the price will be expected to increase and in equilibrium carbon interest rates will be lower than money interest rates. Note that if carbon units can be stored at the registry indefinitely (i.e. if they do not expire) the minimum equilibrium interest cannot fall below zero; this is not true if they can expire.[9] If carbon interest rates are zero or negative, a lending market will not be established because there will be no additional gain from lending out credits rather than simply holding them in a registry.

Unless there are good reasons to believe that the price of carbon will increase indefinitely at a rate higher than money interest rates, long term carbon interest rates will be positive; and unless there are good reasons to believe the price of carbon increases at a rate higher than the inflation rate, long term carbon interest rates will be equal to long term real (inflation adjusted) money interest rates. In these circumstances, a carbon debt market will have the same long term returns as money debt markets, but the actual returns will vary with the price of carbon and provide a carbon price hedge to participants in the market. In this respect, a carbon debt market would function very similarly to debt markets denominated in different currencies.

[9] The literature examining the consequences of allowing carbon units to be banked in a government registry for later use, at zero interest, when carbon targets are getting more stringent shows the carbon price should rise at the market interest rate (Cronshaw and Kruse, 1996; Rubin, 1996; Kling and Rubin, 1997).

4.3. Existence of Non-Money Debt Markets

The similarity of debt and forward/futures markets mean the above arguments can be used to argue for the existence of all sorts of commodity debt markets: an oil debt market, for instance, or a wheat debt market. On the whole, commodity debt markets are much less common than commodity forward or futures markets, and commodity forward or futures markets do not exist for many commodities. It is natural to wonder, therefore, whether a carbon debt market is likely to be practical.

This question can be answered in two parts: first, is it likely that either a carbon forward/futures market or carbon debt market comes into existence; and secondly, if it does, would it be organised as a forward/futures market or a debt market.

For a commodity loans market to flourish, there need to be sufficient agents who benefit from lending or borrowing in that particular commodity rather than in some other commodity or currency. In essence, some agents wish to borrow or lend a commodity and repay or be repaid in the same form since they have an underlying use for the commodity and find it easier to structure their business in terms of the commodity rather than money. A necessary condition for such a market to exist is that the commodity futures prices are not highly correlated with other prices, so that holders of the commodity would be exposed to considerable price risk when repayment was due if their loan was contracted in another commodity or currency. Since the market for carbon units has few obvious substitutes, a carbon debt market would appear to be satisfy this condition, particularly as there is considerable uncertainty about future technologies that may or may not lead to significant changes in emissions. In addition, transactions costs – the wedge between borrowing and lending interest rates, or the wedge between buy and sell prices on a forward market – would need to be low.[10]

The question as to whether a forward/futures market or a debt market is the natural form is more difficult to answer. The arguments made above, however, suggest that a carbon debt market is a natural form because of the way forestry is *temporarily* allocated carbon units

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[10] Carlton (1984) used historical experience based on 180 different futures markets that operated between 1921 and 1984 to consider the salient features of successful and unsuccessful futures markets. Williams (1986) extended this analysis to consider why some maturities and not others were traded on successful futures markets. The answers consistently point to two factors:

(i) a commodity yield curve's *spreads* need to move independently of other commodity yield curves;

(ii) a futures market needs sufficient liquidity that participants can be confident that they can trade without waiting excessively.

when a forest is growing. This means there is likely to be a significant supply of units whose owners would find a debt market more convenient than a forward or futures market. The cash flows associated with investments made to reduce emissions also mean there is a natural constituency of firms wishing to borrow credits and repay once the carbon reducing investments are operational. So long as transactions costs can be minimised and a suitable range of debt maturities is found, a carbon debt market seems eminently feasible. If the market has large volumes, there is no reason why market transactions costs should be high.

A carbon debt market is an intriguing possibility. There would appear to be natural borrowers and lenders, but it remains to be seen whether the size of the benefits is enough to cover the costs of establishing a market. To a small scale forest grower, the case may not be clear. A forest grower with 20 hectares that has been growing for 15 years would have approximately 7,500 units. If carbon interest rates were 3%, this would earn approximately 225 units per year, with a market value of approximately $5,000 (subject to tax). This is certainly better than simply keeping the units at the registry, which earns nothing. Alternately, if the units were sold, they would have a sum of $170,000 before tax, and $120,000 after tax, which would earn $3,600 per year (subject to tax), if lent at 3%. This is a similar sum to the carbon debt market, although somewhat lower because a forest grower pays income tax when carbon units are sold. Nonetheless, the forest grower might consider that the sum could be better utilised if they are willing to take the risk that the price of carbon may be significantly higher at harvest.

4.4. Other Literature

This paper is by no means the first to investigate the topic of carbon banking, although to date there has been no attempt to link the idea with the insights of Keynes and Williams on commodity markets. The first papers were by Cronshaw and Kruse (1996), Rubin (1996), and Kling and Rubin (1997). These papers analysed what would happen under conditions of certainty if the Kyoto agreement allowed permits to be banked or borrowed. They showed that if the government allowed banking and borrowing but did not pay interest on banked allowances, permit prices would increase at a rate no higher than the money interest rate; alternatively, if they paid a carbon interest rate equal to the money interest rate, prices would be constant through time. Another set of papers considered the use of carbon rental payments for units issued against sequestered forestry carbon, to take into account the possible lack of permanence of carbon sequestered in this manner. (Marland, Fruit and Sedjo, 2001; Sedjo and Marland, 2003; Chomitz and Lecocq, 2003). These rental payments would have similar properties to carbon interest rates, although the link between carbon rental rates and carbon interest rates (or forward prices) was not formally made. This literature observed that temporary carbon units could be used to reduce the price risks facing firms when they make long term investments to reduce carbon emissions. A third literature has explicitly analysed how carbon lending markets might be useful to agents such as forest growers that earn units from sequestration (Esuola and Weersink, 2005; Bigsby, 2009). Esuola and Weersink in particular emphasise how a carbon bank could mitigate price risk and lower transactions costs for forest growers. This paper covers much of their ground, but by exploiting the longer-established literature on commodity finance, not only shows how carbon interest rates would be determined, but how carbon banks have the potential to significantly reduce carbon emissions even if sequestration activity is only temporary.

5. Conclusions

The Emissions Trading Scheme has opened new possibilities for forest growers, by allowing them to earn carbon units while the forest is growing. To date, the only way forest growers can take advantage of the scheme is to sell the carbon units as they are earned. Since this exposes them to the risk that they will have to repurchase the carbon units at a much higher price when the forest is harvested, not all forest growers take advantage of the scheme. While forward or futures contracts could be used to mitigate this price risk, these contracts can be expensive and they expose forest growers to other types of risk. Moreover, only short dated forward and futures market contracts currently exist, limiting their usefulness to foresters with decade-long horizons.

The Emissions Trading Scheme also provides industrialists with an incentive to make investments in carbon reducing capital equipment and technologies. These investments are risky, however, for if the price of carbon falls the reductions will not be sufficiently valuable to justify the initial investment. Industrialists may also be concerned that the scheme will not be continued, and defer investments until there is greater political certainty. In this case uncertainty about the future price of carbon may be a major reason why investments are not undertaken.

A carbon debt market is an institution that could simultaneously solve these two problems. If foresters were able to lend units, they would earn carbon interest income as the carbon units they earned accumulate, while avoiding the risk that the carbon price rises. If investors were able to borrow units, they could sell them to fund carbon reducing investments and eliminate the risk that the investments would be unprofitable if the price of carbon fell. Similarly, investors contemplating buying land for new forests could borrow and sell carbon units, repaying the loan with the carbon units earned as the forest grows. The matching of these two parties would create considerable economic value and enable the temporary forest carbon units to be converted into permanent industrial emission reductions. Such a match is not riskless, for the foresters face counterparty risk should the borrowers default. This risk would be minimised, however, if a financially strong bank were the intermediary, for then the risk faced by forest owners would be no different than the risks they face whenever they deposit money in a bank.

History is littered with potentially Pareto improving opportunities for trade. The history of commodity markets teaches that these opportunities often fail because of the high transactions costs needed to establish and run the market. It would appear plausible that a bank could find a way of introducing a carbon debt market, for they could make a profit by simultaneously offering foresters an income they otherwise would not have had and industrialists a means of eliminating the price risk associated with carbon reducing investments. Of course whether such profit can be realised depends on the level of transactions costs involved establishing the market. One of the transactions costs associated with this market is the fee paid by foresters to the Ministry of Agriculture and Forestry to register their carbon units as the forest grows. A low fee structure makes it more likely a carbon lending market will exist.

A carbon debt market is not the only way to achieve these results. Carbon forward and carbon futures markets could also be used to match these parties, and these already exist. Nonetheless, carbon debt markets have an innate attractiveness in this context. This is partly because they can be constructed to minimise the transaction costs facing small scale forest growers, just as bank deposit accounts minimise the transactions costs facing retail depositors, and partly because they can be offered in a range of maturities that would enable foresters to easily reinvest their carbon units until needed. It is plausible that these contracts could be retailed in conjunction with forward and futures markets as a way of minimising transactions costs for small scale forest growers. If so, carbon lending markets will provide an additional instrument to reduce greenhouse gas emissions by enabling the conversion of temporary forest sequestration into permanent reductions in industrial emissions.

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