Discounts, Fungibility and Agricultural GHG Offset projects

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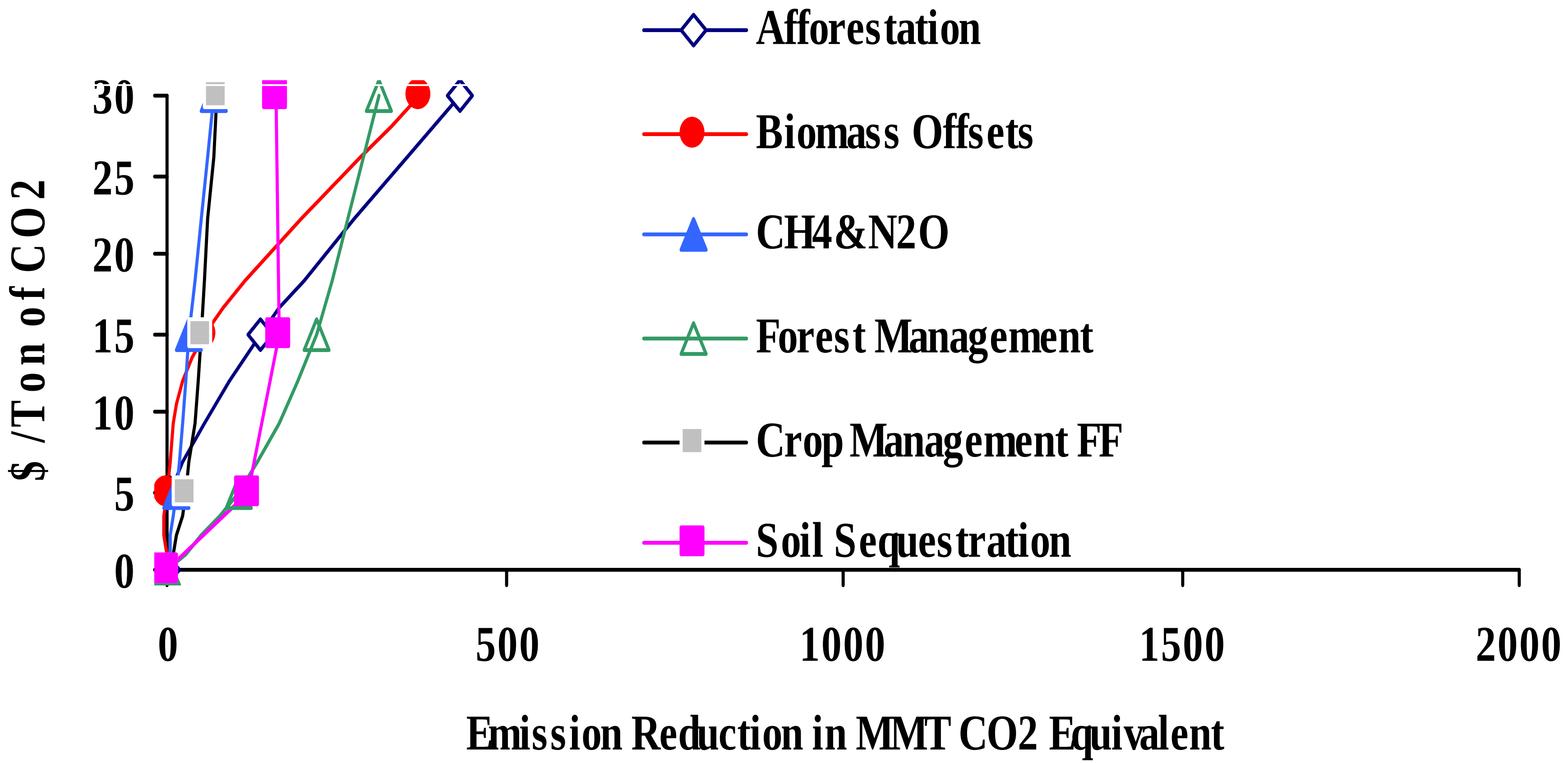
Paper/Study Objectives

- **Address whether discounts matter**
- **Address fungibility**
- **Discuss fungibility and appraisal modeling**

Multi Strategy Portfolio

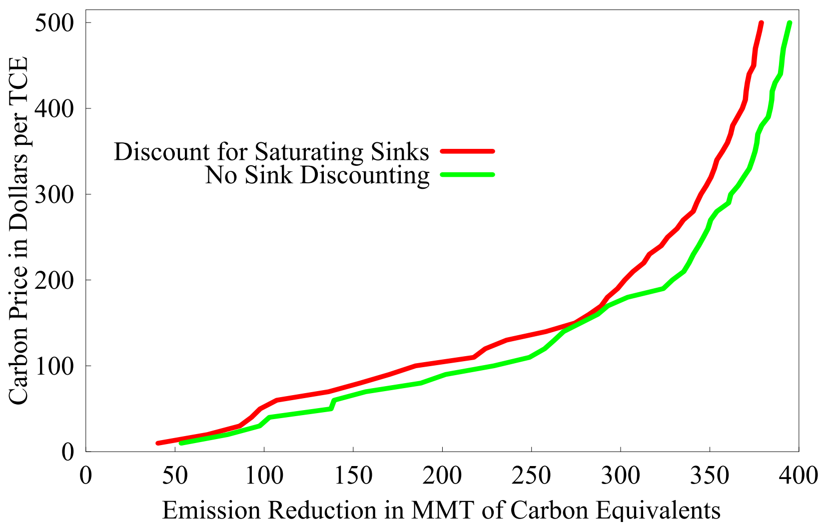
MMt arising at an offset price giving $/tonne carbon equiv



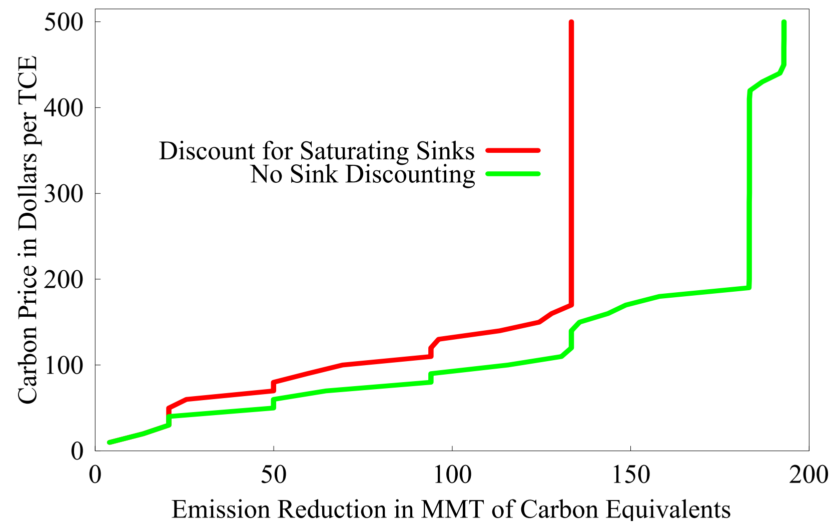
- Assumes offsets are perfect substitutes
- Different strategies dominate at different price levels

What issues might IAM modelers consider?
Fungibility - Aggegate

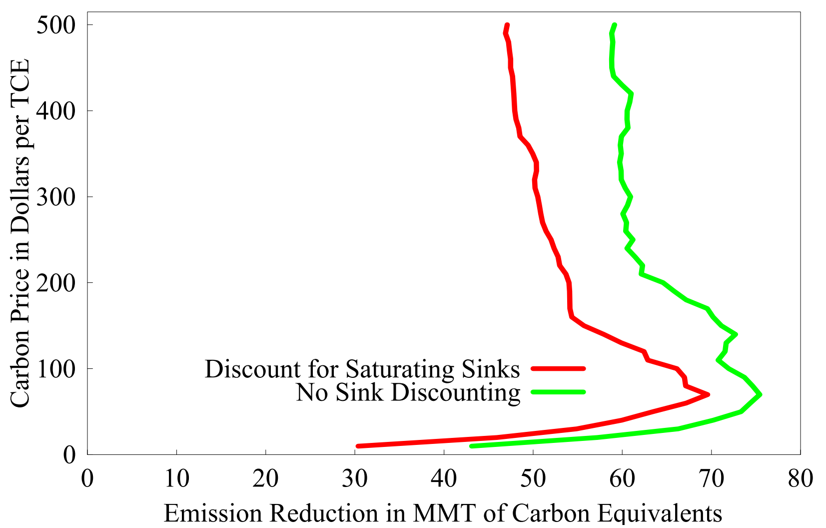
Total Greenhouse Gas Emission Reductions from Agriculture and Forestry



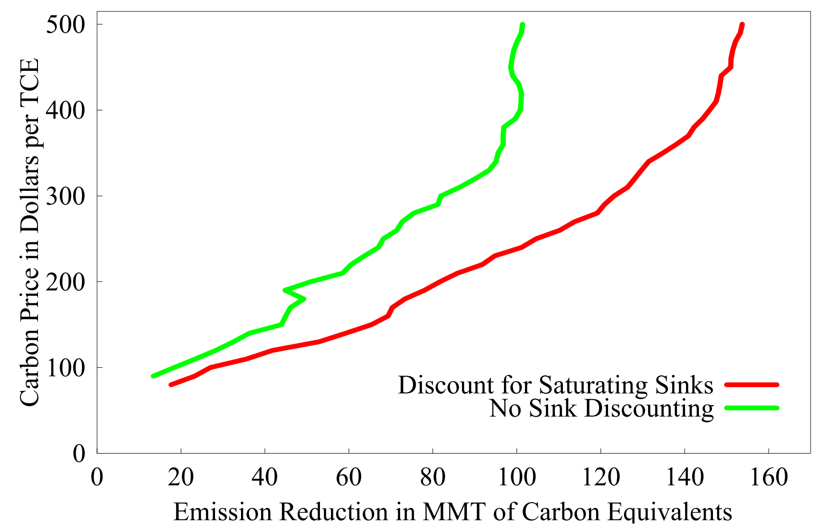
Carbon Sequestration from Trees



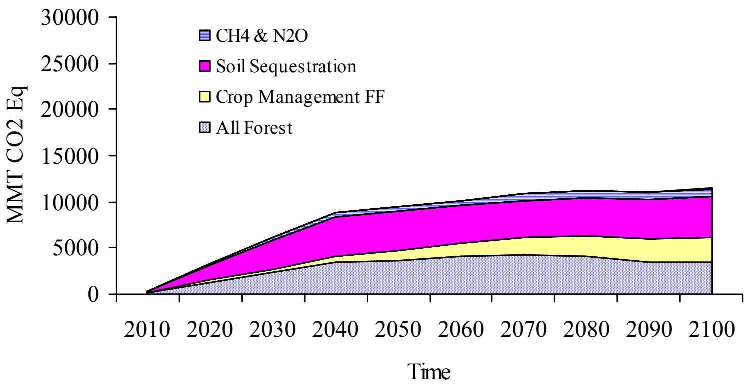
Soil Carbon Sequestration



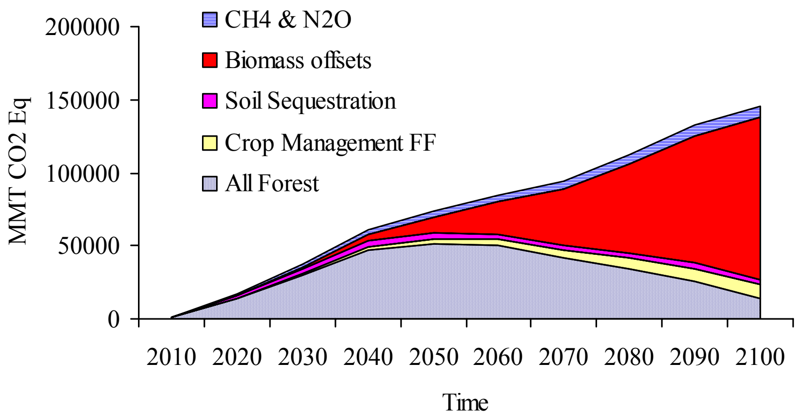
Biofuel Offsets



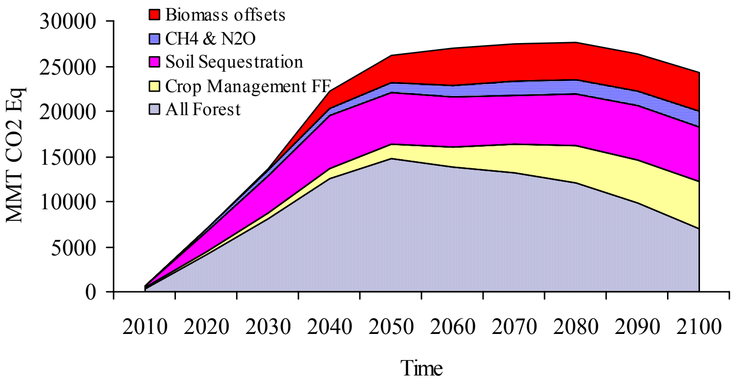
Portfolio Dynamics



Cumulative Contribution at a $5 per tonne CO2 Price



Cumulative Contribution at a $50 Price



Cumulative Contribution at a $15 Price

Note

Effects of non permanence on sequestration
Growing permanent nonco2 and biofuels

Source Lee, H.C., B.A. McCarl and D. Gillig, "The Dynamic Competitiveness of U.S. Agricultural and Forest Carbon Sequestration," 2003.

Fungibility

A number of concepts have arisen that are likely to differentially characterize the contribution of alternative possible offsets within the total regulatory structure. These involve:

Permanence
Additionality
Leakage
Uncertainty
GWP

General concern price may differentiate based on characteristics like a grading standard

Fungibility

Grading standards

#2 yellow corn, CD plywood,
long staple cotton

Receive a price premium/discount depending upon product characteristics and consumer cost of using

GHG offsets may have consumer cost effects being not fully claimable due to

Permanence
Additionality
Leakage
Uncertainty

Fungibility- How do we derive price discount?

$$\text{CurCostPerTon} = \frac{\text{PresValueCostOfOffset}}{\text{QuantityOffsetToday}}$$

$$\text{PresValueCostOfOffset} = \sum_{t=0}^{T} \frac{\text{PriceOffsetInYear}_t\ \text{QuantityOffsetInYear}_t + OtherCost_t}{(1+\text{D}isc)^t}$$

$$\text{QuantityOffsetToday} = \sum_{t=0}^{T} \frac{\text{QuantityOffsetInYear}_t}{(1+\text{D}isc)^t}$$

$$\text{CurCostPerTon} = \frac{\sum_{t=0}^{T} (\Pr iceOffset * QuantityOffsetInYear_t + OtherCost_t)/(1+Disc)^t}{\sum_{t=0}^{T} QuantityOffsetInYear_t/(1+Disc)^t}$$

Note I have a non constant price variant

Fungibility- How do we derive price discount?

To derive price discount for permanence etc add some terms (Pdiscount, buyback and claimable offsets) then equate a perfect perpetual offset with an imperfect one

$$CurCostPerTon_{perfect} = \frac{\sum_{t=0}^{T} (OffsetPr * QOffset_t * (1 - PDiscount) - OffsetPr * Buyback_t + OthCost_t)/(1+Disc)^t}{\sum_{t=0}^{T} ClaimQuanOffset_t / (1+Disc)^t}$$

$$QOffset = QOffset_t$$

$$PDiscount = 0$$

$$Buyback_t = 0$$

$$OthCost_t = 0$$

$$ClaimQuanOffset_t = QOffset$$

$$CurCostPerTon_{perfect} = OffsetPr$$

implies $CurCostPerTon_{perfect} = CurCostPerTon_{imperfect}$

Fungibility- How do we derive price discount?

Permanence case

$$CurCostPerTon_{impermanent} = \frac{\sum_{t=0}^{T}(OffsetPr*(1-Pdiscount)*QOffset_t - OffsetPr*Buyback_t + OthCost_t)/(1+Disc)^t}{\sum_{t=0}^{T} ClaimQuanOffset_t/(1+Disc)^t}$$

OffsetPr	paid to nonperm offset is discounted $= OffsetPr*(1-PDiscount)$
$QOffset_t$	varies with t
$Buyback_t$	<> 0 if leasing or if project reverses
$OthCost_t$	<> 0 if maintainence is paid that is not a function of offset quantity
$ClaimQuanOffset_t$	$= QOffset_t$
$CurCostPerTon_{perfect}$	$= CurCostPerTon_{imperfect}$

$$OffsetPr = \frac{\sum_{t=0}^{T}(OffsetPr*((1-PDiscount)*QOffset_t - Buyback_t) + OthCost_t)/(1+Disc)^t}{\sum_{t=0}^{T} QOffset_t/(1+Disc)^t}$$

implies $$PermDiscount = \frac{\sum_{t=0}^{T}(\;Buyback_t + MainCost_t/PriceOffset)/(1+Disc)^t}{\sum_{t=0}^{T} QOffset_t\;/(1+Disc)^t}$$

Fungibility- How do we derive price discount?

Permanence case

$$\text{PermDiscount} = \frac{\sum_{t=0}^{T} (\ \text{Buyback}_t + \text{MainCost}_t\ /\text{PriceOffset}\ )/\ (1+\text{Disc})^t}{\sum_{t=0}^{T} \text{QOffset}_t\ \ /\ (1+\text{Disc})^t}$$

When is discount zero

No Buyback

No Maintenance cost

25 year lease with 100% buyback – 48% price discount

Maintenance at 10% of cost -- 36%

Fungibility - Additionality

$$\text{ProportionAdditional} = \frac{\text{WithProjectOffsets - BaselineOffsets}}{\text{WithProjectOffsets}}$$

$$\text{AdditionalityDisc} = \frac{\sum_{t=0}^{T} \text{QuanOffset}_t * \text{ProportionAdditional}_t / (1+\text{Disc})^t}{\sum_{t=0}^{T} \text{QuanOffset}_t / (1+\text{Disc})^t}$$

Texas Rice Case

– 67% acreage reduction in 15 years

12% price discount when converting to grass, 4% to trees

Fungibility - Uncertainty

$$UncertaintyDisc = Z_{\alpha} * CV$$

Yield to carbon correlation .75 to .93

One year

	Sorghum	Corn	Rice	Wheat	Upland Cotton	Soybean
US	8.8	10.0	5.2	7.1	8.1	7.0
State (TX)	10.4	11.0	7.5	11.2	9.0	15.6
Ag. District (District 9, TX)	17.0	25.2	7.4*	25.0	23.4	18.1
County (Brazoria, TX)**	21.4	26.3	14.2	N/A	31.1	23.1

Field cv 1?

Five years

	Sorghum	Corn	Rice	Wheat	Upland Cotton	Soybean	Average
US	1.33	4.59	2.01	4.30	1.49	2.51	2.71
State(Texas)	3.31	2.76	2.24	5.17	3.28	3.91	3.45
Crop District	2.88	5.96	2.30	5.68	5.93	5.44	**4.70**
County	3.46	4.48	1.05	N/A	6.87	10.76	**5.52**

Fungibility - Uncertainty

$$\text{UncertaintyDisc} = Z_{\alpha} * \text{CV}$$

Confidence Level	Multiplier from Normal Distribution Z_{α}	Discount given a Coefficient of Variation (CV) of	
		5%	10%
80%	0.84	4.21%	8.42%
85%	1.04	5.18%	10.36%
90%	1.28	6.41%	12.82%
95%	1.64	8.22%	16.44%
99%	2.33	11.63%	23.26%

Fungibility - Leakage

$$LeakDisc = 1 - \text{ProportionLeaking}$$

$$\text{ProportionLeaking} = \frac{e * C_{ot}}{[e - E * (1 + P)]\, C_{pr}}$$

e is the price elasticity of supply for off project producers.

E is the price elasticity of demand for commodity produced.

Cot is GHG emissions per unit of increased commodity production outside project.

Cpr is GHG offsets per unit of reduced commodity production in project.

P is relative market share and is quantity of commodity produced by project divided by market amount produced.

Fungibility - Leakage International

Scope of Participation

	US Only		US and Annex B Countries		All Countries	
	$10	$100	$10	$100	$10	$100
U.S.						
Production of Traded Crops	99.60	93.47	99.87	97.09	100.52	105.11
All Production	99.33	**97.53**	99.93	**97.43**	99.47	**98.59**
Exports	98.84	81.77	99.93	97.65	102.19	126.92
Production of traded commodities in rest of world						
Global production	99.96	**99.60**	99.95	**99.44**	99.98	**99.71**
Annex B Countries (excluding U.S.)	100.36	**102.66**	99.51	**92.31**	99.61	**99.25**
Non-Annex B Countries	100.32	**112.22**	100.49	**120.13**	96.89	**57.60**

Note All datat are index nubers of production in a category

Participating production is offset by production elsewhere

Fungibility - Empirical

Beaumont through Columbus Texas area has historically produced rice. In 1985, 600,000 acres. In 2000, 214,000 acres. Policy, environment and markets are applying pressure. Today, many rice producers are in quest of new opportunities. Trees, other crops and pasture provide possible alternatives to some.

$$\text{PricetoOffsetProducer} = \text{Offsetprice} * (1 - \text{PermDisc}) * (1 - \text{UncerDisc}) * (1 - \text{AddDisc}) * (1 - \text{LeakDisc})$$

	Perm	Add	Leak	Uncer	All	Saleable
Rice to crops	30%	12%	32%	10%	62%	**38%**
Rice to pasture	50%	4%	17%	10%	64%	**36%**
Rice - trees(pulp)	30%	1%	16%	10%	48%	**52%**
Rice - trees (saw)	10%	1%	16%	10%	33%	**67%**

Not additive

Is this a problem – in a model

Not always

Full coverage eliminates leakage
Multi period is handled in fasom
Additionality handled by dynamic baseline

Uncertainty is not

Is this a problem – with projects

Always

Partial coverage virtually insures leakage
Multi period needs to be handled when buyback or maintenance
Additionality depends on rules

Uncertainty is there

Is this a problem – with projects

More than a trinity

Cost of Carbon -- Private cost

PDC – Cost producer incurs to switch from current practices (estimated by models we have looked at)

PAIC - Cost to get producer to adopt above PDC in terms of incentive to get trained bear extra risk etc.

MTC - Transactions cost to assemble, measure, monitor, certify, sell, carbon

GC - Government cost share

$$\text{Private cost per ton} = \frac{(PDC + PAIC + MTC - GC)}{QGHGO * DISC}$$

Is this a problem – with projects

More than a trinity

Cost of Carbon -- Public cost

PUBF –Public Funds Cost
GC - Government cost share
ACB - Ag co benefits
NCB - Non Ag co costs

$$\text{Private cost per ton} = \frac{(PDC + PAIC + MTC - PUBF * GC + ACB - NCB)}{QGHGO * DISC}$$

SO WHAT

Fungibility can be a problem
Opportunities are not perfect substitutes
Projects may aggravate problem
Modelers will lose hair over payment schemes

Big Holy Trinity