Environmental Targeting Under Heterogeneity when Multiple Benefits Matter

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Background

- Environmentally-friendly agricultural practices generate multiple benefits, but value of these benefits uncertain
  - Some benefits predictable with models
  - Others even less measurable
- Current policy approach: subsidies for practices, with possible targeting of benefits

Our Paper

- Use conservation tillage adoption model combined with EPIC to study alternative targeting strategies in Iowa
- Questions:
  1. How much sequestered carbon can a subsidy for conservation till generate in Iowa?
  2. What are the co-benefits of targeting carbon?
  3. How much carbon would result from targeting other environmental attributes?
  4. How might different objectives generate different targeting choices?

Conservation Tillage in Iowa

- Econometric model of adoption of conservation till (presented last year)
- EPIC for environmental indicators, including Carbon, Nitrogen runoff, Water Erosion, Wind Erosion
- Model and EPIC runs predict at NRI level

Problem Facing Policy maker

- Problem faced by policy maker: wants to maximize environmental benefits from this program

  Social utility: $U = U(X_1,\ldots,X_K)$

  where $X_1 = \Sigma X_1^n$ = total amount of env attribute 1, etc.

  c^n = cost of enrolling farm n (bids)

  C = budget

- Which bids should be accepted?

How to choose farms to enroll?

- Define $x_k^n = X_k^n / c^n$ = environmental attribute k received per dollar spent on farm n

- Total environmental contribution per dollar spent from each farm

$$v^n = U_1 x_1^n + U_2 x_2^n + \ldots + U_K x_K^n$$

- Rank order v^n highest to lowest, enroll farms until exhaust budget

Single Target

- Assumes you know benefits and can target on multiple attributes
- What if target a single attribute?
- Enrollment rule: rank order x_1^n highest to lowest (assuming attribute 1 is the target), enroll farms until exhaust budget

Carbon Benefits and Co-Benefits of a Carbon Targeting Policy

Budget	$10 (mil)	$20 (mil)	$40 (mil)
Carbon, 1,000,000 tons	2.8	3.0	3.2
N Runoff reduction, 1,000 tons	3.7	3.9	4.1
Water erosion reduction, 1,000 tons	10.1	10.5	11.1
Wind erosion reduction, 1,000 tons	9.7	10.2	10.9

Average Cost of Carbon and Co-Benefits (C Targeting Policy)

Budget	$10 (mil)	$20 (mil)	$40 (mil)
Carbon, $/ ton	3.5	6.7	12.5
N Runoff reduction, $1,000/ton	2.7	5.2	9.6
Water erosion reduction, $1,000/ton	1.0	1.9	3.6
Wind erosion reduction, $1,000/ton	1.0	2.0	3.7

Benefits from a single target

- How much of potential environmental benefits does a particular targeting scheme achieve?

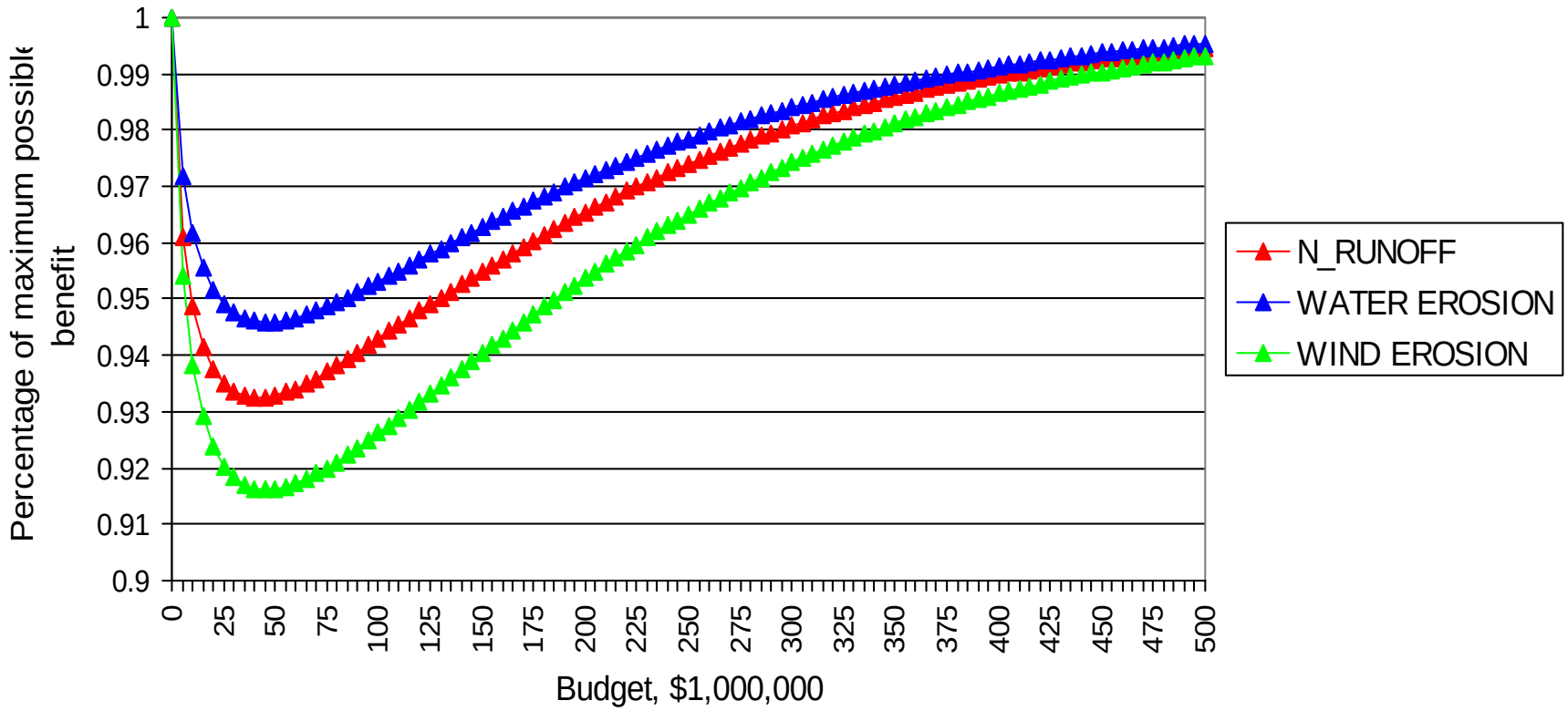
- Compute the fraction of attribute generated, at any given budget level, relative to its potential

$W_{21} = X_{21} / X_{11}$, $W_{31} = X_{31} / X_{11}$, etc.

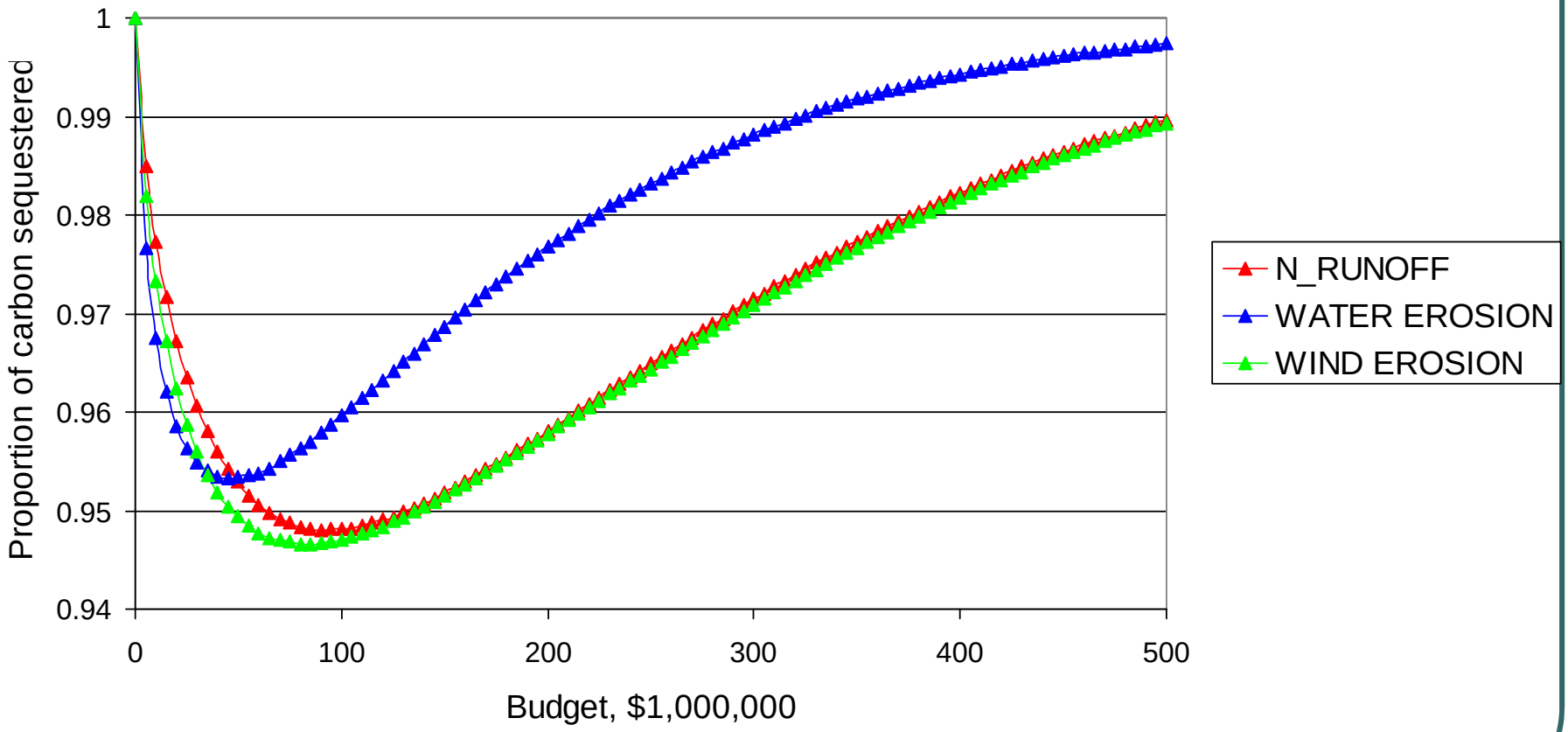
where X_{21} = Attribute 2 achieved when target 1,

X_{31} = Attribute 3 achieved when target 1, etc.

CO-BENEFITS of CARBON SEQUESTRATION via ADOPTION of CONSERVATION TILLAGE (Policy targets CARBON)



PROPORTION of MAXIMUM POSSIBLE CARBON SEQUESTERED UNDER DIFFERENT TARGETING STRATEGIES

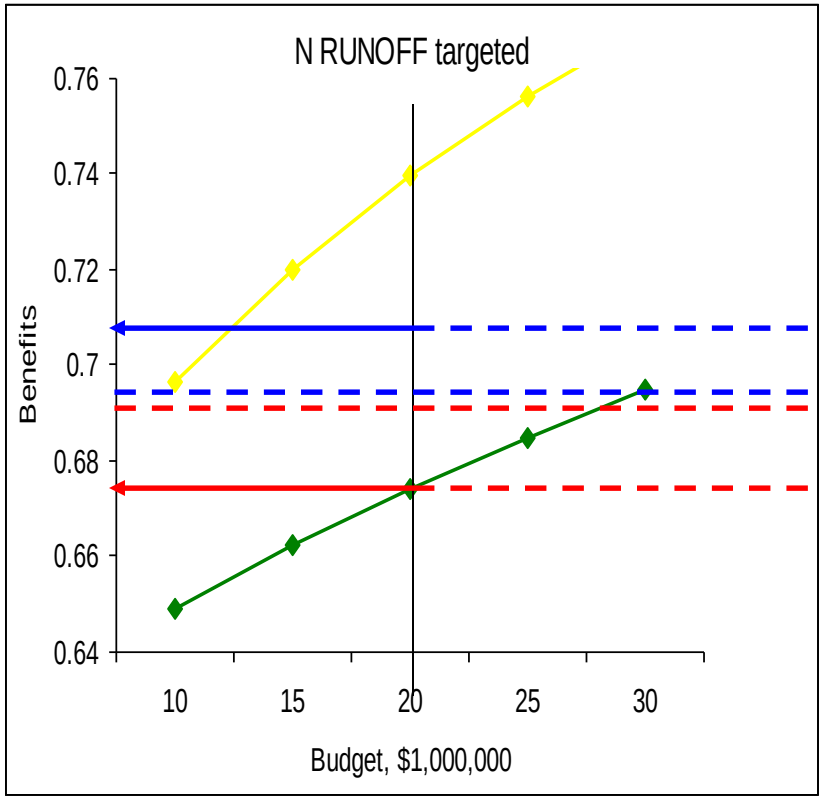


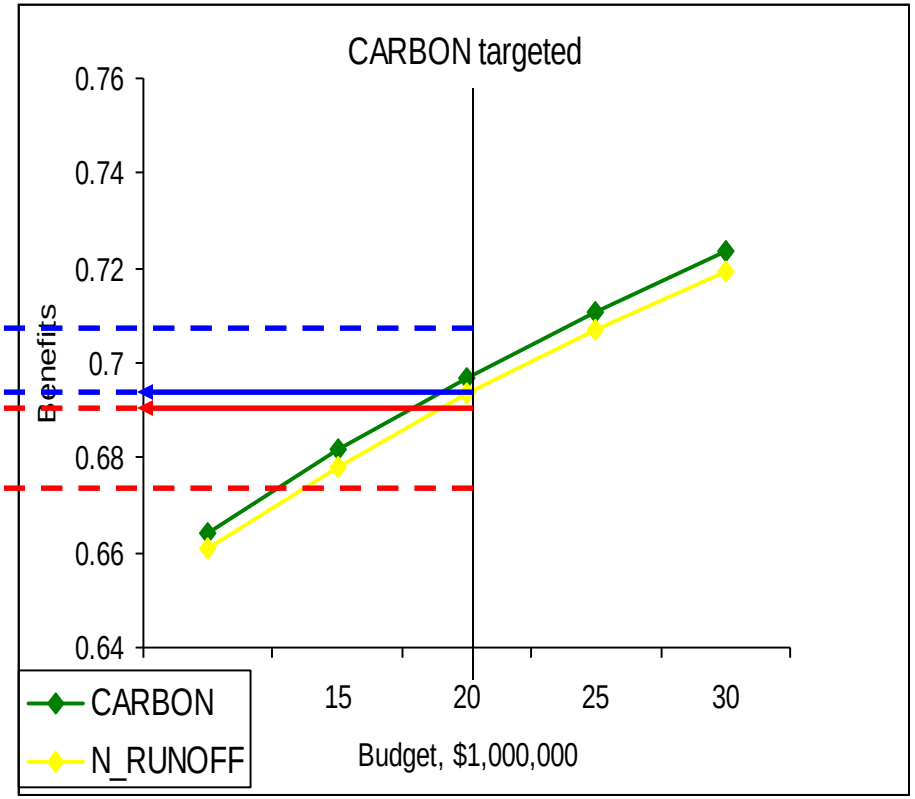
Choice of Targeting Strategies

1. Target attribute that gives you the highest percentage of total achievable benefits

2. Target attribute that assures the greatest level of the minimum attribute

Equal weight vs. max-min criterion





Preferred by equal weight

Preferred by max-min

Best targeting strategies under equal weight criterion

Budget ($ million)	Benefit targeted
5 to 95	Minimize N Runoff
100 to 50	Minimize Water Erosion

Best targeting strategies under MAX-MIN criterion

Budget ($mil)	Benefit targeted
5 to 10	Wind Erosion
15 to 225	Carbon
230 to 500	Water Erosion

Future Directions

- More environmental indicators
  - EPIC
  - CENTURY
  - SWAT
- Beyond Iowa: UMRB
- Additional Targeting Policies
  - Multiple Benefits
  - Policy Design