Alternative Green Payment Policies under Heterogeneity when Multiple Benefits Matter

Jinhua Zhao, Catherine Kling, and Luba Kurkalova

CARD, Department of Economics

Iowa State University

Paper presented at the 2003 NAREA Workshop "Linkages between Agricultural and Conservation policies", Portsmouth, NH, June 2003

Background

- Conservation Security Program (CSP) proposes paying farmers for the adoption of environmentally friendly practices

- Approach: **green payments for practices**, with possible targeting of benefits or practice

- Environmentally-friendly agricultural practices generate multiple benefits, but value of these benefits uncertain

Problem facing policy maker

- Maximize environmental benefits from green payment program

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

  where $X_1 = \Sigma X_1^n$ = total amount of benefit 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
- Target practice: rank order $1/c^n$ highest to lowest, enroll farms until exhaust budget
- Target single benefit j: rank order x_j^n highest to lowest, enroll farms until exhaust budget

Targeting single benefit

- How to summarize the environmental benefits of a particular targeting program?

- How do we compare alternative targeting schemes? What is the best/optimal targeting scheme?

Our paper

- Develop a methodology of summarizing multiple benefits from targeting
  - Lorenz curve: targeting one benefit, the percentage of other benefits generated relative to their respective maxima (under direct targeting)
  - Depends on the correlation of the rank order of the benefits/$
- Use Lorenz curves to choose optimal targeting
  - Special utility functions: with perfect or no substitutability among benefits
- Empirically apply the methodology to conservation tillage in Iowa

Previous research

- CRP
  - Babcock et al 1996, 1997
- CSP
  - Johansson, Claassen, and Peters 2002
  - Baylis et al 2002

Lorenz curves

- w(C, i, j) = ratio between benefit i obtained when targeting j and that obtained when targeting i, under budget C
- Higher curves indicate better choice of targeting
- Curves are higher as
  - The fields are more homogeneous
    - Rank order of benefits/$ is more positively correlated
  - The budget rises

Choosing optimal targeting

- Special utility functions:

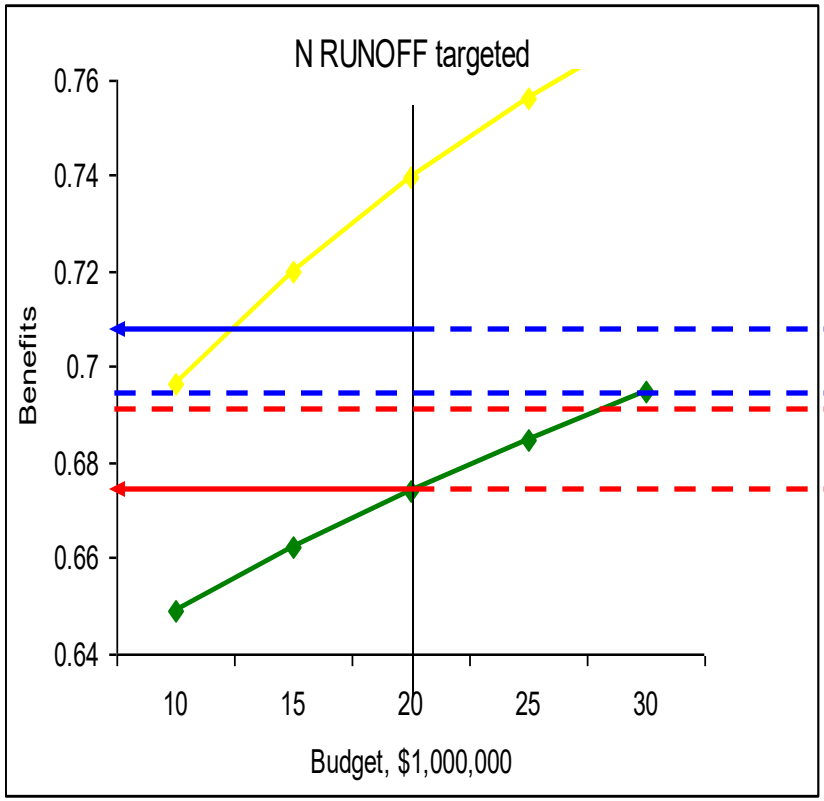
$$U(X_1,...,X_K) = \sum_{k=1}^{K} \alpha_k X_k$$

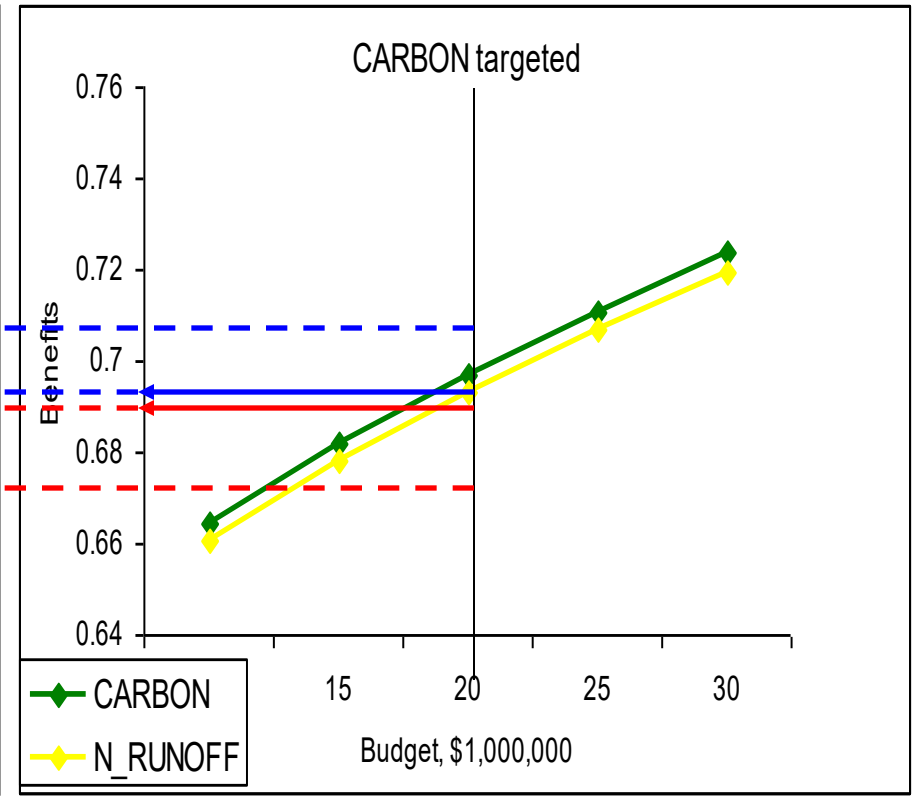
$$U(X_1,...,X_K) = \min\{\alpha_k X_k, k = 1,...,K\}$$

- Under perfect substitutability, vertical summation of Lorenz curves, i.e. target attribute that gives the highest percentage of total achievable benefits

- Under Leontieff, max-min of Lorenz curves, i.e. 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

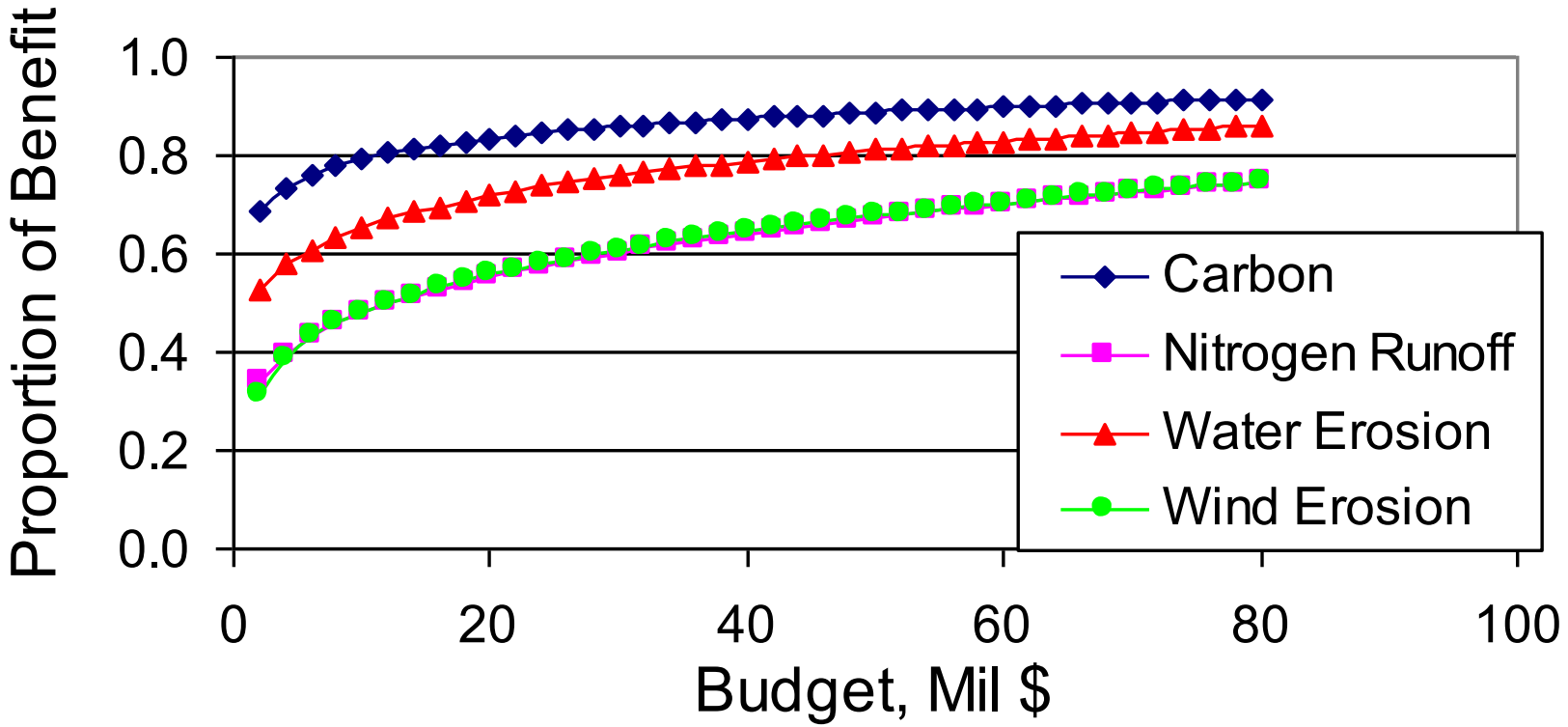
Conservation tillage in Iowa

- Econometric model of adoption of conservation till
- EPIC for environmental indicators
  - Carbon
  - Nitrogen runoff
  - Water Erosion
  - Wind Erosion
- Model and EPIC runs predict at NRI level (13,000 points)

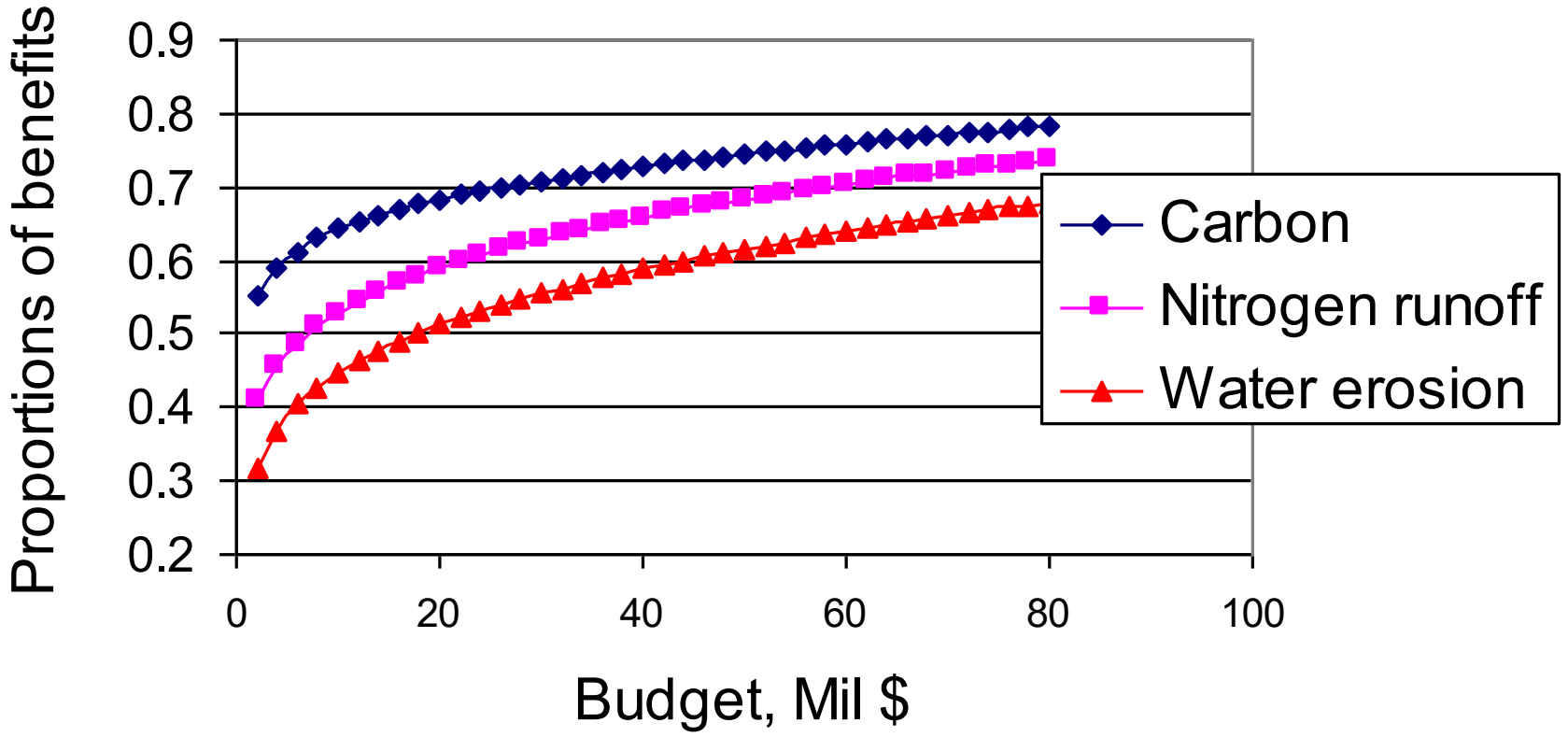
Benefits of a practice targeting policy

Budget	10 Mil $	20 Mil $	40 Mil $
Carbon, 1,000 tons	169	296	495
N Runoff reduction, tons	237	406	671
Water erosion reduction, 1,000 tons	597	1033	1729
Wind erosion reduction, tons	704	1206	1976

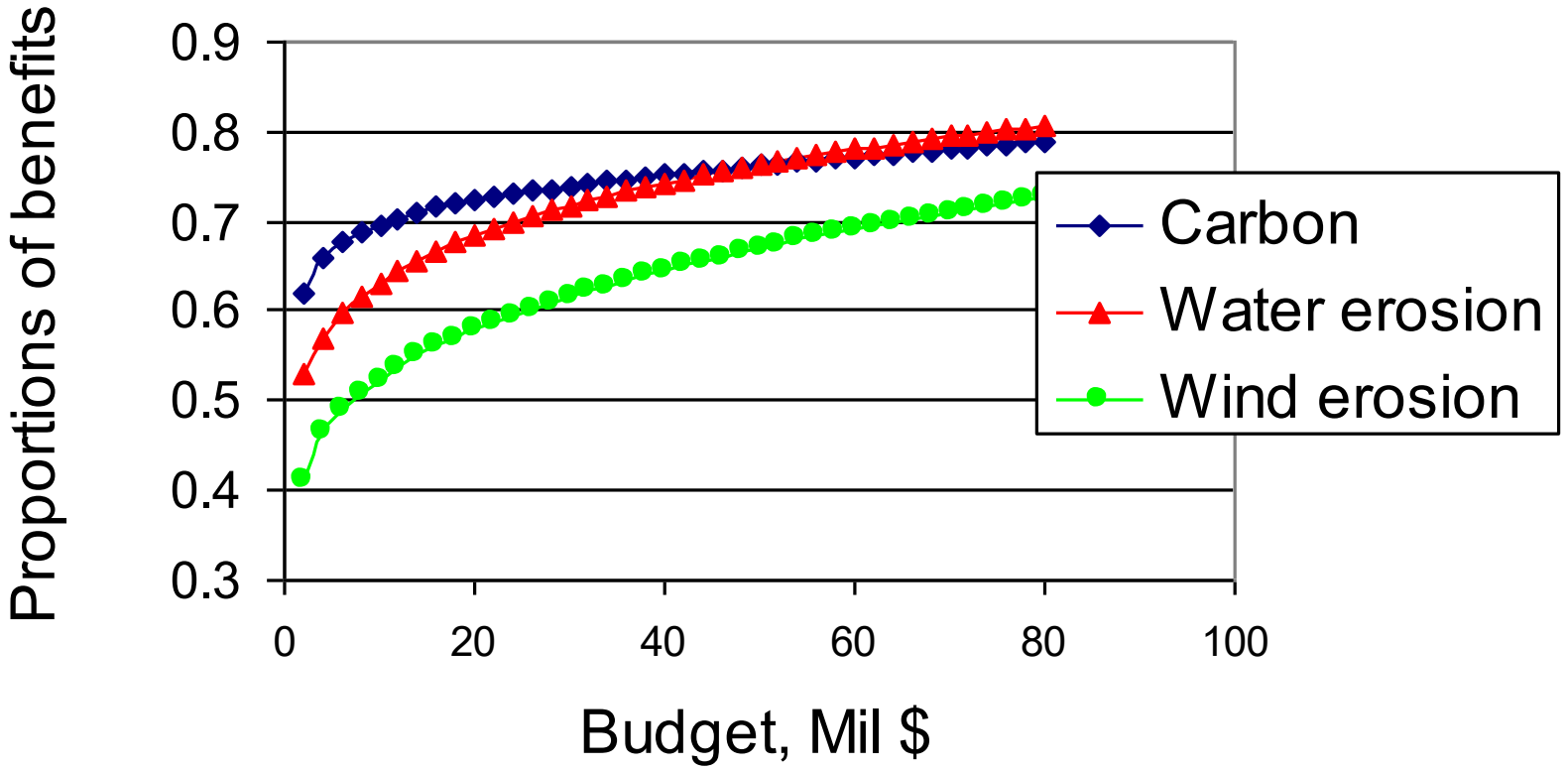
Lorenz curves: Benefits obtainable under a practice- vs. specific benefit-targeting policy



Lorenz curves:
Benefits obtainable under a wind-erosion- vs. specific benefit - targeting policy



Lorenz curves: Benefits obtainable under a N-runoff- vs. specific benefit - targeting policy



Best targeting strategies under different criteria

Budget, Mil $	Equal weight	Max min
2-36	Minimize Nitrogen runoff	Minimize Nitrogen runoff
38-70	Minimize Nitrogen runoff	Maximize carbon sequestration
72-80	Maximize carbon sequestration	Maximize carbon sequestration

Future directions

- More environmental indicators
- Spatial aspects: SWAT
- Beyond Iowa: UMRB
- Institutions