Tradeoff between Efficiency and Equity in the Targeting of the Conservation Reserve Program

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Research Questions

- What is the tradeoff between efficiency and equity in the targeting of the Conservation Reserve Program (CRP)?
- How do alternative CRP targeting criteria perform in terms of efficiency and equity?
- Could CRP acres be redistributed to improve both efficiency and equity?

Efficiency and Equity

Efficiency

- Economic efficiency is measured by the percent of the maximum environmental benefit generated for a given budget.
- Environmental benefits are measured by the Environmental Benefit Index (EBI) developed by the US Department of Agriculture (excluding the rental rate part).
- EBI takes into account improvements in water quality, soil erosion, air quality, wildlife habitat, and conservation priority area.
- The maximum environmental benefit is achieved for a given budget if CRP bids are ranked and accepted according to their benefit-cost ratios.

Equity

- Equity is measured by the indicators listed in Table 1, each of which is constructed as one minus the Gini coefficient.
- The equity indicator varies from 0 to 1, with 0 being maximum inequality and 1 perfect equality.

Table 1. Equity Indicators

Category	Indicator
Equity in access1	Submitted land acreage per capita
Equity in access2	Total environmental benefits per capita if all submitted bids were enrolled
Equity in access3	Total rental payment per capita requested by submitted bids
Equity in outcome1	Ratio of enrolled acreage to all submitted acreage
Equity in outcome2	Ratio of CRP payment to total income
Equity in outcome3	Ratio of CRP payment to local government tax revenue
Equity in outcome4	CRP payment per capita
Equity in outcome5	Environmental benefits achieved per capita

The Efficiency-Equity Frontier (EEF)

- A downward sloping EEF indicates that higher efficiency can only be achieved with a sacrifice of equity.
- Pareto optimal: For any distribution on a downward-sloping EEF, there is no way to redistribute to achieve a higher level of efficiency or equity without sacrificing the other.
- Concavity: The marginal rate of substitution between efficiency and equity is decreasing; improving efficiency (equity) at increasing costs of equity (efficiency).

Procedure for Estimating EEFs

1. Generate the most efficient allocation of CRP funds using the benefit-cost ratio targeting, and calculate the the equity measures for the distribution.
2. Start from the most efficient allocation, and redistribute a small amount of fund (ΔM) from one county to another, and find the redistribution that results in the largest improvement in equity for a given loss in efficiency among all possible redistributions.
3. Iterate the redistribution process until no more equity improvement can be made to trace out the whole frontier.

Data

- CRP enrollment data for Sign-up 18 contains 89,886 individual bids from 2015 counties in 43 states.
- The data include information about the acreage, EBI scores, and rental payment requested for each proposed parcel.
- 61,219 bids were accepted based on the EBI scores and the total payment for the new contracts was about $226 million for FY2000.
- Population, total income and local government tax revenue at county level were collected from the US Census Bureau.

Results

EEF patterns

- The three equity in access indicators are 0.13, 0.13 and 0.16, indicating that the CRP is highly "inequitable" in access if bids submitted in sign-up18 are representative of eligible parcels across counties.
- Equity in outcome, measured by the percent of submitted bids accepted, is high (see the EEF for indicator 1 in Fig 1).
- The rest four equity in outcome indicators range from 0.1 to 0.3, indicating program benefits are distributed quite unequally across counties.
- All are downward sloping and concave, indicating a tradeoff relationship and a decreasing marginal rate of substitution between efficiency and equity.

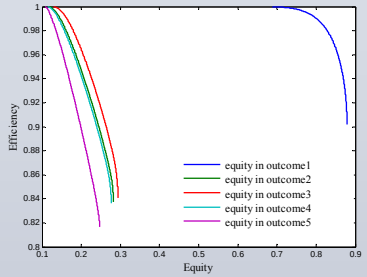

Figure1: Efficiency-Equity Frontiers for five indicators

- Under the current CRP design, it is impossible to redistribute the funds to achieve equity in outcome beyond 0.3 according to indicators 2-5.
- Counties in the first decile of the average household income received 29.26% of the total CRP payment, indicating the performance of the CRP as a pro-poor policy.

Table 2: Cumulative percentage of fund allocation

Cumulative percentage of lowest tax revenue/ income	Tax revenue: Most efficient allocation (BC)	Tax revenue: Current allocation (EBI)	Tax revenue: Most equitable allocation (Convergence)	Income: Most efficient allocation (BC)	Income: Current allocation (EBI)	Income: Most equitable allocation (Convergence)
10%	57.49%	50.97%	57.49%	31.83%	29.26%	26.99%
25%	82.12%	78.28%	82.12%	59.20%	58.48%	56.42%
50%	97.50%	96.26%	97.50%	91.01%	90.63%	89.69%
75%	99.41%	99.10%	99.41%	98.76%	98.69%	98.62%
90%	99.66%	99.62%	99.66%	99.64%	99.64%	99.75%

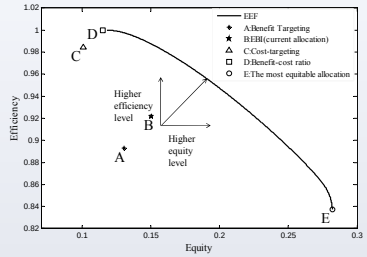

Figure2: Efficiency-Equity Frontiers and allocations by different targeting rules (Equity in outcome2)

Targeting rules of the CRP

- The current allocation of CRP acres across counties is not Pareto optimal, as indicated by point B in Fig.2. CRP funds could be reallocated to increase both efficiency and equity.
- To achieve higher efficiency, CRP funds should be shifted from the Corn Belt and Lake States to the Northern and Southern Plains and the Southeast under the current measure of benefits (Fig. 3).
- To achieve higher equity, CRP funds should be shifted from the Northern and Southern Plains to the rest of the country (Fig. 4).
- Targeting parcels with the highest environmental benefits per unit (A in Fig.2) performs poorly in terms of both efficiency and equity.
- Targeting parcels with the lowest rental rate (C in Fig.2) or with the highest benefit-cost ratio (D in Fig.2) can achieve a higher level of efficiency at a cost of lower equity.

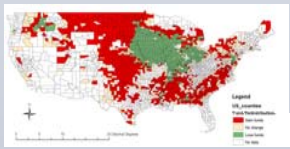

Figure 3. Redistribution process from current allocation to the most efficient one (from B to D in Fig.2)

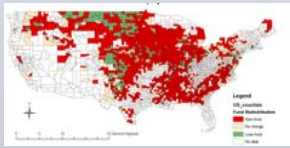

Figure 4. Redistribution process from current allocation to the most equal one (from B to E in Fig.2)

Conclusions

- The current CRP acreage allocation is highly inequitable in both program access and program outcomes, nor is it efficient.
- CRP funds can be reallocated to increase both the program's efficiency and equity.
- To improve equity, some CRP dollars should be reallocated from the Northern and Southern plains to other regions.
- To improve efficiency, some CRP dollars should be shifted away from the Corn Belt and Lake States, at least under the current measure of environmental benefits.

Contact Information

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