Farm-level Impacts of Participation in the U.S. Environmental Quality Incentives Program (EQIP)

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Part 1:
Research Motivation

Improving Efficiency? Thirty Four Years of U.S. Irrigation

Year	Total acres irrigated	Total water use (acre-feet)	Average application rate (ac.ft./ac.)	Change in application rate since 1979
1979	50,154,249	93,071,345	1.86	
1984	45,821,428	82,182,177	1.80	-3.4%
1988	47,753,727	84,182,177	1.76	-5.0%
1993	46,418,380	79,627,392	1.72	-7.6%
1998	50,028,439	90,563,665	1.81	-2.4%
2003	52,492,687	86,757,665	1.65	-10.9%
2008	55,540,978	91,956,721	1.66	-10.7%
2013	55,319,417	88,510,811	1.60	-13.8%

Source: USDA Agricultural Census, FRIS: 2013, table 4; 2008, table 11; 1998, table 10; 1994, table 10; 1983, table 10.

Broad Research Question

- Do technology subsidies work?
- Common market failures with irrigation water
  - Water rights are poorly defined
  - Water rights are defined but are not tradeable
  - Water or infrastructure is subsidized
- Common policy for inefficient use of water
  - Subsidies for improved irrigation technology
  - Water rights reform

The U.S. Environmental Quality Incentives Program

- Financial and technical assistance for farms to adopt conservation practices that address five national priorities:
  - Water conservation
  - Non-point source pollution
  - Air quality
  - Soil erosion
  - Habitat conservation

- About **11 %** of U.S. irrigators relied on EQIP (and other USDA programs) between 2004 and 2008 for irrigation or drainage improvements. (Source: 2008 FRIS Table 39)

- Just under **5%** of those irrigators who made capital investments in 2008 relied on EQIP as the primary source of financial assistance. (Source: 2008 FRIS Table 23)

Specific Research Question

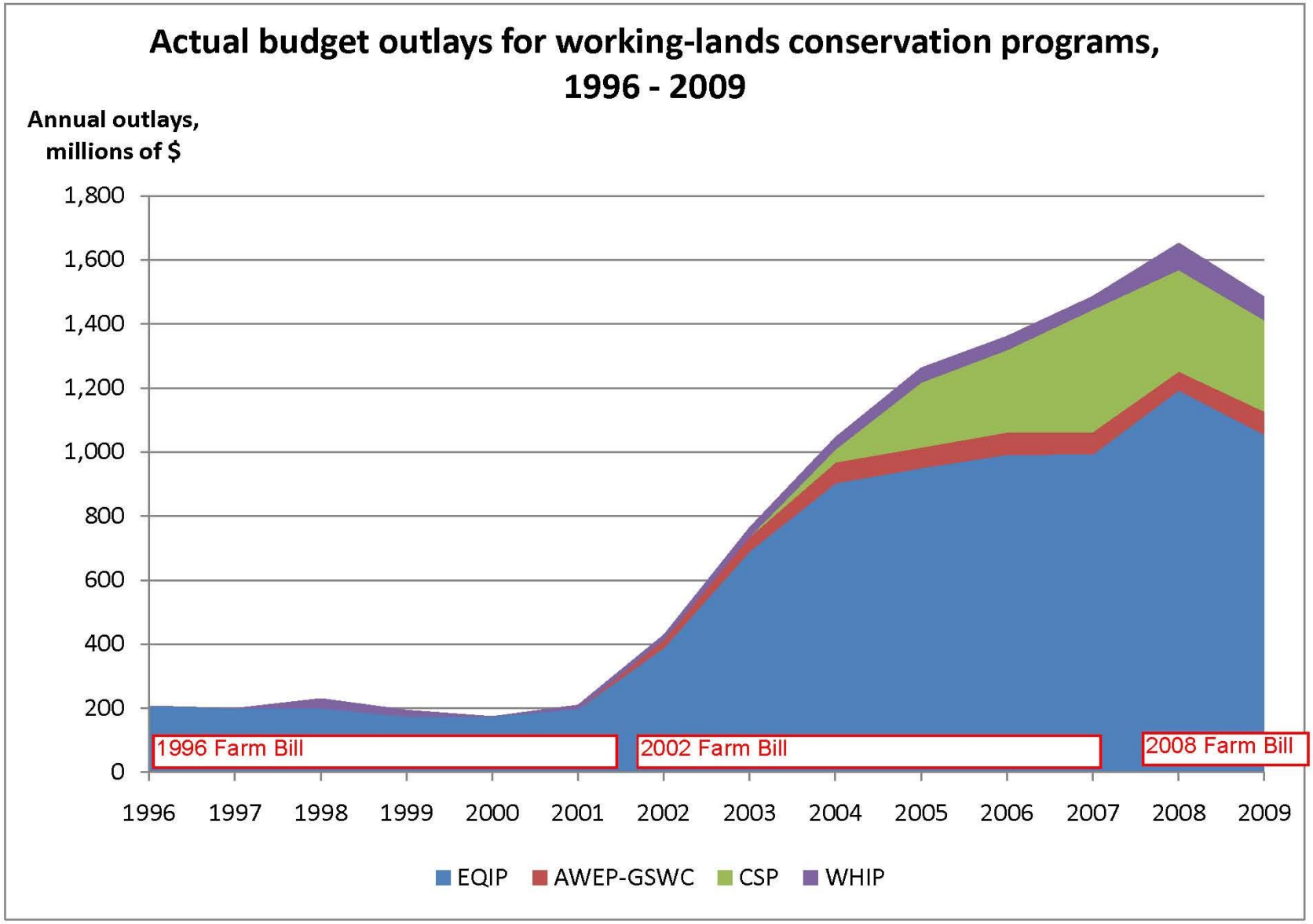
- How do irrigators that participate in EQIP compare to (appropriately chosen) irrigators that don't participate?

- Do farms that receive EQIP payments…
  - … invest more in **CONSERVING TECHNOLOGY?**
  - … have lower **WATER APPLICATION RATES**?
  - … increase or reduce **IRRIGATED ACREAGE**?
  - … have lower or higher **WATER USE?**

Part 2:
Background on EQIP

EQIP: History (through 2008)

- Creation: 1996 Farm Act
  - Consolidated earlier working lands programs
  - Long-term, small contracts (5-10 years, max. $50,000/contract)
  - Some geographic targeting: conservation priority areas
  - Maximum 75% cost share with bid-down
- Expansion: 2002 Farm Act
  - **Dramatic increase in funding**
  - Shorter-term, larger contracts (1-10 years, max. $450,000/farm)
  - Contracts “scored” based on resource concerns
  - Bid-down prohibited
  - Maximum 75% cost share, 90% for targeted farmers
- Continuation: 2008 Farm Act
  - Minor increases in funding and decreases in payment cap



Source: OBPA Annual Budget Summaries.

Funding for Selected Practices: 1996-2010

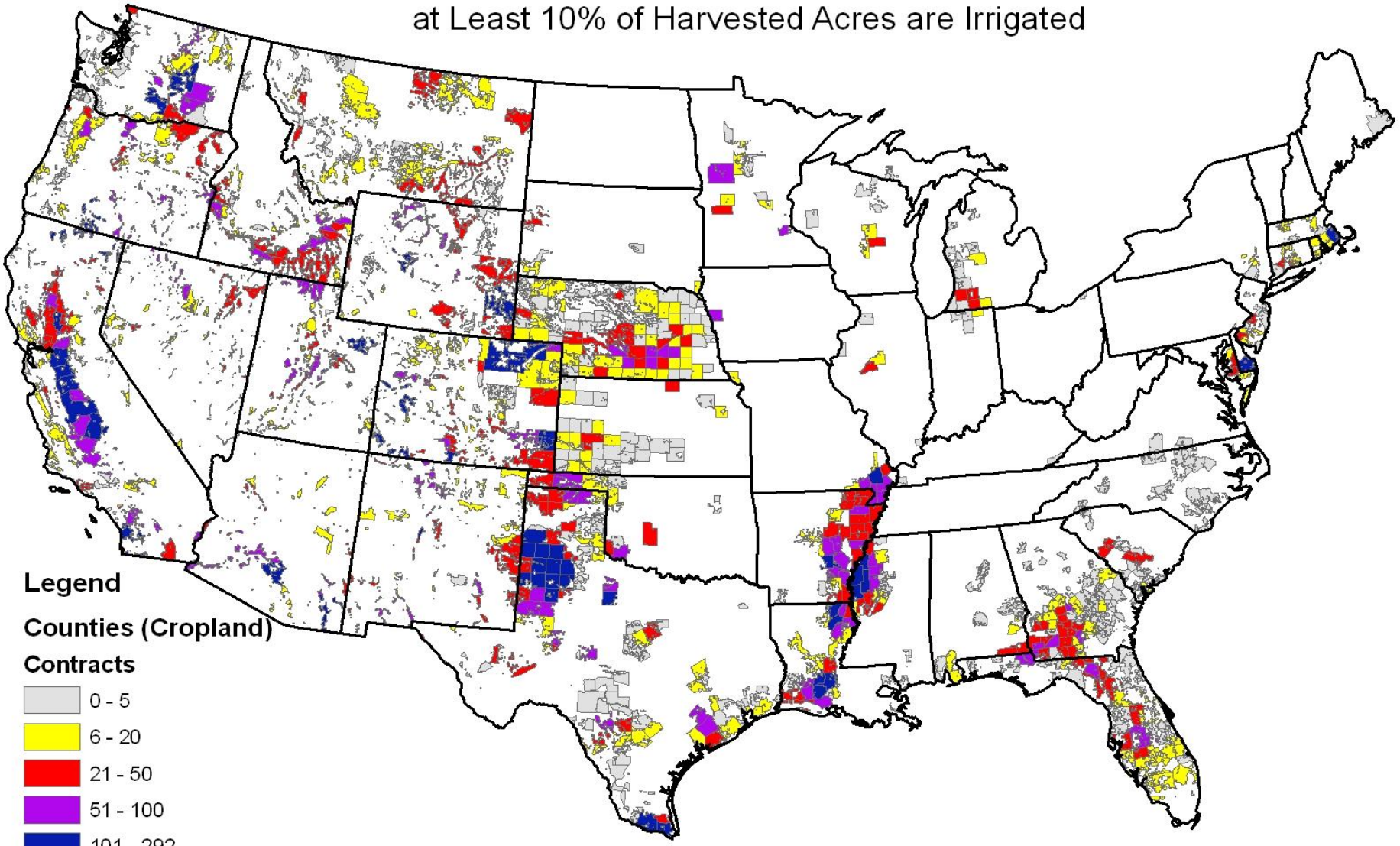
Major Irrigation Practices (Rank)		*Total Obligated*
• **Sprinkler**	**(3)**	**$433 million**
• **Conveyance – Pipe**	**(4)**	**$333 million**
• **Microirrigation**	**(9)**	**$202 million**
• **Land leveling**	**(19)**	**$99 million**
• **Irrigation Water Mgmt**	**(31)**	**$45 million**
• **Conveyance – Ditch**	**(42)**	**$35 million**

Major Non-Irrigation Practices		
• Waste Storage Facility	(1)	$611 million
• Fence	(2)	$455 million
• Conservation Tillage	(6)	$250 million
• Nutrient Management	(8)	$234 million

Source: USDA ProTracts Database, Nominal Dollars

Irrigation-related EQIP
Number of Contracts from 2005 to 2008

Map Shows Cropland in Counties Where at Least 10% of Harvested Acres are Irrigated



Source: ProTracts

Part 3: Literature

Do Technology Subsidies Achieve Water Conservation?

- Irrigation Technology, Application Rates, Acreage
  - Caswell, Zilberman 1986
    - Joint decisions, local characteristics
  - Moore et al. 1994; Kim et. al. 1997; Schaible and Aillery 2003
    - Crop acreage allocations should also be considered
  - Schoengold et al. 2006
    - Extensive margin (fallowing) matters
- The Controversy Over Technology Subsidies
  - Huffaker, Whittlesey 1995,2003
    - Limited water savings – theoretical model, general.
  - Peterson and Ding 2005, Ward and Pulido-Velazquez 2008
    - Programming models: Savings in Nebraska, None in New Mexico.
  - Scheierling et. al 2006.
    - Simulation model of reallocations within basins.
- Econometric Evaluation of Subsidies
  - Pfieffer and Lin 2014
    - Well diversions panel in Kansas, Subsidies induce shift in cropping patterns

Program Evaluation Methods

- Difference-in-Differences
  - Abadie 2005
- Matching: Propensity or Nearest Neighbor
  - Heckman, Ichimura and Tood 1997
    - Panel data methods with matching
  - Caliendo and Kopeinig 2008
    - Overview of propensity score matching
  - Pufahl and Weiss 2009, Mezzatesta et al. 2013 Claassen et al. 2014
    - Applied to USDA and European conservation program participation
  - Lynch et al. 2007, Liu and Lynch 2011
    - Applied to farmland preservation

Part 4:
Empirical Strategy

A “Treatment Effect” Approach

- Treatment effect
  - Participation in the program is a binary variable.
  - Allows “simple” comparison of participants against an appropriately chosen control group of non-participants
  - Does not distinguish between alternative irrigation practices
- Multiple, farm-level outcome variables
  - Technology and Investment
  - Total Water Use and Application Rates
  - Acreage

Panel Data

- National sample of farm-level data with:
  - EQIP participation periods (‘96-’98, ’99-’03, ’04-’08)
  - Water application rates
  - Other outcomes: acreage, water use, technology shares
- Observation over time
  - High sample rate plus stratification induces resampling
- Adequate control for assignment of EQIP
  - Rely on expansion of EQIP as an exogenous shock
  - Also rely on local spatial variation in participation

Basic Model

- Difference-in-Difference Estimator

$$Y(i,t) = \alpha(i) + \beta \cdot D(i,t) + \delta \cdot t + \varepsilon(i,t)$$

- With two time periods, first difference

$$let: \varepsilon(i,1) - \varepsilon(i,0) = \mu(j) + u(i)$$

$$Y(i,1) - Y(i,0) = \delta + \beta \cdot D(i,1) + \mu(j) + u(i)$$

  - Controls for time-invariant farm-level characteristics
  - Controls for common trends within regions
  - Assumes participation is uncorrelated with individual trend shocks conditional on region fixed effects.

Selection Concerns and Solutions

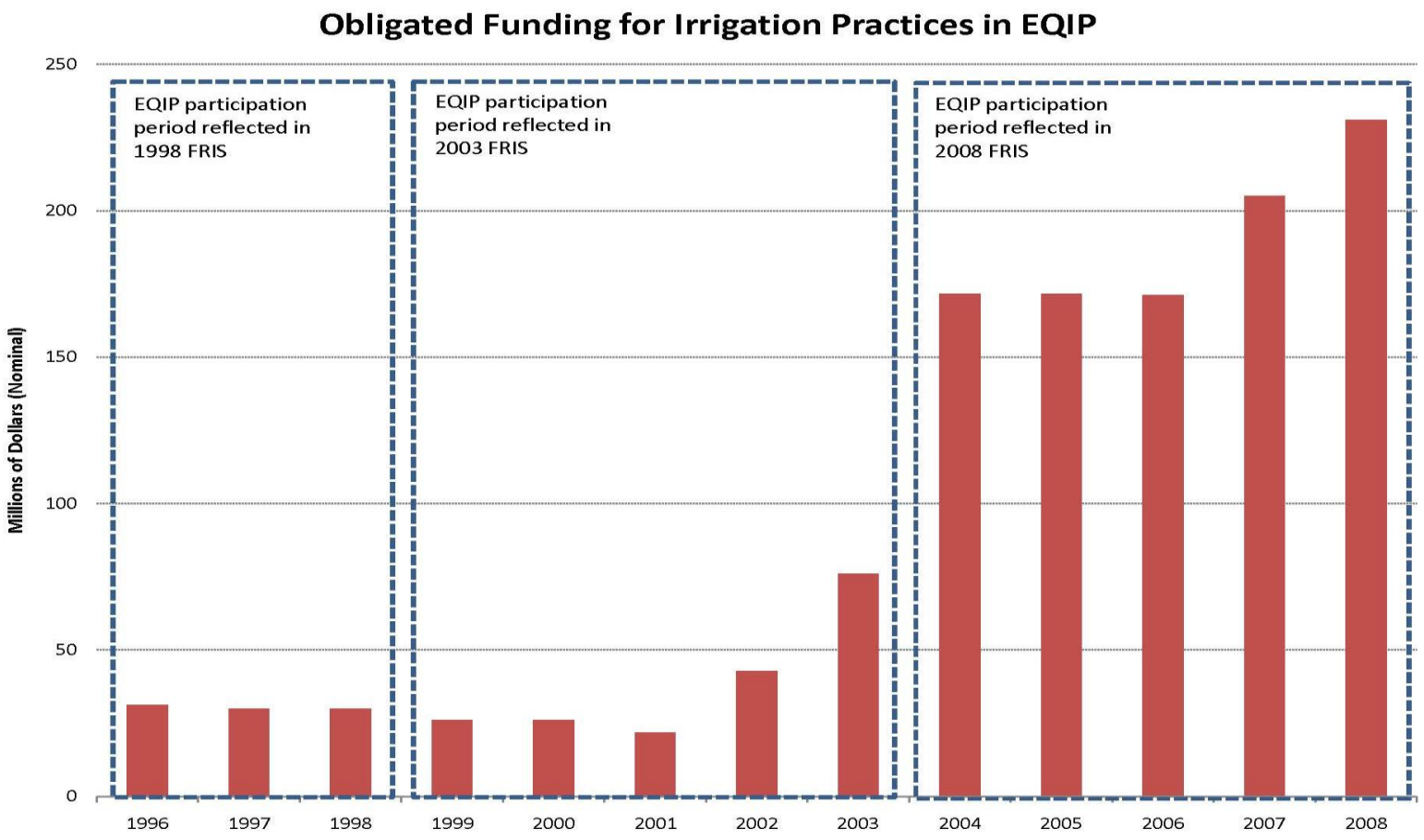
- Contracts are not randomly assigned.
  - Farms choose to submit a conservation plan.
  - NRCS selects which contracts to fund.
- Possible controls
  - Condition on time-varying characteristics
  - Matching: Baseline characteristics
    - Sources of information, water costs (groundwater depth), shortage factors, technology shares.
  - IV: Competition for EQIP funds (PROTRACTS)
    - Livestock EQIP shares, within-state EQIP shares.

Part 5:
Data Overview

FRIS

- Farm and Ranch Irrigation Survey
  - Water application rates
  - Program participation (over previous 5 years)
  - Acreages, technology, water sources

- Panel structure
  - Performed every 5 years, following Ag Census
  - Large sample relative to population (about 10%)
  - Stratified sampling; largest irrigators sampled with probability of 1.



Notes: 2005-2010 obligated funds are calculated from identified irrigation practices in the PROTRACTS database. 1996-2004 data are estimated using two data points in each year: 1) total EQIP funds as reported in Office of Budget and Program Analysis (OBPA) annual reports, and 2) the average share of EQIP funding going to irrigated practices from 1997 to 2000 and from 2001 to 2003, which is calculated from EQIP data available on the ERS website.

Selected Summary Statistics

2003/2008 Panel	Mean	Std. dev.	N
PARTICIPATION VARIABLES			
Participated '04-'08	0.095	0.294	3,781
Participated '99-'03	0.049	0.215	3,781
Participated both	0.021	0.142	3,781
OUTCOME VARIABLES			
Improved '04-'08	0.391	0.488	3,781
Share conserving '08	36.366	45.472	3,781
Share conserving '03	35.727	44.524	3,781
Water use '08	611.301	2718.683	3,781
Water use '03	536.828	2202.950	3,781
Application rate '08	1.875	1.719	3,780
Application rate '03	1.191	0.816	3,717
Acres irrigated '08	413.143	1016.387	3,781
Acres irrigated '03	369.999	1020.962	3,781

Part 6: Results

Results: Effect of EQIP Participation 2003-2008 Panel

OUTCOME	DND-1	DnD-2	NN
Technology improvement (0/1)	**0.2814*** **	**0.2613*** **	**0.1089**
Share of conserving	**3.3612*** **	**0.6647**	**5.9682**
Water use (acre-ft)	**205.0744*** **	**80.1353** **	**24.5318**
Application rate (ac.ft./ac.)	**-0.8378*** **	**-0.2227*** **	**-0.0787**
Alternative app. rate	**-0.7458*** **	**-0.2633*** **	**-0.0417**
Acres irrigated	**109.6832*** **	**85.7923*** **	**-46.5130**
Share of acres irrigated	**3.3097*** **	**-1.2544*** **	**-0.2591**

Model notes:
DnD-1: First-differences in outcome regressed on EQIP participation dummy variable.
DnD-2: DnD-1 with weather and price differences as well as crop reporting district fixed-effects
NN: Nearest-neighbor matching estimator of average treatment effect for the treated with three matches. Matching covariates are latitude, longitude, difference in weather and water price, and baseline values for acres operated, acres rented, acres in pasture, application rate, share of acres in groundwater, water supplier and prior EQIP participation.

Results: Effect of EQIP Participation 1998-2008 Panel

OUTCOME	DND-1	DnD-2	NN
Technology improvement (0/1)	**0.0114***	**0.1957*****	**0.1020**
Share of conserving	**37.1074*****	**18.8031*****	**17.7322**
Water use (acre-ft)	**598.5524*****	**121.8216****	**1021.0570**
Application rate (ac.ft./ac.)	**0.1595*****	**-0.2844*****	**-0.0759**
Alternative app. rate	**0.3600*****	**-0.2019*****	**-0.1054**
Acres irrigated	**224.8989*****	**147.3422*****	**514.0017***
Share of acres irrigated	**6.7054*****	**-0.6228**	**2.9534**

Model notes:
DnD-1: First-differences in outcome regressed on EQIP participation dummy variable.
DnD-2: DnD-1 with weather and price differences as well as crop reporting district fixed-effects
NN: Nearest-neighbor matching estimator of average treatment effect for the treated with three matches. Matching covariates are latitude, longitude, difference in weather and water price, and baseline values for acres operated, acres rented, acres in pasture, application rate, share of acres in groundwater, water supplier and EQIP participation.

Summary

- Difference-in-difference estimators (which assume that sample selection is not an issue) indicate that EQIP participation, on average, reduces water application rates but leads to higher water use due to an expansion in irrigated acreage.
- Matching estimators (which control for sample selection) indicate that the effects of EQIP are generally smaller in magnitude and not statistically significant, with possible exception of irrigated acreage.
- Future research needs:
  - Evaluate the bias-efficiency tradeoff between DND and matching estimators
  - Examine the net effect on irrigated acreage
  - Estimate regions separately
  - Look at productivity impacts of payments