

Local Economic Benefits of the Environmental Quality Incentives  
Program: Evidence from Rural Housing Markets

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# Motivation

- ▶ Environmental externalities of agricultural production
  - ▶ water pollution
  - ▶ air pollution
  - ▶ GHG emissions
  
- ▶ Provision of ecosystem services from agriculture
  - ▶ habitats for wildlife
  - ▶ carbon sequestration

# Motivation

- ▶ USDA voluntary conservation programs: Environmental Quality Incentives Program (EQIP)
- ▶ How effective are agricultural conservation programs in delivering environmental benefits?
- ▶ What are the economic benefits of agricultural conservation programs?

# The influence of the Environmental Quality Incentives Program on local water quality

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## Abstract

The Environmental Quality Incentives Program (EQIP) is the primary conservation program on working agricultural land. The United States Department of Agriculture obligated over \$15 billion through EQIP cost-sharing contracts during the fiscal years 2009–2019. The voluntary nature of the program and the lack of performance assessment have led to speculations regarding the effectiveness of the program in delivering environmental benefits, in particular for improving water quality. This study provides quantitative estimates of the influence of EQIP payments on local water quality at a national scale. We link monitoring station level water quality readings with EQIP contract data and exploit the direction of river flow for identification. The estimated effects of EQIP vary across water quality measures. Estimates indicate that EQIP payments have significantly reduced biochemical oxygen demand and nitrogen, indicating improvements in water quality, but increased total suspended solids, fecal coliform, and phosphorus, suggesting that the implementation of certain conservation practices might have increased soil erosion and pathogen transfer, especially in watersheds with more agricultural production.

## KEYWORDS

agricultural pollution, best management practices, environmental quality incentives program, water quality

## JEL CLASSIFICATION

D24, H41, Q15, Q18, Q53

## Resource Question

- ▶ Agricultural conservation projects could affect property values by altering neighborhood characteristics and amenities
- ▶ We use a hedonic approach to estimate residents' value of EQIP projects
  - ▶ improvement in environmental amenities, especially water quality, has been shown to positively impact housing prices
- ▶ We provide the first estimates of the impact of EQIP on housing prices on a national scale
- ▶ Broadly, we contribute to the assessment of the efficiency of agricultural conservation programs

# Priorities of EQIP

- ▶ Created by the 1996 Farm Act and administered by NRCS
- ▶ The primary conservation program in the U.S. aimed at working agricultural lands
- ▶ National priorities
  - ▶ Water quality
  - ▶ Water conservation
  - ▶ Air quality
  - ▶ Soil erosion and sedimentation
  - ▶ Energy conservation
  - ▶ At-risk species habitat conservation

# Importance of EQIP

- ▶ Financial and technical assistance to farmers and ranchers
  - ▶ NRCS obligated over \$10 billion during the 2005-2015
  - ▶ The most recent 2018 Farm Bill authorized \$1.85 billion funding for EQIP in FY2022 and \$2.025 billion in FY 2023
  - ▶ The Inflation Reduction Act (IRA) of 2022 appropriated \$8.45 billion additional funding for EQIP during 2023–2026

## How EQIP Works

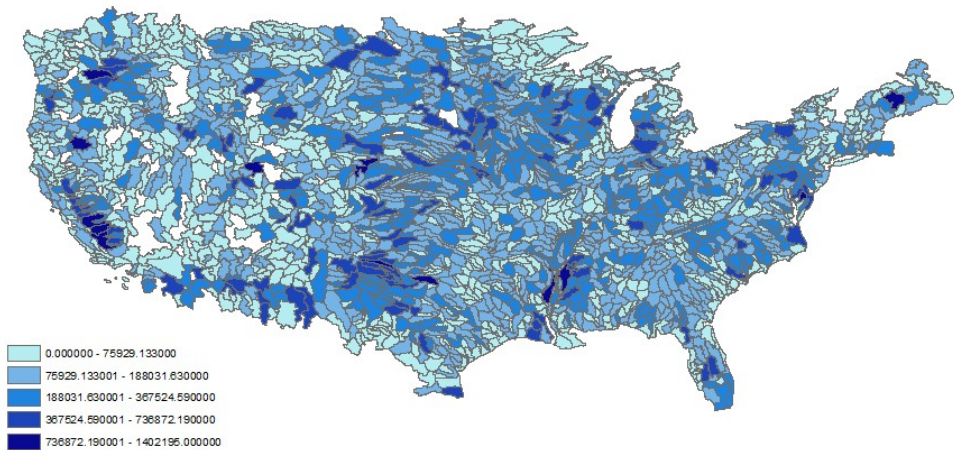
- ▶ Applications are accepted throughout the year with a specific deadline for each state
- ▶ Local NRCS conservation planners schedule an in-person consultation and then recommend conservation practices
- ▶ Landowner's chosen conservation practice will be evaluated at a national, state, or local funding pool
  - ▶ National Priorities, State Issues, and Local Issues
  - ▶ Cost-effectiveness
- ▶ U.S. Government Accountability Office (2017) found that the process for allocating EQIP funds to state offices is not based primarily on environmental concerns and some state offices do not use environmental concerns as the leading factor for allocating funds within their states



## EQIP Contract Data

- ▶ USDA NRCS: EQIP data at the individual contract level for all contracts completed and certified during 2005–2015
- ▶ Contracts are geocoded to subwatershed (HUC12)
  - ▶ the size of a HUC12 ranges from 10 to 40 acres
  - ▶ unique contract identifier, practice names and codes, practice units, year of payment, and payment amount
  - ▶ over 200 unique conservation practices were implemented
  - ▶ most contracts in the dataset last for one to three years
  - ▶ the exact geolocation of each contract was not provided
  - ▶ no farm or farmer specific information

# Average Annual EQIP Payments at HUC8



## EQIP Payments for Different Environmental Amenities

- ▶ NRCS evaluates the “physical effects” of conservation practices along six resource dimensions—soil, water, plant, animal, energy, and air (NRCS, 2021)
- ▶ Most practices have effects on more than one resource dimension
- ▶ We merge our EQIP dataset with the NRCS Conservation Practices Physical Effects database using conservation practice codes
- ▶ We classify EQIP practices into these six resource dimensions: the corresponding payments are payments for the dimension

# EQIP Payments for Different Environmental Amenities

- ▶ Practices that have the highest scores in each dimension include
  - ▶ soil: alley cropping (Conservation Practice Standard (CPS) 311) and tree-shrub establishment (CPS 612)
  - ▶ water: riparian forest buffer (CPS 391)
  - ▶ plant: forest stand improvement (CPS 666), prescribed burning (CPS 338), and tree-shrub site preparation (CPS 490)
  - ▶ animal: windbreak-shelterbelt establishment (CPS 380) and windbreak-shelterbelt renovation (CPS 650)
  - ▶ energy: combustion system improvement (CPS 372), energy efficient building (CPS 672), farmstead energy improvement (CPS 374), and livestock pipeline (CPS 516)
  - ▶ air: feed management (CPS 592), air filtration and scrubbing (CPS 371)

# Zillow Transaction and Assessment Database (ZTRAX)

- ▶ Zillow aggregates data from local town/county tax assessor offices and forms a national database
- ▶ The transaction dataset includes information from over 2,750 counties since the early 1900s
  - ▶ single family home
  - ▶ sales price is the outcome variable of this study
- ▶ We followed Nolte et al. (2021) on the guidelines to process the property dataset
- ▶ We use properties with repeat sales: property fixed effects

## Geospatial Analysis

- ▶ We match each parcel in the Zillow transaction dataset during 2005–2015 with EQIP projects located within a certain radius
  - ▶ measure distance from each parcel using its coordinates to the centroid of each HUC12
  - ▶ match parcels with EQIP projects located in HUC12s within the radius
  - ▶ sum across HUC12s within the radius to construct EQIP payments for each parcel in each year
- ▶ The geographic extent that agricultural conservation provides environmental amenities is not sharply defined: alternative radii based on the literature
- ▶ When using a 10 mile radius, our estimation sample includes properties from all 50 states and 1,238 counties

# Summary Statistics

	mean	sd	p5	p95
<i>5-mi radius</i>				
Transaction Price	178,623	1,865,005	18,908	436,407
Age of House	34	51	0	107
Payments for All EQIP Practices	6,361	25,053	0	30,560
Payments for Soil Practices	5,185	21,989	0	25,787
Payments for Water Practices	5,972	24,750	0	28,905
Payments for Plant Practices	4,828	20,627	0	23,650
Payments for Animal Practices	3,017	12,542	0	14,400
Payments for Energy Practices	2,399	12,509	0	10,190
Payments for Air Practices	2,746	12,434	0	12,741
Observations	228,119			
<i>10-mi radius</i>				
Transaction Price	183,762	1,864,412	19,010	453,794
Age of House	33	49	0	105
Payments for All EQIP Practices	14,850	44,412	0	70,384
Payments for Soil Practices	11,960	38,069	0	56,678
Payments for Water Practices	13,823	43,602	0	67,804
Payments for Plant Practices	11,502	36,629	0	54,414
Payments for Animal Practices	7,357	23,518	0	32,571
Payments for Energy Practices	5,774	23,836	0	25,934
Payments for Air Practices	6,681	22,664	0	30,848
Observations	1,330,032			

## Empirical Design

- ▶ The hedonic property value model has been widely used to estimate people's willingness to pay for environmental amenities (Rosen, 1974)
  - ▶ recent applications to valuation of land conservation (see, e.g., Lang, 2018; Richardson, Liu, and Eggleton, 2022).
  - ▶ from a program evaluation perspective, Keiser and Shapiro (2019) estimate residents' value of Clean Water Act grants
- ▶ A challenge in estimating the hedonic price function is that unobserved variables may be correlated with the amenity of interest
  - ▶ slope of land: correlated with property values and EQIP projects
- ▶ Repeat sales: property fixed effects to control for unobserved time-invariant property and neighborhood characteristics



# Empirical Model

$$(1) \quad \ln(P)_{iat} = \gamma \log(\text{Payment})_{it-1} + \beta X_{it} + \eta_i + \theta_{at} + \epsilon_{ist}$$

- ▶  $\ln(P)_{iat}$  is the log price of property  $i$  in location  $a$  time  $t$
- ▶ The  $\log(\text{Payment})_{it-1}$  is the log of EQIP payments in the previous year within a certain radius of property  $i$
- ▶  $X_{it}$  is a vector of time-varying controls: age and age squared of the house and neighborhood economic conditions
- ▶  $\eta_i$  property fixed effects
- ▶  $\theta_{at}$ : location-specific temporal fixed effects: state-specific or county-specific monthly shocks
- ▶ Standard errors are clustered at the county level for all regressions

# Results: All EQIP Practices

	(1)	(2)	(3)	(4)	(5)	(6)
		Previous Year			Previous Two Years	
<i>5-mi radius</i>						
log(EQIP Payments)	0.0033*** (0.0006)	0.0034*** (0.0006)	0.0032*** (0.0008)	0.0032*** (0.0008)	0.0033*** (0.0008)	0.0027** (0.0011)
Age of House	-0.3070*** (0.0195)	-0.3062*** (0.0191)	-0.3121*** (0.0217)	-0.3258*** (0.0224)	-0.3241*** (0.0223)	-0.3198*** (0.0250)
Age Squared	-0.0003** (0.0001)	-0.0003** (0.0001)	-0.0004*** (0.0001)	-0.0003** (0.0001)	-0.0003** (0.0001)	-0.0005*** (0.0001)
Adj. R-squared	0.567	0.575	0.590	0.565	0.574	0.585
Observations	228,119	228,119	228,119	168,380	168,380	168,380
<i>10-mi radius</i>						
Previous Year EQIP Payments	0.0025*** (0.0004)	0.0024*** (0.0004)	0.0018*** (0.0006)	0.0030*** (0.0007)	0.0029*** (0.0007)	0.0018** (0.0009)
Age of House	-0.2500*** (0.0133)	-0.2476*** (0.0130)	-0.2441*** (0.0136)	-0.2691*** (0.0151)	-0.2647*** (0.0148)	-0.2602*** (0.0153)
Age Squared	-0.0002*** (0.0001)	-0.0002*** (0.0001)	-0.0003*** (0.0001)	-0.0003*** (0.0001)	-0.0003*** (0.0001)	-0.0003*** (0.0001)
Adj. R-squared	0.576	0.584	0.593	0.577	0.587	0.597
Observations	1,330,032	1,330,032	1,330,032	947,063	947,063	947,063
Property FE	✓	✓	✓	✓	✓	✓
State-Year FE	✓	X	X	✓	X	X
Month FE	✓	X	X	✓	X	X
State-Year-Month FE	X	✓	X	X	✓	X
County-Year-Month FE	X	X	✓	X	X	✓

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

# Results: Across Resource Dimensions

	(1)	(2)	(3)	(4)
	Previous Year		Previous Two Years	
<i>5-mi radius</i>				
log(Payments for Soil Practices)	0.0035*** (0.0007)	0.0034*** (0.0009)	0.0033*** (0.0008)	0.0026** (0.0011)
log(Payments for Water Practices)	0.0036*** (0.0007)	0.0033*** (0.0008)	0.0033*** (0.0008)	0.0023** (0.0011)
log(Payments for Plant Practices)	0.0036*** (0.0007)	0.0035*** (0.0009)	0.0033*** (0.0008)	0.0024** (0.0012)
log(Payments for Animal Practices)	0.0038*** (0.0008)	0.0036*** (0.0009)	0.0037*** (0.0009)	0.0026** (0.0013)
log(Payments for Energy Practices)	0.0029*** (0.0007)	0.0040*** (0.0010)	0.0023*** (0.0009)	0.0021* (0.0012)
log(Payments for Air Practices)	0.0041*** (0.0008)	0.0038*** (0.0010)	0.0038*** (0.0010)	0.0025** (0.0012)
Adj. R-squared	0.575	0.590	0.574	0.585
Observations	227,505	227,505	167,842	167,842
Age of House	✓	✓	✓	✓
Age Squared	✓	✓	✓	✓
Property FE	✓	✓	✓	✓
State-Year-Month FE	✓	X	✓	X
County-Year-Month FE	X	✓	X	✓

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

# Results: Across Resource Dimensions

	(1)	(2)	(3)	(4)
	Previous Year		Previous Two Years	
<i>10-mi radius</i>				
log(Payments for Soil Practices)	0.0025*** (0.0004)	0.0019*** (0.0005)	0.0028*** (0.0006)	0.0019** (0.0009)
log(Payments for Water Practices)	0.0025*** (0.0004)	0.0019*** (0.0006)	0.0029*** (0.0006)	0.0019** (0.0009)
log(Payments for Plant Practices)	0.0025*** (0.0004)	0.0018*** (0.0006)	0.0026*** (0.0007)	0.0017* (0.0009)
log(Payments for Animal Practices)	0.0026*** (0.0005)	0.0020*** (0.0006)	0.0027*** (0.0007)	0.0011 (0.0010)
log(Payments for Energy Practices)	0.0022*** (0.0005)	0.0018** (0.0008)	0.0020*** (0.0007)	0.0011 (0.0011)
log(Payments for Air Practices)	0.0027*** (0.0005)	0.0020*** (0.0006)	0.0029*** (0.0006)	0.0011 (0.0010)
Adj. R-squared	0.584	0.593	0.587	0.597
Observations	1,329,429	1,329,429	946,522	946,522
Age of House	✓	✓	✓	✓
Age Squared	✓	✓	✓	✓
Property FE	✓	✓	✓	✓
State-Year-Month FE	✓	X	✓	X
County-Year-Month FE	X	✓	X	✓

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

## Preliminary Findings

- ▶ The choice of geographic scale in our analysis involves an internal-external validity trade-off
  - ▶ a smaller radius allows us to better control for time-varying omitted variables using temporal fixed effects
  - ▶ radii smaller than 5 miles lead to much smaller samples and less representative houses
- ▶ Across all specifications, previous year EQIP payments are estimated to have a positive and statistically significant impact on housing prices
  - ▶ at the sample mean, the estimate implies that a \$10,000 increase in EQIP payments within 5 miles would increase the average house price by \$899
- ▶ Residents nearer to agricultural conservation seem to benefit more

## Preliminary Findings

- ▶ EQIP payments made in the previous two years are also estimated to have a positive impact, and the estimates are slightly smaller
- ▶ Across all resource dimensions, previous year EQIP payments are estimated to have a positive and statistically significant impact on housing prices
- ▶ There is some evidence that soil, water, and plant practices have more persistent benefits

## Next Steps...

- ▶ We will obtain from the American Community Survey census tract level variables to control for time-varying socioeconomic conditions
- ▶ We will consider using physical measures of EQIP for robustness checks, such as the number of EQIP practices
- ▶ We plan to implement alternative identification strategies
  - ▶ an instrumental variable approach: use contract obligations to instrument payments
  - ▶ a matching estimator: housing attributes from the ZTRAX assessment dataset
- ▶ We will compare the estimated benefits from housing markets with EQIP costs to assess the efficiency of EQIP

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