Investigating Treatment Effects of Participating Jointly in SNAP and WIC when the Treatment is Validated Only for SNAP

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Outline

- Motivation and research objectives
- FoodAPS data and key variables
- SNAP verification in FoodAPS
- Overview of methodology
- Analytical results
- Empirical results
- Summary

Food Insecurity

Conceptually, **food insecurity** means limited access to food needed for active and healthy life

Gundersen et al. (2011) summarize evidence suggesting that food insecurity harms health and wellbeing

National surveys indicate substantial prevalence of food insecurity in low-income population

Coleman-Jensen et al. (2018): In 2017, among households with income below 130% of poverty (17.3M households), **34.5%** (**6.0M** households) experienced food insecurity

For reference, among all households (127.3M), 11.8% (15.0M) were food insecure (estimates are based on December CPS data)

Food Assistance Programs

USDA operates 15 food programs (Oliveira, 2017)

Five largest programs:

- **SNAP**: Supplemental Nutrition Assistance Program (*aka* **food stamps**)
- National School Lunch Program (NSLP)
- **WIC**: Special Supplemental Nutrition Program for Women, Infants & Children
- School Breakfast Program
- Child and Adult Care Food Program

SNAP:	\$68.1b spent (FY17) 42.2m participants/month	**WIC**:	\$5.7b spent 7.3m participants

We focus on **SNAP** and **WIC** due to data availability, particularly availability of partially **verified program participation** info based on administrative data

SNAP vs. WIC

Supplemental Nutrition Assistance Program (SNAP)

- Targets low-income persons
- Provides targeted benefits to households for food purchase
- Eligibility:
  - Income ≤ 130% poverty (before deductions)
  - Or, categorical eligibility (e.g., based on receipt of some TANF benefits)
  - Employment requirements

Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

- Target population is low-income, nutritionally at-risk pregnant, breastfeeding, other post-partum women, infants, children < 5 y.o.
- Provides "vouchers" for foods in WIC package
- Eligibility:
  - Income ≤ 185% poverty
  - Or, automatic income eligibility (e.g., participation in Medicaid, TANF)

Why Study Two Programs at Once?

Most papers focus on **only one** program. Literature on effects of participating in ≥2 programs is small (e.g., Keane and Moffitt, 1998; Schmidt et al., 2016)

Assistance recipients often participate in ≥2 programs. In our sample, **37%** of households report being both on SNAP and WIC

Studying joint program participation could be informative about:

- Programmatic synergies
- Programmatic redundancies
- Improvements in food safety net design

Methodological Challenge

Identifying **causal** effect is difficult even for a single program:

- **Nonrandom selection**: unobservables simultaneously affect food security and program participation
  - ➢ OLS, probit produce **inconsistent** estimates of causal effects
- **Nonclassical measurement error**: households systematically **underreport** benefits; misreporting varies with respect to household attributes
  - ➢ Standard IV methods produce **inconsistent** estimates too

Joint program participation adds complexity:

- Participation is modeled using a multinomial, partially-ordered variable
- Dimensionality of measurement error problem increases

Our approach:

- Use **partially administratively verified** program participation data to try to mitigate measurement error problem
- Extend 'joint programs' methodology of Jensen et al. (2016), which accounts for selection and measurement errors in a single framework, to **estimate bounds** on causal effects

Research Focus

To what extent does participation in **both SNAP and WIC** increase household food security compared with participation in **SNAP alone** or in **WIC alone**?

- **Econometric objective**: Derive sharp bounds on average treatment effects (**ATEs**) of joint program participation when participation is endogenous and can be misreported
  - Bounds must be logically consistent with observed data and any imposed statistical or behavioral assumptions
  - In surveys, SNAP and WIC receipt are severely underreported (Meyer et al., 2015; Bitler et al., 2003)
- **Additional objective**: Use available administrative data on SNAP receipt to tighten inference on ATEs

Note: no verification data are available for WIC

Qualitative Preview of Key Results

- Partial verification on its own does **not** help to identify ATE:
  - Worst-case ATE bounds under no assumptions are **completely uninformative** with or without validation of SNAP participation
  - To make progress, we combine partial verification with assumptions about misreporting and selection
- Restrictions on misreporting under partial verification produce informative bounds
  - However, without further restrictions on selection, we **cannot sign** ATE
- **Nondifferential (ND) errors** substantially tighten bounds
- When ND errors are combined with MTS and MIV, effect on food security of SNAP+WIC vs. SNAP alone is **strictly positive**

Data Source: **FoodAPS**

National Household **Food A**cquisition and **P**urchase **S**urvey (FoodAPS, restricted-access version hosted by NORC):

- Sample of **4,826** households who participated during one week between April 2012 and January 2013
- Data features of particular value for our research:
  - FoodAPS contains **administratively verified** info on SNAP participation
  - FoodAPS-GC provides **local food environment** data: we construct monotone instrumental variables (**MIVs**) related to household food environment
- FoodAPS also collects info on at-home and away-from-home food purchases, food security, demographics, health, diet, income, self-reported SNAP and WIC receipt

Verification of SNAP Receipt

FoodAPS asked households for consent to being matched to admin records

Two sources of admin data:

- State SNAP **caseload files** (contain participant & benefits data): Households are matched probabilistically using name, address, phone #
- SNAP **ALERT database** (contains EBT card transactions): Households who report using SNAP to buy food during survey week are probabilistically matched to ALERT; then, their EBT card balance histories are traced for benefits receipt

Courtemanche et al. (2018) and others point out limitations of admin data and several **data quality** issues

We rely on ERS's judgment and use variable ***SNAPNOWHH*** as indicator of true receipt. Same approach in Kang & Moffitt (2018)

Participation in SNAP and WIC

- Our sample (***N* = 460**) includes households with:
  - income ≤ 130% poverty, and
  - a pregnant woman, or a child < 5 y.o.

- Weighted sample distribution by reported participation when SNAP participation indicator does not **[does]** incorporate admin data:

		WIC	
		No	*Yes*
SNAP	*No*	15.3% **[13.0%]**	16.6% **[13.6%]**
	Yes	31.4% **[33.6%]**	36.7% **[39.7%]**

Food Security Across Participation Subsamples

Weighted prevalence of food security status by self-reported food program participation **[modified using admin SNAP data]**:

Proportion of food secure in subsample:

		WIC	
		No	*Yes*
SNAP	*No*	53.2% **[55.1%]**	54.5% **[50.5%]**
	Yes	52.2% **[51.6%]**	58.5% **[59.5%]**

Food security measure is based on USDA's 10-item, 30-day-referenced **adult food security scale**

Selected Sample Characteristics

Characteristic	Mean	Std.Dev.
Household:		
Number of members	4.48	1.76
Number of children	2.34	1.31
Monthly income, $	1,607	954
Income-to-poverty ratio	0.75	0.36
Weekly expenditures on food at home, $	112.9	126.0
Primary respondent:		
Age, years	33.7	10.8
Female	0.88	0.32
Black or African American	0.29	0.45
Other race (non-White)	0.16	0.37
Married	0.29	0.45
Employed	0.43	0.50

Motivation for Our Methodology

Compare with a simple parametric approach:

$$Y_i = \gamma \cdot S_i + x_i \cdot \beta + \varepsilon_i$$

Outcome (Y_i) | Treatment (S_i) | Covariates (x_i) | Error term (ε_i)

- Treatment S_i is **binary**. Say, $S_i = 1$ if i is on SNAP, 0 if not
- If same unobservables affect S_i and Y_i, then $cov(S_i, \varepsilon_i) \neq 0$ and OLS is inconsistent due to **endogeneity**
- Measurement error in S_i is **nonclassical** → standard IV estimation is inconsistent as well (e.g., Nguimkeu et al., 2017)
- Our **nonparametric bounding** methodology handles endogeneity, misreporting, and multiple treatments (not just binary S_i)

Notation

$\boldsymbol{S^*}$: **true** program participation status is **partially ordered**

participation intensity ↓

- $S^* = 0$: neither SNAP nor WIC
- $S^* = 1$: SNAP alone
- $S^* = 2$: WIC alone
- $S^* = 3$: both SNAP and WIC

($S^* = 1$ and $S^* = 2$: not mutually ordered)

$\boldsymbol{S}$: **reported** program participation; $\boldsymbol{S}$ need not equal $\boldsymbol{S^*}$

Manski's potential outcomes framework:

$\boldsymbol{Y(S^*)}$: potential outcome under treatment S^*

$Y = 1$ if household is food secure, $Y = 0$ if food insecure

$\boldsymbol{X}$: covariates, used to define subpopulations or as MIVs

Average Treatment Effect (ATE)

We focus on **average treatment effects** (**ATEs**):

$$ATE_{jk} = P[Y(S^* = j) = 1 \mid X] - P[Y(S^* = k) = 1 \mid X] \text{ for } j \neq k$$

For example, consider ATE_{31}:

$$ATE_{31} = P[Y(S^* = 3) = 1 \mid X] - P[Y(S^* = 1) = 1 \mid X]$$

ATE_{31} measures by how much prevalence of food security would change if household were to participate in both SNAP and WIC vs. in SNAP alone

No regression orthogonality conditions to satisfy

Covariates are **not** used as regressors

Decomposition Strategy

ATE cannot be point-identified without assumptions even if $S = S^*$

Lets decompose formulas into what **is** vs. **is not** identified

Simplify notation: $ATE_{31} = P[Y(3)=1] - P[Y(1)=1]$

Consider decomposition:

$$P[Y(3)=1] = \underbrace{P[Y(3)=1 \mid S^* = 3]}_{\text{identified}} \underbrace{P(S^* = 3)}_{\text{identified}} + \underbrace{P[Y(3)=1 \mid S^* \neq 3]}_{\text{not identified}} \underbrace{P(S^* \neq 3)}_{\text{identified}}$$

Data cannot identify $P[Y(3)=1 \mid S^* \neq 3]$ because it refers to unobserved **counterfactual**. We only know that $P[Y(3)=1 \mid S^* \neq 3] \in [0,1]$

We derive worst-case bounds for ATE_{31} by extending Manski (1995) to account for potentially mismeasured treatments

Addressing Misreporting (I)

When S may deviate from S^*, define: $\theta_i^{j,k} \equiv P(Y = i, S = j, S^* = k)$

$P[Y(3)=1]$ becomes:

$$P[Y(3)=1] = P(Y=1, S=3) + \theta_1^{-3,3} - \theta_1^{3,-3}$$
$$+P[Y(3)=1 \mid S^* \neq 3]\left\{P(S \neq 3) + \sum_{j \neq 3}(\theta_1^{-j,j} + \theta_0^{-j,j} - \theta_1^{j,-j} - \theta_0^{j,-j})\right\}$$

ATE_{31} is bounded as:

$$-1 + P(Y=1, S=3) + P(Y=0, S=1) + \Theta_{3,1}^{LB}$$
$$\leq ATE_{31} \leq$$
$$1 - P(Y=0, S=3) - P(Y=1, S=1) + \Theta_{3,1}^{UB}$$

unobserved

$$\Theta_{3,1}^{LB} \equiv \theta_1^{-3,3} - \theta_1^{3,-3} + \theta_0^{-1,1} - \theta_0^{1,-1}, \quad \Theta_{3,1}^{UB} \equiv -\theta_0^{-3,3} + \theta_0^{3,-3} - \theta_1^{-1,1} + \theta_1^{1,-1}$$

Addressing Misreporting (II)

In our FoodAPS sample:

$$P(Y=1,S=3)=0.238,\ P(Y=0,S=1)=0.159$$
$$P(Y=0,S=3)=0.165,\ P(Y=1,S=1)=0.172$$

$$\Rightarrow \quad -0.603+\Theta_{3,1}^{LB} \quad \le ATE_{31} \quad \le 0.663+\Theta_{3,1}^{UB}$$

Manski's (1995) classic worst-case ATE bounds: [-0.603,0.663]

Error rates are logically bounded: e.g., $\theta_1^{-1,1} \le P(Y=1,S\ne 1)=0.378$

However, so far the Manski bounds **expand to [–1, 1]**. E.g., for UB:
$\theta_0^{3,-3}$ could be as large as $P(Y=0,S=3)=0.165,$ while
$\theta_1^{1,-1}$ could be as large as $P(Y=1,S=1)=0.172$

$$\Rightarrow \quad UB=0.663+\Theta_{3,1}^{UB}=1$$

Partial Verification (I)

Validation of SNAP participation status places informative restrictions on $\Theta_{3,1}^{LB}$ and $\Theta_{3,1}^{UB}$

Cannot help determine exact value of S^*

But identifies whether $S^* \in \{1,3\}$ or $S^* \in \{0,2\}$

Then 16 out of 24 error components vanish. E.g., for LB:

$$\Theta_{3,1}^{LB} \equiv (\theta_1^{0,3} + \theta_1^{1,3} + \theta_1^{2,3}) - (\theta_1^{3,0} + \theta_1^{3,1} + \theta_1^{3,2}) + (\theta_0^{0,1} + \theta_0^{2,1} + \theta_0^{3,1}) - (\theta_0^{1,0} + \theta_0^{1,2} + \theta_0^{1,3})$$

reduces to $\Theta_{3,1}^{LB} = \theta_1^{1,3} - \theta_1^{3,1} + \theta_0^{3,1} - \theta_0^{1,3}$ because:

$$\theta_1^{0,3} = \theta_1^{2,3} = \theta_1^{3,0} = \theta_1^{3,2} = \theta_0^{0,1} = \theta_0^{2,1} = \theta_0^{1,0} = \theta_0^{1,2} = 0$$

Partial Verification (II), No False+

Then $$-1 + P(Y=1, S=3) + P(Y=0, S=1) + \Theta_{3,1}^{LB}$$

$$\leq ATE_{31} \leq$$

$$1 - P(Y=0, S=3) - P(Y=1, S=1) + \Theta_{3,1}^{UB}$$

becomes

$$-1 + P(Y=1, S=3) + P(Y=0, S=1) + \theta_1^{1,3} - \theta_1^{3,1} + \theta_0^{3,1} - \theta_0^{1,3}$$

$$\leq ATE_{31} \leq$$

$$1 - P(Y=0, S=3) - P(Y=1, S=1) + \theta_1^{1,3} - \theta_1^{3,1} + \theta_0^{3,1} - \theta_0^{1,3}$$

Under **no false positives**, we can set $\theta_1^{3,1} = \theta_0^{3,1} = 0$, and bounds **shrink** to [-0.762, 0.835]

Assumptions about Selection Process

To **restrict selection process**, we can employ:

- **Exogenous selection** assumption (it **rarely** holds)
- Monotone treatment selection (**MTS**) (Manski & Pepper, 2000)
- Monotone treatment response (**MTR**) (Manski, 1995)
- Monotone instrumental variables (**MIVs**) (Manski & Pepper, 2000)
- Instrumental variables (**IVs**): e.g., IVs for SNAP (Ratcliffe et al., 2011)

We extend these assumptions to the case of partially-ordered treatments

Endogenous Selection

Proposition: *Given no false+ and verification of SNAP status but not WIC status, the impact on food security associated with participating in both programs compared with SNAP alone is bounded sharply as follows:*

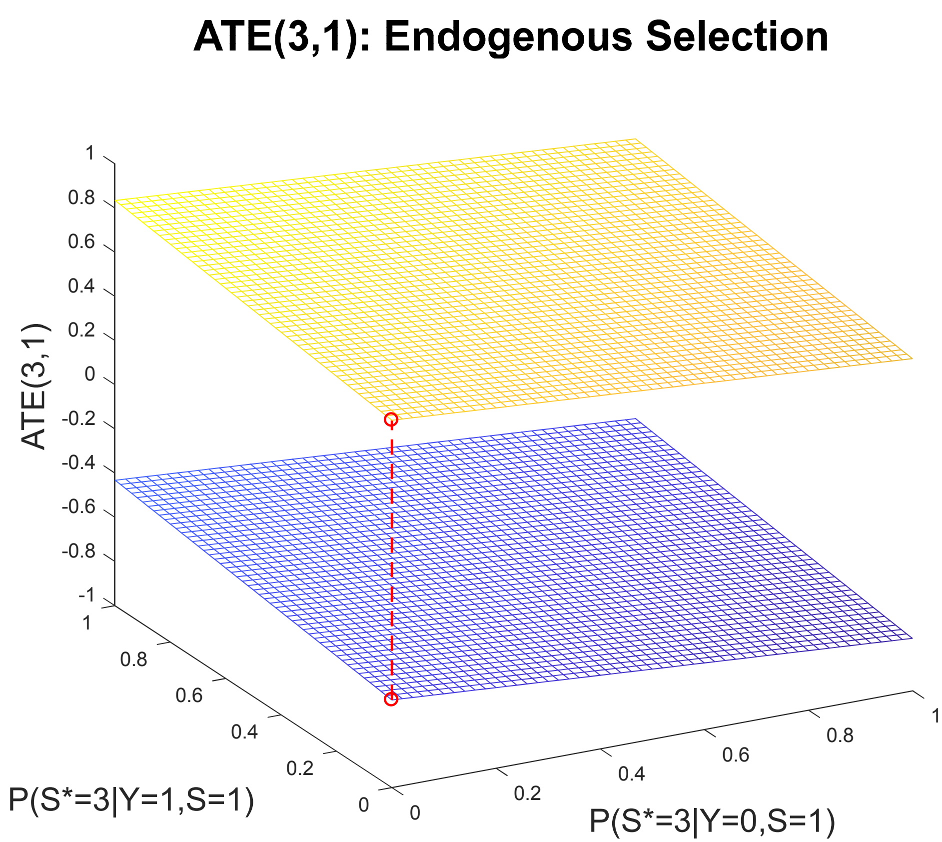
$$-1 + P(Y = 1, S = 3) \leq ATE_{31} \leq 1 - P(Y = 0, S = 3)$$

- Very wide bounds: width $2 - P(Y = 0, S = 3) - P(Y = 1, S = 3)$
  - ATE ∈ [-0.762,0.835] with width 1.60
  - For reference: $P(Y = 1, S = 3) = 0.238$

    $P(Y = 0, S = 3) = 0.165$

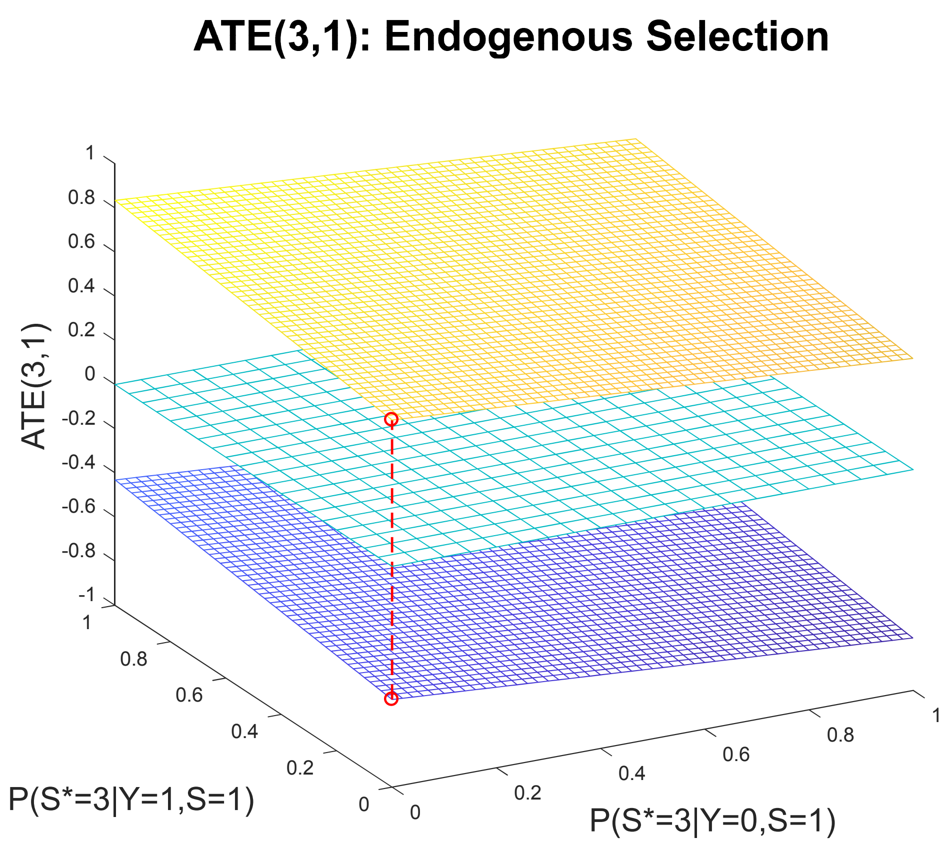
Endogenous Selection: Illustration (I)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Endogenous Selection: Illustration (II)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Nondifferential (ND) Errors

Proposition: *Under additional* ***nondifferential errors*** *assumption that participation errors arise independently of food security status:*

$$P(S^* = j \mid Y = 0, S = k) = P(S^* = j \mid Y = 1, S = k)$$

bounds narrow as follows:

$$-1 + P(Y = 1, S = 3) + \min\left\{P(Y = 0, S = 1), P(Y = 1, S = 1)\right\}$$

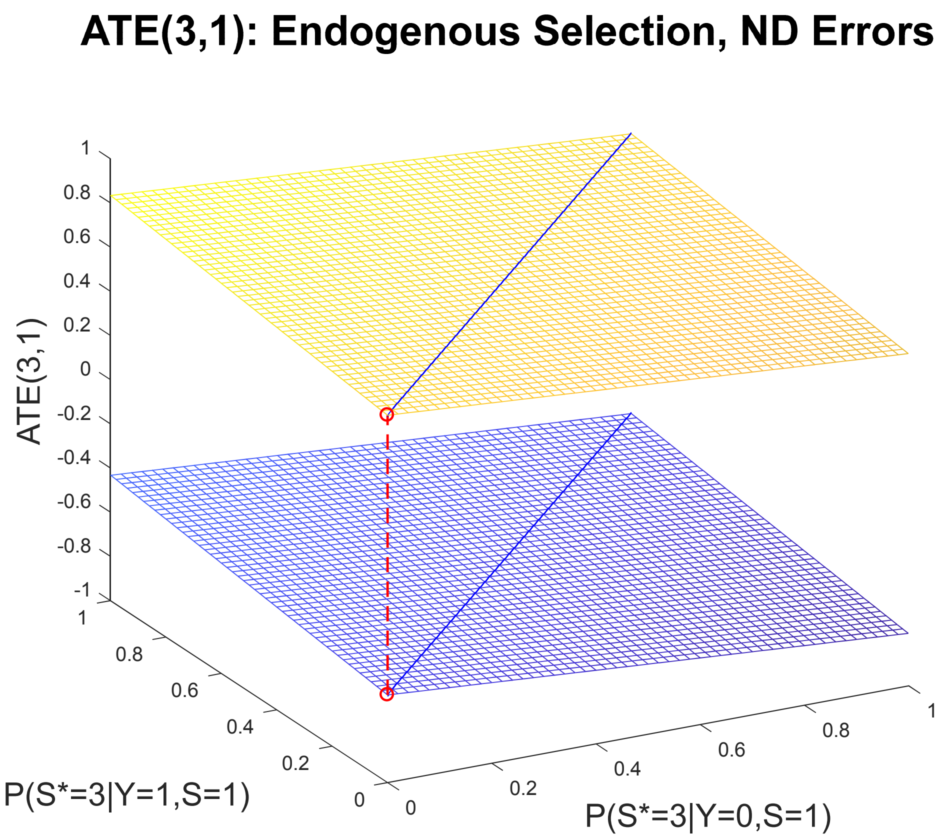
$$\leq ATE_{31} \leq$$

$$1 - P(Y = 0, S = 3) - \min\left\{P(Y = 0, S = 1), P(Y = 1, S = 1)\right\}$$

Bounds narrow from [-0.762,0.835] to [-0.603,0.676]

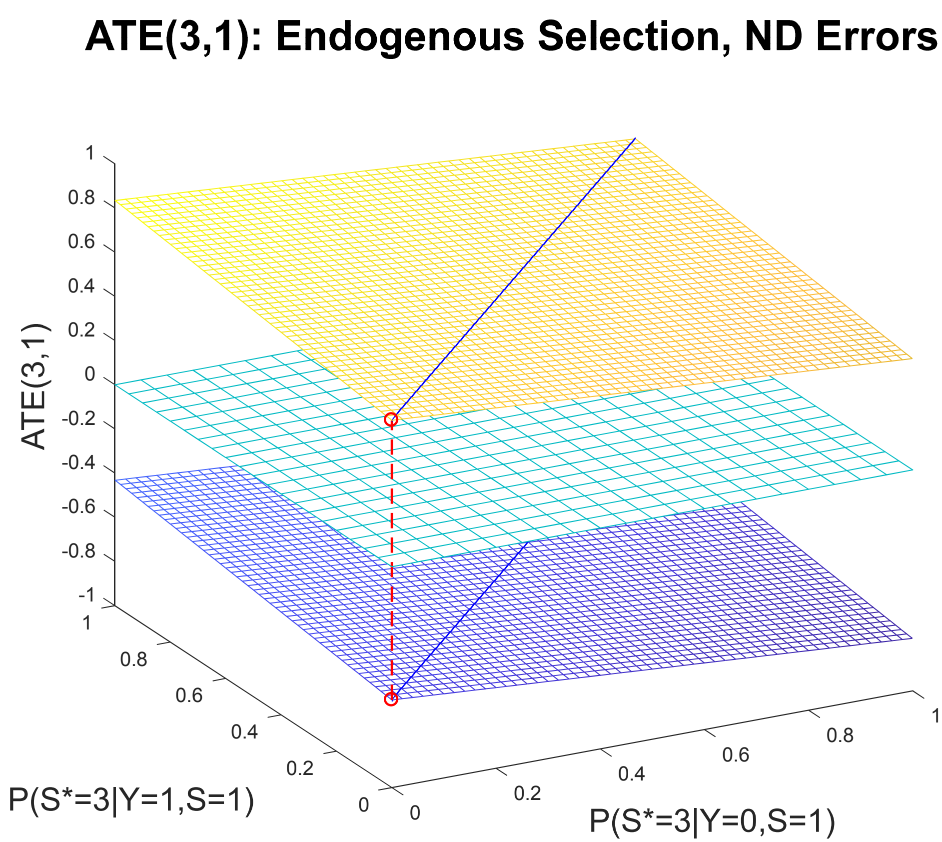
Endogenous Selection, ND Errors (I)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Endogenous Selection, ND Errors (II)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Exogenous Selection: Definition

Exogenous selection:

$$P[Y(j)=1]=P[Y(j)=1\,|\,S^{*}=k]\quad \forall j,k$$

Assumption means that expected potential outcomes do not depend on realized treatment

Assumption makes sense when assignment to programs is truly **random**

Exogenous Selection: Bounds

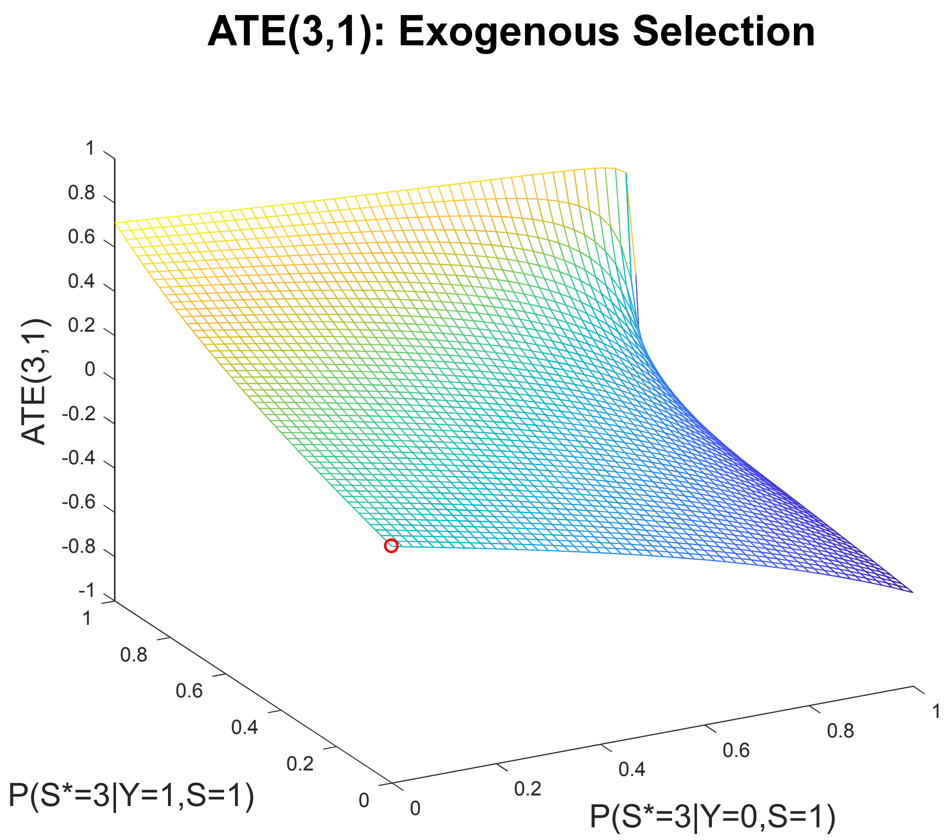
Proposition: *Under exogenous selection (e.g., random assignment) given by* $P[Y(j)=1]=P[Y(j)=1 \mid S^*=k] \;\; \forall j,k,$ *no false+ worst-case bounds narrow as follows:*

$$-\frac{P(Y=0,S=3)+P(Y=0,S=1)}{P(S=3)+P(Y=0,S=1)} \leq ATE_{31} \leq \frac{P(Y=1,S=3)+P(Y=1,S=1)}{P(S=3)+P(Y=1,S=1)}$$

- Bounds narrow from [-0.762,0.835] to [-0.576,0.713]
- Bounds remain very wide despite uncertainty about counterfactuals being eliminated

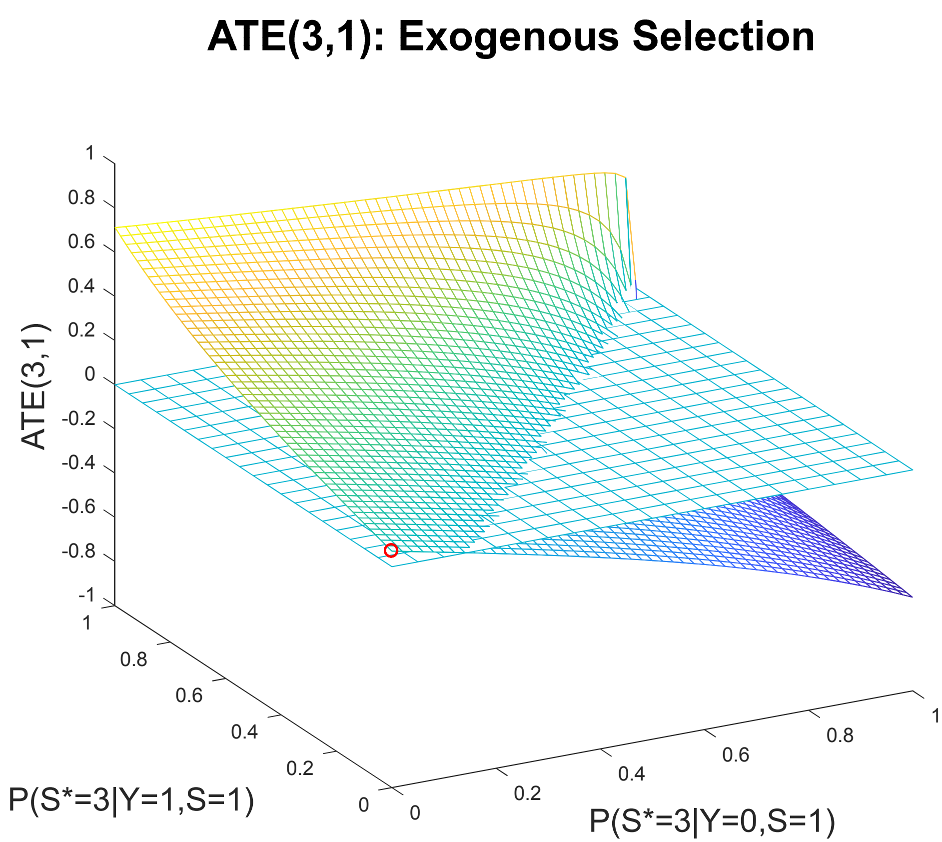
Bounds on ATE under Exog. Sel. (I)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Bounds on ATE under Exog. Sel. (II)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Exogenous Selection with ND Errors

Proposition: *Under exogenous selection combined with ND errors, bounds become:*

$$\min\left\{P(Y=1\mid S=3),\frac{P(Y=1,S=3)+P(Y=1,S=1)}{P(S=3)+P(S=1)}\right\}-P(Y=1\mid S=1)$$

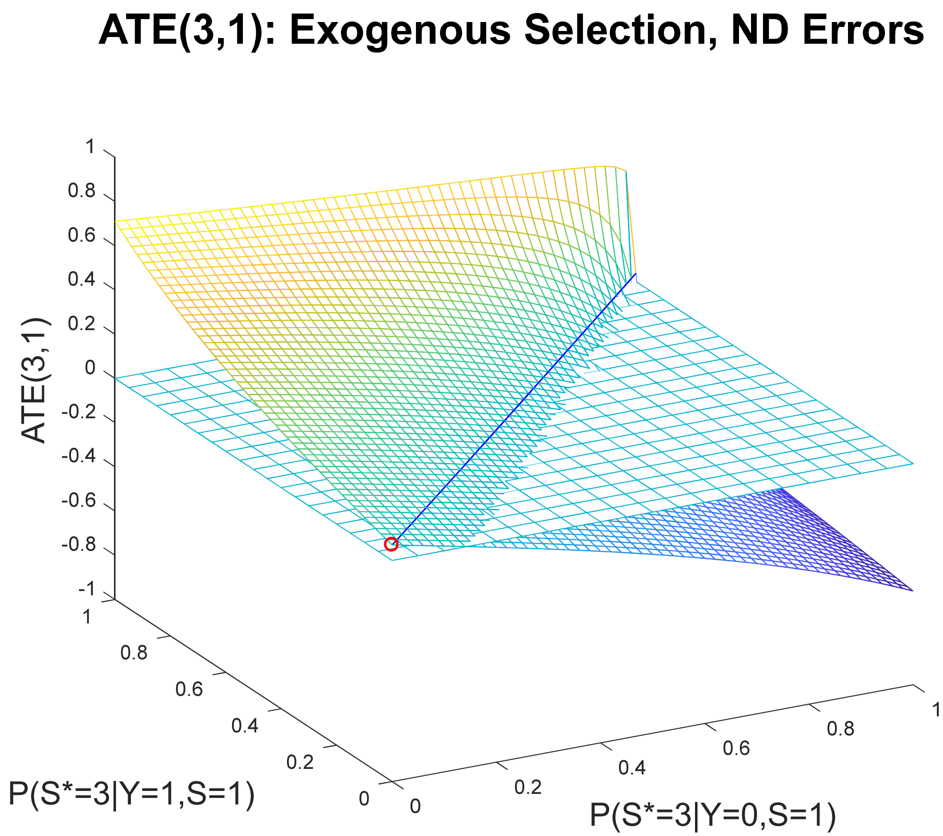
$$\leq ATE_{31} \leq$$

$$\max\left\{P(Y=1\mid S=3),\frac{P(Y=1,S=3)+P(Y=1,S=1)}{P(S=3)+P(S=1)}\right\}-P(Y=1\mid S=1)$$

ATE belongs to narrow range $[0.038, 0.070]$

Bounds on ATE under Exogenous Selection and ND Errors

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



MTS: Definition

Monotone treatment selection (**MTS**):

$$P[Y(j)=1 \mid S^{*}=3] \le P[Y(j)=1 \mid S^{*}=k] \le P[Y(j)=1 \mid S^{*}=0] \quad \forall\ j;\ k=1,2$$

Under MTS, decision to participate is monotonically related to food insecurity: households choose to participate in more programs in anticipation of worse food security outcome

Bounds under MTS

Proposition: *Under MTS, lower bound becomes:*

$$-1+\frac{P(Y=1,S=3)}{P(S=3)+P(Y=0,S=1)} \leq ATE_{31}$$

- Compare with worst case: $-1+P(Y=1,S=3) \leq ATE_{31}$

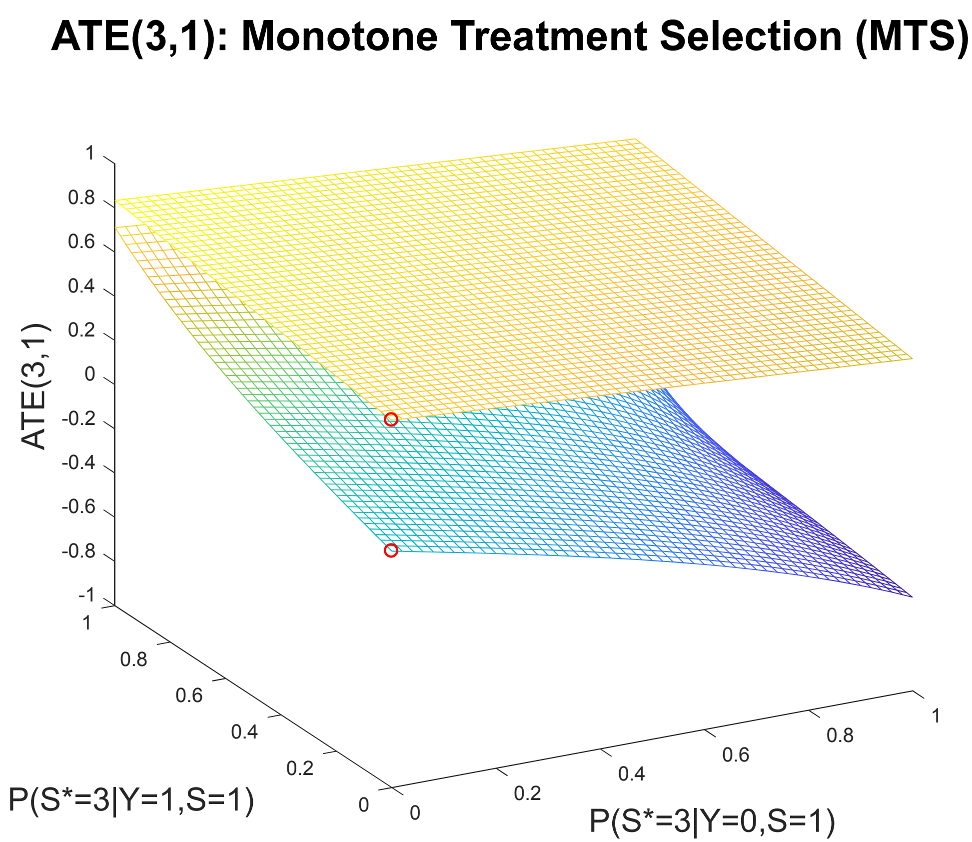
Upper bound is unchanged (compared with worst case):

$$ATE_{31} \leq 1-P(Y=0,S=3)$$

- Bounds narrow from [-0.762,0.835] to [-0.576,0.835]

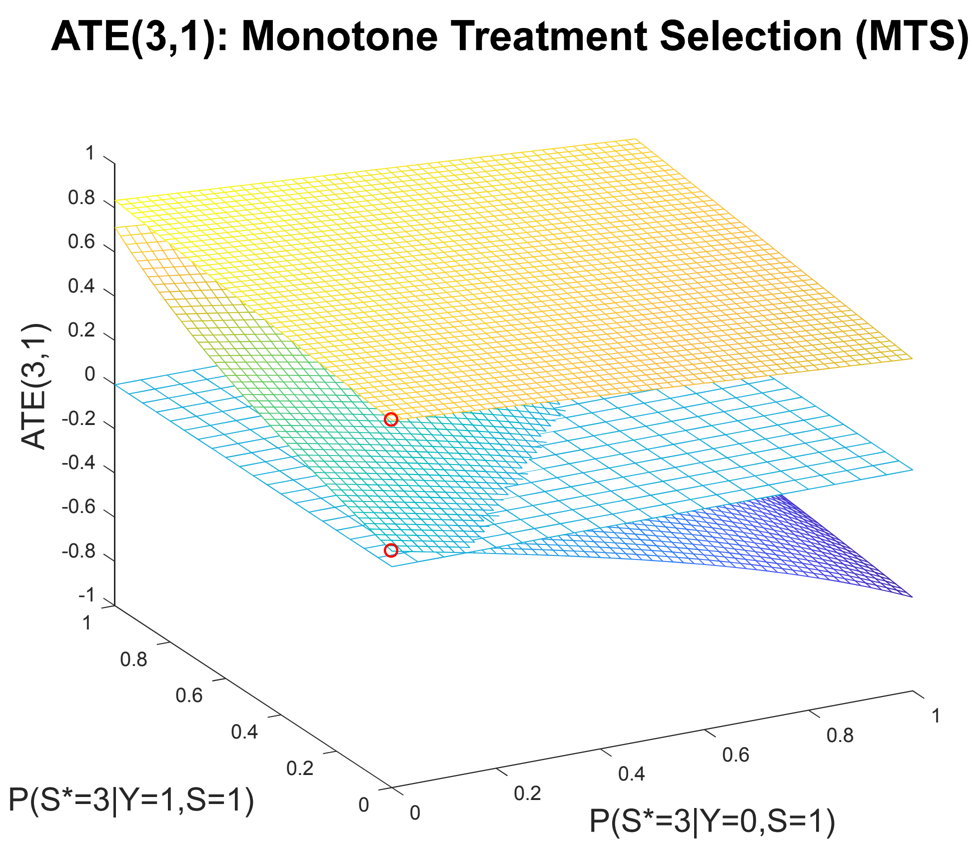
Bounds on ATE under MTS (I)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Bounds on ATE under MTS (II)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



MTS and ND Errors

Proposition: *Under MTS with ND errors, bounds become:*

$$-1+\max\left\{P(Y=1\mid S=3),\frac{P(Y=1,S=3)+P(Y=1,S=1)}{P(Y=3)+P(Y=1)}\right\}$$

$$+P(Y=0\mid S=1)\left[P(S=3)+P(S=1)\right]$$

$$\leq ATE_{31}\leq$$

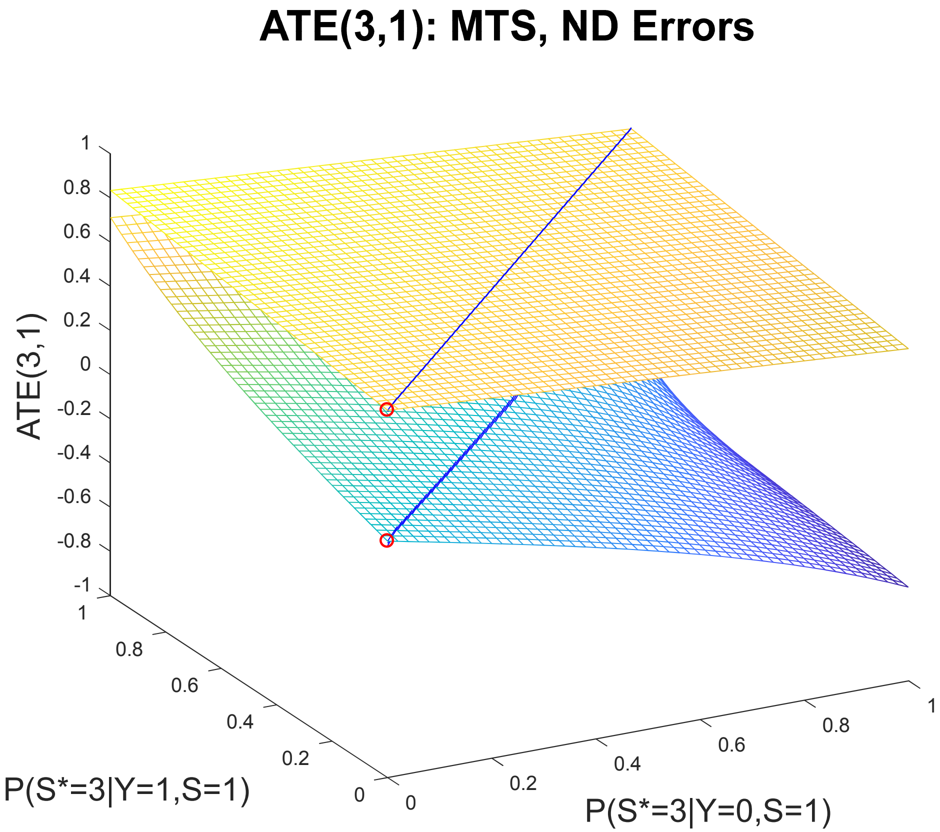
$$1-P(Y=0,S=3)-\min\left\{P(Y=0,S=1),P(Y=1,S=1)\right\}$$

Compared to case of MTS without ND errors, bounds improve from [-0.576,0.835] to [-0.058,0.676]

Dramatic improvement compared to our worst-case bounds and Manski's (no errors) worst-case bounds

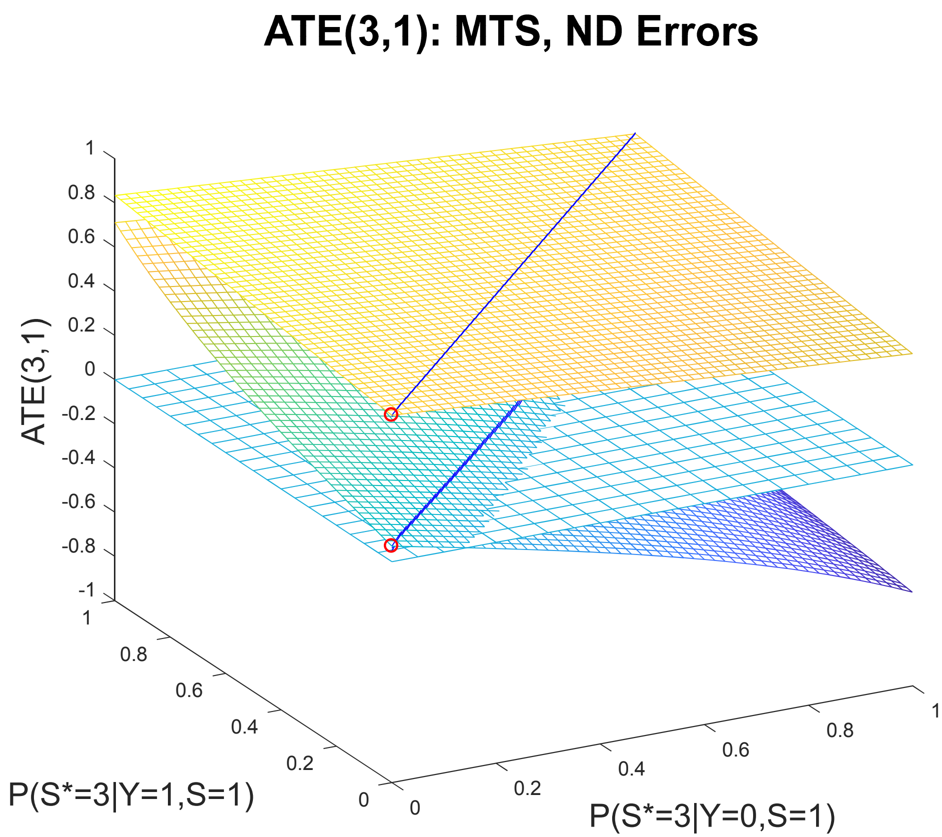
Bounds on ATE under MTS, ND Errors (I)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Bounds on ATE under MTS, ND Errors (II)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



Monotone Instrumental Variable (MIV)

Monotone instrumental variable (**MIV**) *v* :

$$u_1 \le u \le u_2 \Rightarrow P[Y(j)=1 \mid v=u_1] \le P[Y(j)=1 \mid v=u] \le P[Y(j)=1 \mid v=u_2]$$

We construct and use as MIVs:

(1) v = income-to-poverty ratio

(2) $v = \dfrac{\text{actual food-at-home expenditure}}{\text{TFP-based food expenditure}}$

Assumption: higher value of v would not harm food security on average

Bounds Using Income-to-Poverty MIV

Differential Errors			Nondifferential Errors		
	MTS + MIV LB UB			MTS + MIV LB UB	
p.e. CI	[-0.549, 0.657] [-0.694, 0.752]		p.e. CI	**[0.025, 0.657]** [-0.143, 0.752]	
	MTR + MIV LB UB			MTR + MIV LB UB	
p.e. CI	[0.000, 0.657] [-0.118, 0.752]		p.e. CI	[0.000, 0.657] [-0.118, 0.752]	
	MTS + MTR + MIV LB UB			MTS + MTR + MIV LB UB	
p.e. CI	[0.000, 0.657] [-0.118, 0.752]		p.e. CI	**[0.031, 0.657]** [-0.135, 0.752]	

Bounds Using Expenditure-to-TFP MIV

Differential Errors			Nondifferential Errors		
	MTS + MIV LB UB			MTS + MIV LB UB	
p.e. CI	[-0.485, 0.634] [-0.685, 0.768]		p.e. CI	**[0.239, 0.634]** **[0.006, 0.752]**	
	MTR + MIV LB UB			MTR + MIV LB UB	
p.e. CI	[0.000, 0.634] [-0.164, 0.768]		p.e. CI	[0.000, 0.634] [-0.164, 0.752]	
	MTS + MTR + MIV LB UB			MTS + MTR + MIV LB UB	
p.e. CI	[0.000, 0.634] [-0.183, 0.768]		p.e. CI	**[0.242, 0.634]** **[0.019, 0.768]**	

Summary

Objective: Study extent to which joint participation in SNAP and WIC improves food security vs. participation in SNAP alone

Methods: We extend nonparametric set-identification methods to handle a multinomial, partially-ordered treatment

- We accommodate underreported program participation
- We draw on a unique aspect of FoodAPS that partially validates food program participation status

Main finding: We can isolate ATE to be strictly positive using MIV created from FoodAPS-GC combined with assumptions about classification error patterns and selection into programs

Thank you!
Questions?

Appendix

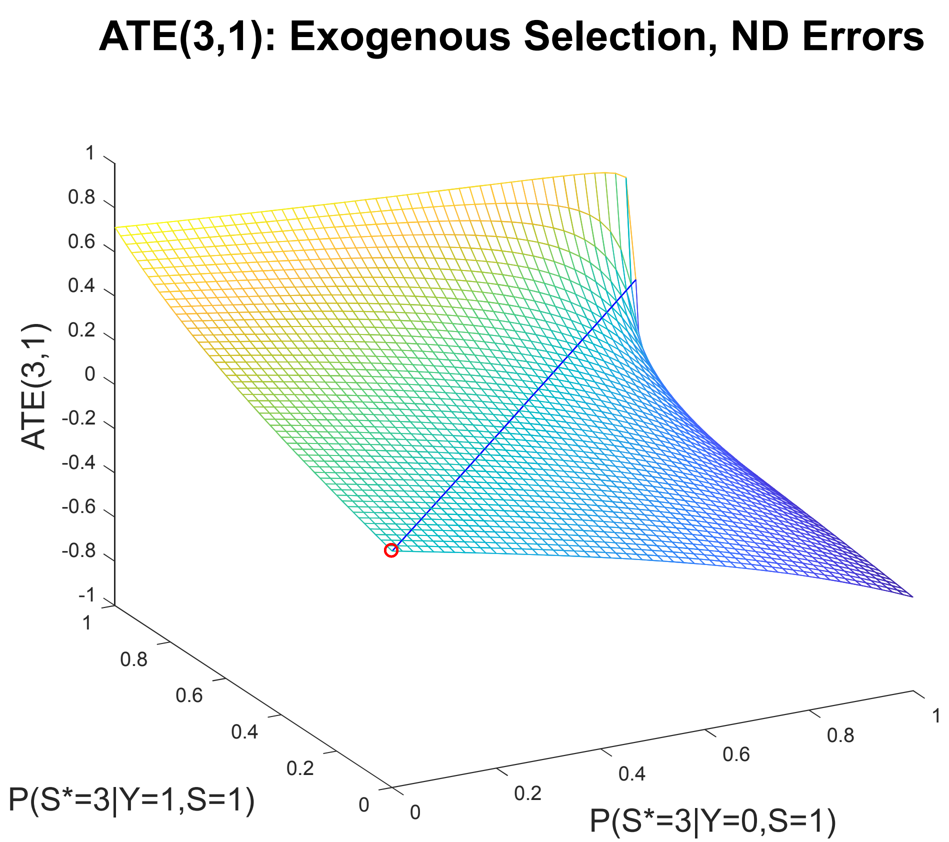
SNAP Verification Status

Verification Status	Sample Fraction (Weighted)
Matched households:	
Confirmed participation	57.6%
Confirmed nonparticipation	2.6%
Unmatched households:	
Not matched to administrative data	37.5%
Withheld consent to be matched	2.3%

Note: no consensus in FoodAPS studies regarding how to treat “not matched” cases

Bounds on ATE under Exogenous Selection, ND Errors (no zero plane)

Bounds on ATE of participating in SNAP+WIC vs. SNAP alone:



MTR: Definition

Monotone treatment response (**MTR**):

$$P[Y(3)=1 \mid S^*] \geq P[Y(1)=1 \mid S^*] \geq P[Y(0)=1 \mid S^*]$$

$$P[Y(3)=1 \mid S^*] \geq P[Y(2)=1 \mid S^*] \geq P[Y(0)=1 \mid S^*]$$

Under MTR assumption, potential participation in (more) food programs would not harm food security on average

IV: Definition

Instrumental variable (**IV**):

$$\forall u_1, u_2 :$$
$$P[Y(j)=1 \mid v=u_1] = P[Y(j)=1 \mid v=u_2]$$

IV is a special case of MIV

We employ **SNAP Policy Database** to construct conventional IVs used in previous literature to instrument for SNAP participation. Many such IVs are binary

We create a scalar IV with many values by combining seven conventional IVs

Selected Abbreviations

ALERT: Anti-Fraud Locator EBT Retailer Transactions (database)

ATE: average treatment effect

EBT: electronic benefit transfer (card)

ERS: Economic Research Service of USDA

FoodAPS: National Household Food Acquisition and Purchase Survey

FoodAPS-GC: Geography component of FoodAPS

FSM: food security module

MIV: monotone instrumental variable

MTR: monotone treatment response

MTS: monotone treatment selection

NORC: National Opinion Research Center (University of Chicago)

SNAP: Supplemental Nutrition Assistance Program

TFP: Thrifty Food Plan

WIC: Special Supplemental Nutrition Program for Women, Infants, and Children