Causal Effects of Mental Health on Food Security: A Partial Identification Analysis

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Motivation

Mental health conditions affect many individuals:

- 21% of U.S. adults suffer from mental illness

Studies find **correlation** between mental health and food security:

- Depressive symptoms and food insecurity
- Mother's mental health problems and food insecurity

No known research on **causal** effect of mental health on food security that **simultaneously** accounts for:

- **Misreporting** of true mental health status
- **Endogeneity** of mental health

Preview of Main Findings

We focus on **nonspecific psychological distress** (**NPD**) in adults who are 18-64 years old and below 130% of poverty line

Self-reported rate of moderate to severe NPD is **23.5%** (in 2011–2014)

NPD is **underreported**: we develop an approach to approximate the **true** rate of moderate to severe NPD and find it to be **30%**

Only **68%** of families of these adults are food secure

Under mild assumptions, alleviating NPD would increase food security rate by at least **14 p.p.**, i.e., by at least **24%**

Main Data Source

National Health Interview Survey (**NHIS**):

- Principal source of information on health of U.S. civilian population
- Cross-sectional, nationally representative, 80% response rate
- Annual sample of 35,000 households containing 87,500 individuals

Core components of NHIS questionnaire:

- Household: basic demographics, geocodes (restricted access)
- **Family**: demographics, **food security**, program participation, health status, injuries, healthcare utilization, health insurance
- **Sample adult** (one randomly selected adult per family): **psychological distress**, selected **mental health problems**, other aspects of health status, health care services, health behaviors
- Sample child (one randomly selected child per family): health status, health care services, health behaviors

NHIS also provides imputed income and covers additional topics

Analytical Sample

We pool linked sample adult–family records, NHIS 2011–14:

- Sample adult is aged **18–64** years (working age)
- Every family member is a U.S. citizen
- Family income ≤ **130% of poverty line** (gross income cutoff for SNAP)
- ***N* = 21,520**
- *Note 1:* NHIS started administering food security survey module in 2011
- *Note 2:* In 98% of cases, "household" is identical to "family"

Selected characteristics:

Variable	Mean (weighted)
Adult's **age** (years)	37.1
Adult is **male** (indicator)	0.436
Income-to-poverty ratio (%)	68.9
SNAP participation (indicator)	0.485

Food Security Indicators

NHIS includes a **10-item** food security survey module:

- Referenced to **last 30 days**
- Includes family- and adult-specific questions (no child questions)

We create two indicators of family **food security status**:

1) **Food secure**: 1 if raw score ≤ 2 (i.e., "high" or "marginal" food security)
2) **Not very low food secure**: 1 if raw score ≤ 5 (i.e., absence of "very low" food security)

Descriptive statistics:

Indicator	% (weighted)
Food secure family	67.7
Not very low food secure family	83.1

Indicators of Psychological Distress

NHIS administers six questions underlying **Kessler (K-6) nonspecific psychological distress (NPD) scale**:

- How frequently in past 30 days one felt sad, nervous, restless, hopeless, that everything was an effort, worthless (5-point Likert scale for answers)
- K-6 is a standardized and validated measure of NPD (CDC, 2013)

We follow McMorrow et al. (2016) and create two NPD indicators:

1) Adult is in **moderate to severe distress**: 1 if K-6 scale ≥ 8
2) Adult is in **severe distress**: 1 if K-6 scale ≥ 13 (max is 24)

Descriptive statistics:

Indicator	% (weighted)
Moderate to severe NPD	23.5
Severe NPD	10.0

Additional mental health measures are in the appendix

Methodological Challenge

Identifying **causal effect** of NPD is difficult:

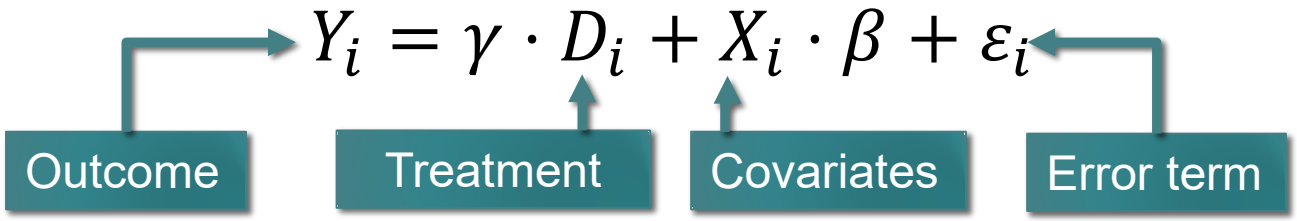
- **Endogeneity**: same unobservables simultaneously affect food security and NPD
  - Simple regression methods produce **inconsistent** estimates of causal effects
- **Measurement error**: stigma leads to misreporting of mental health problems, survey instruments have flaws, etc.
  - Treatment variables (i.e., NPD indicators) are binary → error is **non-classical**
  - Standard IV methods produce **inconsistent** estimates

While psychological distress and food security are **negatively correlated**, quantifying the **causal effect** of NPD on food security presents a significant methodological challenge

We adopt the **partial identification methodology** of Kreider et al. (2012) to bound the causal effect in the presence of indicated endogeneity and measurement error problems

Motivation for Our Methodology

Simple parametric approach:



Treatment D_i is **binary**: $D_i = 1$ if adult i is in distress, 0 if not

If same unobservables affect D_i and Y_i, then $cov(D_i, \varepsilon_i) \neq 0$ and OLS is inconsistent due to **endogeneity**

Measurement error in D_i is **non-classical** → standard IV estimation is inconsistent as well

The **partial identification** (**nonparametric bounding**) methodology handles endogeneity and misreporting in a unified framework and produces **a range of values** to which the causal effect belongs

Basics of Our Approach

Define: D^* = 1 if adult is truly in distress, = 0 otherwise; D is self-reported measure of D^*

We quantify **average treatment effect** (**ATE**) of psychological distress on food security:

$$ATE(1,0 \mid S,X) = P[Y(D^* = 1) = 1 \mid S,X] - P[Y(D^* = 0) = 1 \mid S,X]$$

Y = 1: family is food secure, Y = 0: insecure

$Y(D^* = 1)$ indicates **potential** food security outcome if adult were to be in distress. $Y(D^* = 0)$ denotes potential outcome if adult were not to be in distress

S, X specify subpopulation of interest (e.g., specific SNAP status and income level)

Not a regression framework: covariates are not regressors, no regression error term here, no orthogonality conditions to satisfy

Decomposition Strategy

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

We decompose every formula into what is identified and what is not

Simplify notation: $ATE = P[Y(1)=1] - P[Y(0)=1]$

Consider a decomposition under no misreporting of distress:

$$P[Y(1)=1\ ] = P[Y(1)=1 \mid D^*=1]P(D^*=1) + P[Y(1)=1 \mid D^*=0]P(D^*=0).$$

identified **identified** **not identified** **identified**

Data cannot identify $P[Y(1)=1 \mid D^*=0]$ because it refers to unobserved **counterfactual**. We only know it must lie within the interval [0,1]

However, using methods of Manski (1995), we can still find worst-case bounds for $P[Y(1)=1]$, $P[Y(0)=1]$, and ATE

Addressing Misreporting

$$P[Y(1)=1] = P(Y=1, D^*=1) + P[Y(1)=1 \mid D^*=0]P(D^*=0)$$

$$= P(Y=1, D=1) + \theta_1^- - \theta_1^+ + P[Y(1)=1 \mid D^*=0]P(D^*=0)$$

where $\theta_1^- \equiv P(Y=1, D=0, Z^*=0)$ $\quad \in [0,1]$

$\theta_1^+ \equiv P(Y=1, D=1, Z^*=0)$

$Z^* = 0$ indicates that self-reported NPD status is incorrect

→ Sharp **bounds** on ATE:

$$P(Y=1, D=1) - P(Y=1, D=0) - P^* + 2(\theta_1^- - \theta_1^+)$$

$$\leq ATE \leq$$

$$P(Y=1, D=1) - P(Y=1, D=0) + (1-P^*) + 2(\theta_1^- - \theta_1^+)$$

Note: $P^* \equiv P(D^*=1)$

Tightening Bounds

Without assumptions, ATE bounds are **wide** and **contain zero**

To tighten them, we can:

- Use logical constraints on probabilities and auxiliary data to restrict θ's
- Apply "**no false positives**" assumption $\rightarrow \theta_1^+ = \theta_0^+ = 0$
- Impose (mild) restrictions on potential food security outcomes:
  - Monotone treatment selection (**MTS**)
  - Monotone instrumental variable (**MIV**)
  - Monotone treatment response (**MTR**)

More on these monotonicity assumptions in the appendix

Approximating P^* (True Rate of NPD)

True prevalence rate of NPD, P^*, plays an important role in bounding *ATE* (an appendix figure provides an illustration)

If NPD is misreported, $P^* \neq P = 0.235$. Unfortunately, there are no estimates of P^* available in the literature

We develop **an approximation approach**:

$$P^* \approx \frac{\tilde{P}^*}{\tilde{P}} \cdot P = \frac{0.268}{0.207} \cdot 0.235 = 0.304.$$

$\tilde{P}^*$ and $\tilde{P}$ are true and self-reported rates of a related mental health measure, namely, an indicator of **any mental illness**

$\tilde{P}^*$ comes from SAMHSA's official tables

$\tilde{P}$ is calculated by us using NHIS 2012 data

ATE Bounds Under Few Assumptions

		Self-reported prevalence rate: $P^* = P = 0.235$			True prevalence rate: $P^* = 0.304$		
Endogenous selection		LB	UB	width	LB	UB	width
(a) Arbitrary errors	p.e.†	[-0.912,	0.558]	1.469	[-0.981,	0.627]	1.608
	CI‡	[-0.919	0.567]		[-0.989	0.636]	
(b) No false positives	p.e.	[-0.710,	0.290]	1.000	[-0.779,	0.359]	1.138
	CI	[-0.716	0.296]		[-0.786	0.365]	

† Point estimates of the population bounds.

‡ Imbens-Manski 95% confidence intervals around the true ATE.

- These bounds are **too wide** to determine the sign of ATE

ATE Bounds Under MTS+MIV+MTR

		Self-reported prevalence rate: $P^* = P = 0.235$			True prevalence rate: $P^* = 0.304$		
MTS + Food Density MIV + MTR:		LB	UB	width	LB	UB	width
(a) Arbitrary errors	p.e.	**[-0.852,**	**-0.142]**	0.710	**[-0.861,**	**-0.142]**	0.719
	CI	[-0.894	-0.054]		[-0.965	-0.054]	
(b) No false positives	p.e.	[**-0.224,**	**-0.142**]	0.083	[**-0.422,**	**-0.142**]	0.280
	CI	[-0.340	-0.054]		[-0.448	-0.054]	

Strictly negative average treatment effects in **bold.**

- Alleviating NPD would increase food security rate by at least 14 p.p.

Thank you!

Appendix

Indicators of Mental Health Problems

NHIS asks sample adults about degree of **difficulty** with 12 daily activities (e.g., walking) and what health problem caused this

NHIS also asks whether adults are **limited** in performing 7 activities (e.g., personal care) and what health problem caused this

We create indicators for existence of:

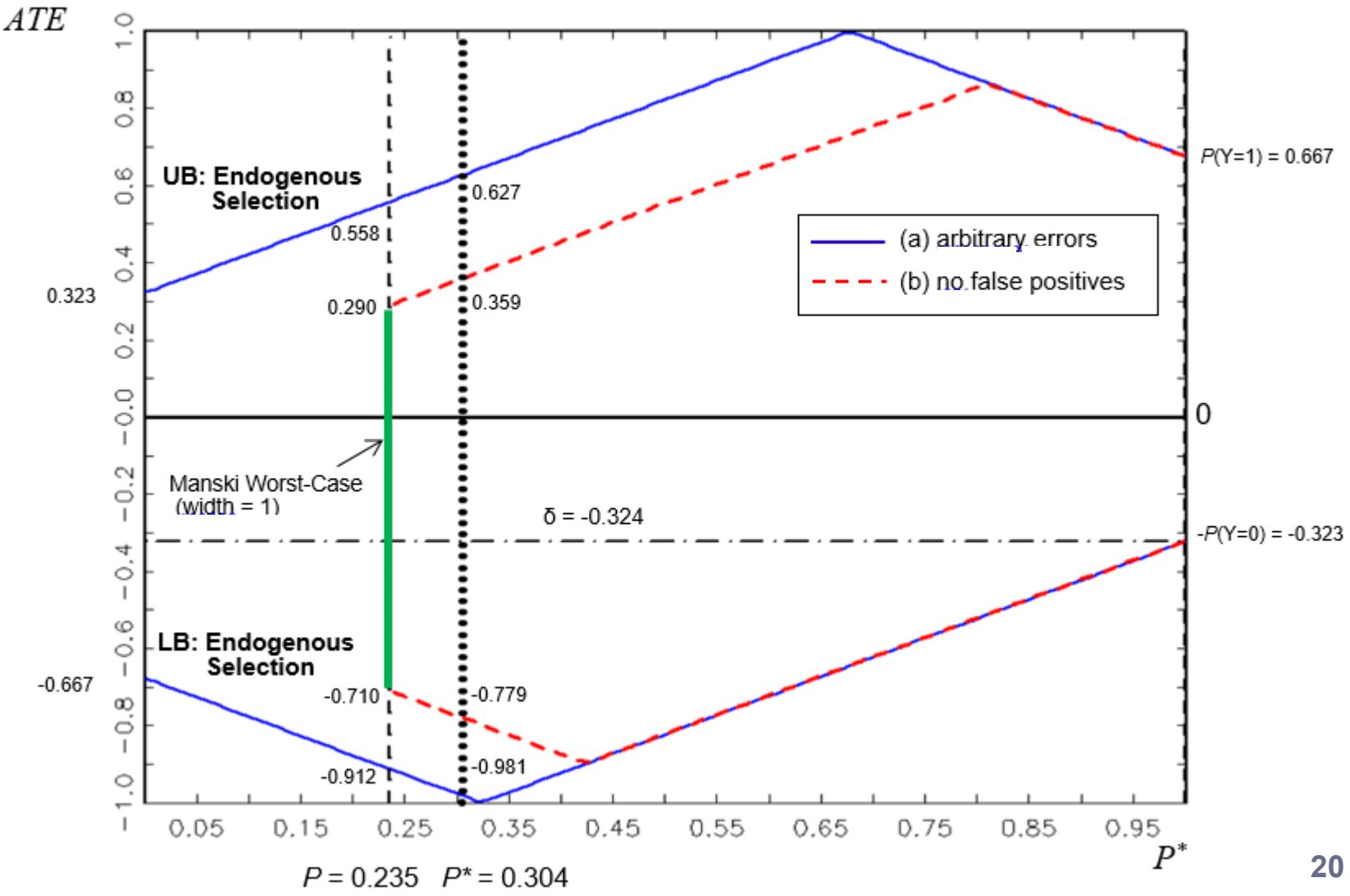
1) **Mental health problem causing difficulty** with activities
2) **Mental health problem causing limitation** in activities

'Problem' includes depression, anxiety, ADD, bipolar, schizophrenia, etc.

Selected descriptive statistics:

Indicator	% (weighted)
Adult has mental health problem causing **difficulty**	6.9
Adult has mental health problem causing **limitation**	8.3

Bounds Under Endogeneity of NPD



Monotonicity Assumptions

Monotone treatment selection (**MTS**):

$$P[Y(j)=1 \mid D^{*}=1] \leq P[Y(j)=1 \mid D^{*}=0],\ j=1,0.$$

Monotone instrumental variable (**MIV**):

Let *v* be food store density. Higher *v* would not harm food security:

$$u_1 \leq u \leq u_2 \Rightarrow$$

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

Monotone treatment response (**MTR**):

Psychological distress would not improve food security on average:

$$P[Y(1)=1 \mid D^{*}] \leq P[Y(0)=1 \mid D^{*}].$$