Household Financial, Time, and Environmental Constraints and Low Food Security among Children

PI: Helen H. Jensen (Iowa State University)
Co-PI: Oleksandr Zhylyevskyy (Iowa State University)

UKCPR Progress Report Conference

Champaign, IL
May 17, 2013
Research Objectives

Main goal: to better understand circumstances of families experiencing low and very low food security among children:

1. How do food prices affect children’s food insecurity?

2. What is the importance of local food environment for children’s food insecurity?

3. Which demographic and socioeconomic characteristics exacerbate or alleviate children’s food insecurity?

4. How do household circumstances affect time in food preparation?
Overview of Research

Conceptualize children’s food security as a “commodity” produced by households with children.

Develop an economic model of food insecurity and time in food preparation, based on household production framework (Becker, 1965; Pollak and Wachter, 1975).

Assemble a large dataset of households with children, by matching data across several national surveys.

Jointly estimate equations for children’s food insecurity and time in food preparation; test hypotheses about effects of local food environment.
Dependent Variables

**Food security status** is determined via responses by adult proxy to 8 child-specific questions in 18-item Household Food Security Survey Module in FSS:

- **Four** ordered categories of children’s food security
- Referenced to last 12 months

**Time in food preparation** includes time in seven activities (ATUS lexicon), measured in minutes on the reference day:

1. Food and drink preparation
2. Food presentation
3. Kitchen and food clean-up
4. Food and drink preparation, presentation, and clean-up, n.e.c.
5. Grocery shopping
6. Travel related to food and drink preparation, clean-up, and presentation
7. Travel related to grocery shopping
Economic Model: Notation

- \( m \geq 1 \) different commodities: \( Z = (z_1, \ldots, z_m)' \)

- \( z_1 \): children’s food security; \( \tilde{z}_1 = -z_1 \): children’s food insecurity

- \( l \geq 1 \) different market goods: \( Y = (y_1, \ldots, y_l)' \)

- \( k \geq 1 \) different time use activities: \( T = (t_1, \ldots, t_k)' \)

- \( t_1 \): time in food preparation (including time in food acquisition and related travel)

- Demographic and socioeconomic characteristics \( H \): household composition, income, etc.

- Location-specific attributes \( L \): local food prices, food establishment densities, etc.
Economic Model: Setup

Decision-maker in household $i$ maximizes utility:

$$\max_{Z_i, Y_i, T_i} U(Z_i; H_i)$$

Subject to:

Production technology constraint: $F(Z_i, Y_i, T_i; H_i, L_i) = 0$

Time endowment constraint: $Q(T_i; H_i) = 0$

Budget constraint: $B(Y_i, T_i; H_i, L_i) = 0$

Non-negativity constraints: $Z_i, Y_i, T_i \geq 0$

Equations for children’s food insecurity and time in food preparation come from the problem solution:

$$\tilde{z}_{1,i} = \tilde{z}_1(H_i, L_i)$$
$$t_{1,i} = t_1(H_i, L_i)$$
Data

• Households with children, pooled across multiple years:
  • Food Security Supplement (FSS) of CPS, 2002–2010
  • American Time Use Survey (ATUS), 2003–2011
  • Matched analytical sample: N = 13,209 households/respondents

• Food prices and other location-specific data:
  • Quarterly Food-at-Home Price Database (QFAHPD, source: ERS)
  • ACCRA database (source: Council for Community and Economic Research, C2ER)
  • County Business Patterns data (CBP, source: Census Bureau)
  • Small Area Income and Poverty Estimates (SAIPE) program database, American FactFinder database (source: Census Bureau)
Data Processing

**CPS–FSS raw data files, 2002–2010**

Data processing:
- Drop incomplete CPS/missing FSS cases
- Drop cases without children
- Drop cases in first 4 months in CPS
- Drop 8th-month CPS rotation in FSS 2007

**FSS sample, 2002–2010**

N = 68,381 (households)
- 5,600-8,600 observations/year

**ATUS raw data files, 2003–2011**

Data processing of linked records:
- Drop cases without ATUS interview
- Drop designated low quality data
- Retain ATUS cases of householder/spouse

**ATUS–FSS analytical sample, 2002–2011**

N = 13,209 (merged households/respondents)
- 1,000–2,200 observations/year

**Merged final analytical dataset, 2002–2011: N = 13,209**

Food Prices and Other Location-Specific Data: **QFAHPD, ACCRA, CBP, SAIPE**
## Selected Descriptive Statistics

### Distribution of households by children’s food security status:

<table>
<thead>
<tr>
<th>Food Security Category</th>
<th>Count</th>
<th>Weighted Fraction, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) High/marginal food security</td>
<td>11,391</td>
<td>86.19</td>
</tr>
<tr>
<td>(2) Marginal food security</td>
<td>881</td>
<td>6.68</td>
</tr>
<tr>
<td>(3) Low food security</td>
<td>871</td>
<td>6.55</td>
</tr>
<tr>
<td>(4) Very low food security</td>
<td>66</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>13,209</td>
<td>100.00</td>
</tr>
</tbody>
</table>

### Time in food preparation (minutes per day):

<table>
<thead>
<tr>
<th></th>
<th>Fraction of Cases with Time = 0</th>
<th>Among Cases with Time &gt; 0 (minutes/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>All respondents</td>
<td>34.14%</td>
<td>79.20</td>
</tr>
<tr>
<td>Men</td>
<td>53.16%</td>
<td>56.20</td>
</tr>
<tr>
<td>Women</td>
<td>18.27%</td>
<td>90.20</td>
</tr>
</tbody>
</table>
Local Food Price Indices

**Food-at-home price index:**
- Based on food price data in **QFAHPD** ($ per 100g of food)
- Expenditure-weighted average of 50+ food group prices (real $)
- Location- and time-specific: by market area and year-quarter

**Fast food price index:**
- Based on individual food item prices in **ACCRA** database
- Same as fast food price index of Chou et al. (2004), Powell (2009): average of prices of three fast food items (real $)
- Location- and time-specific: by metropolitan area and year-quarter
- Merged with ATUS–FSS records by CBSA and state FIPS codes
Food Establishment Densities

Main source: County Business Patterns (CBP) database

Businesses are classified using 6-digit NAICS code

We create densities—number of establishments per 10,000 local residents—for 5 groups of establishments:

- **Supermarkets** and other general line grocery stores
- **Convenience stores**
- **Specialty food stores**
  - Meat markets; fish and seafood markets; fruit and vegetable markets; baked goods stores; confectionery and nut stores; all other specialty food stores; retail bakeries
- **Full-service restaurants**
- **Limited-service eating places**
Empirical Model

Data on food insecurity are **ordered categorical** ⇒ adopt **ordered probit approach**. Latent variable:

$$\tilde{z}_{1,i}^* = X_i^Z' \cdot \beta + \epsilon_i$$

Observed food insecurity:

$$\tilde{z}_{1,i} = k \text{ if and only if } \mu_k < \tilde{z}_{1,i}^* \leq \mu_{k+1}$$

Data on time in food preparation contain **many zeros** ⇒ adopt **Tobit approach**. Latent variable:

$$t_{1,i}^* = X_i^t' \cdot \gamma + \eta_i$$

Observed time in food preparation:

$$t_{1,i} = 0 \text{ if } t_{1,i}^* \leq 0; \quad t_{1,i} = t_{1,i}^* \text{ if } t_{1,i}^* > 0$$

*Note*: $X_i^Z$ and $X_i^t$ are explanatory variables based on $H_i$ and $L_i$
Estimation Approach

Error terms might be correlated; we specify:

\[(\varepsilon_i) | X_i \sim N \left( \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \cdot \sigma \\ \rho \cdot \sigma & \sigma^2 \end{pmatrix} \right) \]

Food insecurity and time in food preparation equations are estimated jointly, by using maximum likelihood method:

\[
\hat{\theta}_{MLE} = \arg \max_\theta \sum_{i=1}^n \ln L_i(\theta)
\]

\(\theta\): parameter vector, \(L_i(\theta)\): likelihood contribution (see Appendix)

After estimation, we compute average marginal effects (AME):

\[
AME(\tilde{z}_1 = k) = \frac{1}{n} \sum_{i=1}^n \frac{\partial}{\partial X_i} \Pr[\tilde{z}_{1,i} = k | X_i; \hat{\theta}_{MLE}]
\]

\[
AME(t_1) = \frac{1}{n} \sum_{i=1}^n \frac{\partial}{\partial X_i} \mathbb{E}[t_{1,i} | X_i; \hat{\theta}_{MLE}]
\]
## Food Insecurity: Average Marginal Effects

<table>
<thead>
<tr>
<th>Selected Explanatory Variables</th>
<th>(3) Low</th>
<th>(4) Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single female-headed household</td>
<td>0.0257*** (0.0037)</td>
<td>0.0034*** (0.0006)</td>
</tr>
<tr>
<td>Single male-headed household</td>
<td>0.0145** (0.0068)</td>
<td>0.0019** (0.0009)</td>
</tr>
<tr>
<td>Children, age 0–4</td>
<td>0.0075*** (0.0023)</td>
<td>0.0010*** (0.0003)</td>
</tr>
<tr>
<td>Children, age 5–12</td>
<td>0.0136*** (0.0017)</td>
<td>0.0018*** (0.0003)</td>
</tr>
<tr>
<td>Children, age 13–17</td>
<td>0.0137*** (0.0025)</td>
<td>0.0018*** (0.0004)</td>
</tr>
<tr>
<td>African American householder</td>
<td>0.0168*** (0.0045)</td>
<td>0.0022*** (0.0006)</td>
</tr>
<tr>
<td>Householder of race other than White/AA</td>
<td>0.0106* (0.0063)</td>
<td>0.0014* (0.0009)</td>
</tr>
<tr>
<td>Hispanic householder/spouse</td>
<td>0.0156*** (0.0048)</td>
<td>0.0021*** (0.0007)</td>
</tr>
<tr>
<td>Education: bachelor’s degree</td>
<td>-0.0328*** (0.0060)</td>
<td>-0.0044*** (0.0009)</td>
</tr>
<tr>
<td>Education: graduate degree</td>
<td>-0.0346*** (0.0072)</td>
<td>-0.0046*** (0.0011)</td>
</tr>
<tr>
<td>Real family income ($, thousands)</td>
<td>-0.0029*** (0.0002)</td>
<td>-0.0004*** (0.0000)</td>
</tr>
<tr>
<td>Income &lt; 185% of poverty level</td>
<td>0.0215*** (0.0049)</td>
<td>0.0029*** (0.0007)</td>
</tr>
<tr>
<td>Food-at-home price index</td>
<td>-0.0897 (0.1379)</td>
<td>-0.0120 (0.0185)</td>
</tr>
<tr>
<td>Fast food price index</td>
<td>0.0187* (0.0111)</td>
<td>0.0025* (0.0015)</td>
</tr>
<tr>
<td>Density of supermarkets</td>
<td>-0.0014 (0.0030)</td>
<td>-0.0002 (0.0004)</td>
</tr>
<tr>
<td>Density of convenience stores</td>
<td>-0.0036* (0.0018)</td>
<td>-0.0005* (0.0003)</td>
</tr>
<tr>
<td>Density of specialty food stores</td>
<td>-0.0082 (0.0058)</td>
<td>-0.0011 (0.0008)</td>
</tr>
<tr>
<td>Density of full-service restaurants</td>
<td>0.0004 (0.0012)</td>
<td>0.0001 (0.0002)</td>
</tr>
<tr>
<td>Density of limited-service eating places</td>
<td>-0.0017 (0.0015)</td>
<td>-0.0002 (0.0002)</td>
</tr>
<tr>
<td>Fraction of households</td>
<td>0.0655</td>
<td>0.0058</td>
</tr>
</tbody>
</table>
## Food Prep. Time: Average Marginal Effects

<table>
<thead>
<tr>
<th>Selected Explanatory Variables</th>
<th>Estimate (min/day)</th>
<th>(Std. Err.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male in married couple</td>
<td>-48.2636***</td>
<td>(1.1327)</td>
</tr>
<tr>
<td>Single female householder</td>
<td>-11.5056***</td>
<td>(1.5865)</td>
</tr>
<tr>
<td>Single male householder</td>
<td>-33.6961***</td>
<td>(2.7926)</td>
</tr>
<tr>
<td>Children, age 0–4 years</td>
<td>6.3372***</td>
<td>(0.8741)</td>
</tr>
<tr>
<td>Children, age 5–12 years</td>
<td>4.4556***</td>
<td>(0.6325)</td>
</tr>
<tr>
<td>Children, age 13–17 years</td>
<td>4.4419***</td>
<td>(0.9128)</td>
</tr>
<tr>
<td>Householder of race other than White/AA</td>
<td>5.6672**</td>
<td>(2.2966)</td>
</tr>
<tr>
<td>Age of householder/spouse (years)</td>
<td>0.4760***</td>
<td>(0.0628)</td>
</tr>
<tr>
<td>Hispanic householder/spouse</td>
<td>4.3683**</td>
<td>(1.8213)</td>
</tr>
<tr>
<td>Education: high school degree</td>
<td>-8.2383***</td>
<td>(2.3627)</td>
</tr>
<tr>
<td>Education: some college</td>
<td>-9.3032***</td>
<td>(2.3572)</td>
</tr>
<tr>
<td>Education: bachelor’s degree</td>
<td>-7.9674***</td>
<td>(2.5011)</td>
</tr>
<tr>
<td>Foreign-born householder/spouse</td>
<td>7.8008***</td>
<td>(1.6779)</td>
</tr>
<tr>
<td>Real family income ($, thousands)</td>
<td>-0.0884**</td>
<td>(0.0425)</td>
</tr>
<tr>
<td>Income &lt; 185% of poverty level</td>
<td>3.0927*</td>
<td>(1.7039)</td>
</tr>
<tr>
<td>Metropolitan area</td>
<td>2.8026*</td>
<td>(1.5474)</td>
</tr>
<tr>
<td>South region</td>
<td>-6.3267***</td>
<td>(2.0778)</td>
</tr>
<tr>
<td>Sunday</td>
<td>5.6820***</td>
<td>(1.8757)</td>
</tr>
<tr>
<td>Friday</td>
<td>-8.2363***</td>
<td>(2.2953)</td>
</tr>
<tr>
<td>Holiday</td>
<td>11.9073***</td>
<td>(3.3186)</td>
</tr>
<tr>
<td>June</td>
<td>-7.0530**</td>
<td>(3.3468)</td>
</tr>
<tr>
<td>July</td>
<td>-13.9172***</td>
<td>(4.1257)</td>
</tr>
<tr>
<td><strong>Average time in food preparation (min/day)</strong></td>
<td>52.16</td>
<td></td>
</tr>
</tbody>
</table>
Summary and Preliminary Conclusions

• Research:
  • Analyze children’s food security as a “commodity” within household production framework
  • Utilize data from large, nationally representative surveys of households and economic areas
  • Test hypotheses about effects of socio-demographic factors and local food environment on:
    • Food insecurity
    • Time in food preparation

• Findings support hypothesized effects:
  • Food insecurity: household structure, income, fast food prices, local food environment (convenience stores)
  • Time in food preparation: household structure/demographics, income, day-of-week, season
Thank you!

Questions?
Details on Likelihood Contribution

When $t_{1,i} = 0$, the likelihood contribution is:

$$L_i(\theta) = \frac{\mu_{z_{1,i}+1} - X_i^t \beta - X_i^t \gamma}{\int_{\mu_{z_{1,i}} - X_i^t \beta}^{\mu_{z_{1,i}+1} - X_i^t \beta} \int_{-\infty}^{\infty} f(\epsilon, \eta)d\eta d\epsilon}$$

When $t_{1,i} > 0$, the likelihood contribution is:

$$L_i(\theta) = f_\eta(t_{1,i} - X_i^t \gamma) \cdot \frac{\mu_{z_{1,i}+1} - X_i^t \beta}{\int_{\mu_{z_{1,i}} - X_i^t \gamma}^{\mu_{z_{1,i}+1} - X_i^t \beta} f_{\epsilon|t_{1,i} - X_i^t \gamma}(\epsilon) d\epsilon}$$
Details on Food Insecurity Measure

Children’s food security status is determined via responses by adult proxy to 8 child-specific questions in 18-item Household Food Security Survey Module in FSS.

Four ordered categories of children’s food security:

1. High/marginal: raw score of 0
2. Marginal: raw score of 1
3. Low: raw score of 2–4
4. Very low: raw score of 5–8

We focus on HFSSM items referenced to last 12 months.
Details on Time in Food Preparation

Kernel Densities of Time in Food Preparation (Conditional on Time > 0)
Details on Research Hypotheses

• **Group A: effects of food prices on food insecurity**
  - Higher prices of food at home and fast food $\Rightarrow$ more food insecurity among children

• **Group B: effects of food environment on food insecurity**
  - Higher density of supermarkets/other food stores, and higher density of full-service restaurants and limited-service eating places $\Rightarrow$ less food insecurity among children

• **Group C: effects of socioeconomic characteristics on food insecurity**
  - More income $\Rightarrow$ less food insecurity
  - Higher educational attainment $\Rightarrow$ less food insecurity
  - More children in household $\Rightarrow$ more food insecurity

• **Group D: effects of household circumstances on time in food preparation**
  - Men spend less time in food preparation than women
  - Householders in single-headed households spend less time than married women
  - More children in household $\Rightarrow$ more time in food preparation by householder/spouse
  - More income, more education $\Rightarrow$ less time in food preparation
  - Amount of time in food preparation varies with day-of-the-week, season