Children’s Food Insecurity, Food Preparation Time and the Effects of Food Environment

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

4. How do household circumstances affect food preparation time?
Motivation

Incidence of food insecurity is substantial among low-income households with children (~43% when income < 130% FPL)

Food insecurity is linked to poor health, depression, other negative outcomes in physical, intellectual, and social development of children

Food preparation decisions influence nutritional content of foods consumed and can affect health outcomes

Better understanding of effects of food prices, food environment, other factors on food insecurity among children and of food preparation time can inform public policy and design of food assistance programs
Overview of Research

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

Develop an economic model of food insecurity and food preparation time, based on household production approach (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 security status and food preparation time; test hypotheses about effects of food prices and food environment.
Economic Model: Notation

- $m \geq 1$ different commodities: $Z = (z_1, ..., z_m)'$
- $z_1$: children’s food security; $\bar{z}_1 = -z_1$: children’s food insecurity
- $l \geq 1$ different market goods: $Y = (y_1, ..., y_l)'$
- $k \geq 1$ different time use activities: $T = (t_1, ..., t_k)'$
- $t_1$: food preparation time (including time in food acquisition and related travel)
- Socioeconomic and demographic characteristics $H$: household composition, income, etc.
- Location-specific attributes $L$: 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 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 food preparation time 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: \( N = 13,474 \) households/respondents

- Food prices and 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)
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: (1) high, (2) marginal, (3) low, and (4) very low
- Referenced to last 12 months

**Food preparation time** includes time in seven ATUS activities, 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 & drink preparation/clean-up/presentation
7. Travel related to grocery shopping
### 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 food security</td>
<td>11,600</td>
<td>85.91</td>
</tr>
<tr>
<td>(2) Marginal food security</td>
<td>911</td>
<td>6.80</td>
</tr>
<tr>
<td>(3) Low food security</td>
<td>897</td>
<td>6.73</td>
</tr>
<tr>
<td>(4) Very low food security</td>
<td>66</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13,474</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

**Food preparation time:**

<table>
<thead>
<tr>
<th></th>
<th>Fraction of Cases with Time = 0</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>All respondents</td>
<td>34.26%</td>
<td>79.20</td>
<td>69.33</td>
<td>1</td>
<td>995</td>
</tr>
<tr>
<td>Men</td>
<td>53.26%</td>
<td>56.15</td>
<td>54.84</td>
<td>1</td>
<td>660</td>
</tr>
<tr>
<td>Women</td>
<td>18.33%</td>
<td>90.26</td>
<td>72.76</td>
<td>1</td>
<td>995</td>
</tr>
</tbody>
</table>
Food Prices & Establishment Densities

**Food-at-home price index**: expenditure-weighted average of 50+ food group prices based on QFAHPD data, in real $ per 100 grams of food

**Fast food price index**: average of real prices of three fast food items in ACCRA (Chou et al., 2004; Powell, 2009)

**Food establishment densities**: number of food-related business establishments, as reported in CBP, per 10,000 residents for:

- Supermarkets and other general line grocery stores
- Convenience stores
- Specialty food stores
- Full-service restaurants
- Limited-service eating places

All these measures are location- and time-specific and are merged with individual sample records accordingly.
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 food preparation time contain **many zeroes** ⇒ adopt **Tobit** approach. Latent variable:

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

Observed food preparation time:

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

\( X_i^Z \) and \( X_i^t \) are explanatory variables based on \( H_i \) and \( L_i \)
Estimation Approach

Error terms might be correlated; we specify:

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

Food insecurity and food preparation time 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

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

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

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

<table>
<thead>
<tr>
<th>Selected Explanatory Variables</th>
<th>(3) Low Estimate</th>
<th>(Std. Err.)</th>
<th>(4) Very Low Estimate</th>
<th>(Std. Err.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmarried couple household</td>
<td>0.0110*</td>
<td>(0.0062)</td>
<td>0.0014*</td>
<td>(0.0008)</td>
</tr>
<tr>
<td>Single female-headed household</td>
<td>0.0288***</td>
<td>(0.0037)</td>
<td>0.0038***</td>
<td>(0.0006)</td>
</tr>
<tr>
<td>Single male-headed household</td>
<td>0.0218***</td>
<td>(0.0077)</td>
<td>0.0029***</td>
<td>(0.0011)</td>
</tr>
<tr>
<td># of children, age 0–4</td>
<td>0.0071***</td>
<td>(0.0023)</td>
<td>0.0009***</td>
<td>(0.0003)</td>
</tr>
<tr>
<td># of children, age 5–12</td>
<td>0.0139***</td>
<td>(0.0017)</td>
<td>0.0018***</td>
<td>(0.0003)</td>
</tr>
<tr>
<td># of children, age 13–17</td>
<td>0.0138***</td>
<td>(0.0024)</td>
<td>0.0018***</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>African American householder</td>
<td>0.0163***</td>
<td>(0.0045)</td>
<td>0.0021***</td>
<td>(0.0006)</td>
</tr>
<tr>
<td>Hispanic householder</td>
<td>0.0190***</td>
<td>(0.0049)</td>
<td>0.0025***</td>
<td>(0.0007)</td>
</tr>
<tr>
<td>Real family income ($, thousands)</td>
<td>-0.0028***</td>
<td>(0.0002)</td>
<td>-0.0004***</td>
<td>(0.0000)</td>
</tr>
<tr>
<td>Income &lt; 185% of poverty level</td>
<td>0.0240***</td>
<td>(0.0049)</td>
<td>0.0031***</td>
<td>(0.0007)</td>
</tr>
<tr>
<td>Food-at-home price index</td>
<td>-0.0893</td>
<td>(0.1374)</td>
<td>-0.0117</td>
<td>(0.0180)</td>
</tr>
<tr>
<td>Fast food price index</td>
<td>0.0200*</td>
<td>(0.0110)</td>
<td>0.0026*</td>
<td>(0.0015)</td>
</tr>
<tr>
<td>Density of supermarkets</td>
<td>-0.0006</td>
<td>(0.0030)</td>
<td>-0.0001</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>Density of convenience stores</td>
<td>-0.0031*</td>
<td>(0.0018)</td>
<td>-0.0004*</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>Density of specialty food stores</td>
<td>-0.0096*</td>
<td>(0.0057)</td>
<td>-0.0013*</td>
<td>(0.0008)</td>
</tr>
<tr>
<td>Density of full-service restaurants</td>
<td>0.0003</td>
<td>(0.0012)</td>
<td>0.0000</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>Density of limited-service eating places</td>
<td>-0.0017</td>
<td>(0.0015)</td>
<td>-0.0002</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>Fraction of households</td>
<td>0.0673</td>
<td></td>
<td>0.0057</td>
<td></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>-48.2817***</td>
<td>(1.1342)</td>
</tr>
<tr>
<td>Female in unmarried couple</td>
<td>-3.7805</td>
<td>(3.2624)</td>
</tr>
<tr>
<td>Male in unmarried couple</td>
<td>-47.9443***</td>
<td>(3.9253)</td>
</tr>
<tr>
<td>Single female householder</td>
<td>-13.0695***</td>
<td>(1.6064)</td>
</tr>
<tr>
<td>Single male householder</td>
<td>-31.2319***</td>
<td>(3.1580)</td>
</tr>
<tr>
<td># of children, age 0–4 years</td>
<td>6.4264***</td>
<td>(0.8654)</td>
</tr>
<tr>
<td># of children, age 5–12 years</td>
<td>4.3608***</td>
<td>(0.6250)</td>
</tr>
<tr>
<td># of children, age 13–17 years</td>
<td>4.2976***</td>
<td>(0.9052)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>0.5028***</td>
<td>(0.0632)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.0663***</td>
<td>(1.9712)</td>
</tr>
<tr>
<td>Foreign-born</td>
<td>10.3164***</td>
<td>(1.8250)</td>
</tr>
<tr>
<td>Real family income ($, thousands)</td>
<td>-0.0581</td>
<td>(0.0419)</td>
</tr>
<tr>
<td>Income &lt; 185% of poverty level</td>
<td>4.1548**</td>
<td>(1.6814)</td>
</tr>
<tr>
<td>Metropolitan area</td>
<td>3.1764**</td>
<td>(1.5292)</td>
</tr>
<tr>
<td>Sunday</td>
<td>5.6434***</td>
<td>(1.8640)</td>
</tr>
<tr>
<td>Friday</td>
<td>-8.5873***</td>
<td>(2.2794)</td>
</tr>
<tr>
<td>Holiday</td>
<td>10.6885***</td>
<td>(3.2740)</td>
</tr>
<tr>
<td>May</td>
<td>-6.6161**</td>
<td>(3.2956)</td>
</tr>
<tr>
<td>June</td>
<td>-7.2748**</td>
<td>(3.3168)</td>
</tr>
<tr>
<td>July</td>
<td>-13.2133***</td>
<td>(4.0870)</td>
</tr>
</tbody>
</table>

Average food preparation time                  | 52.06 min/day     |
Summary and Implications

• Research examines children’s food security as a “commodity” within household production framework

• Findings support hypothesized effects:
  • Food insecurity: household structure, income, fast food prices, food environment (convenience and specialty food stores)
  • Food preparation time: household structure/demographics, income, day-of-the-week, season

• Implications for policies and programs to reduce food insecurity among children:
  • Providing adequate food for children is especially challenging for single-headed and unmarried couple households
  • Social and food assistance programs that increase available financial resources to households support households in meeting food needs
  • Food environment matters: lower fast food prices and more available convenience and specialty food stores are associated with lower probability of food insecurity
Thank you!

Questions?
Details on Likelihood Contribution

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

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

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

$$L_i(\theta) = f_\eta(t_{1,i} - X_i'\gamma) \cdot \int_{\mu_{z_{1,i}}-X_i'\beta}^{\mu_{z_{1,i+1}}-X_i'\beta} f_{\epsilon|t_{1,i}-X_i'\gamma}(\epsilon) d\epsilon$$
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 ⇒ 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 ⇒ less food insecurity among children

• Group C: effects of socioeconomic characteristics on food insecurity
  • More income ⇒ less food insecurity
  • Higher educational attainment ⇒ less food insecurity
  • More children in household ⇒ 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 ⇒ more time in food preparation
  • More income, more education ⇒ less time in food preparation
  • Amount of time in food preparation varies with day-of-the-week, season
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 householder/spouse/partner records

ATUS–FSS analytical sample, 2002–2011
N = 13,474 (merged households/respondents)
- 1,100–2,300 observations/year

Merged final analytical dataset, 2002–2011: N = 13,474

Food Prices and Other Location-Specific Data: QFAHPD, ACCRA, CBP, SAIPE