Estimating Food Loss at Individual Household Level

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Introduction

- National Resources Defense Council and USDA's ERS estimated that about 30%-40% of total food ($160 billion) is wasted every year in the U.S.
- However, little has been known about food loss at the individual household level, and its relation with demographics.
- We utilize the USDA's FoodAPS data, which provides complete information on both at-home and away-from-home food consumption.
- Our approach is to apply a stochastic frontier model with instruments and limited information maximum likelihood (LIML).

Objectives

- Recover food loss for each individual household in the data.
- Analyze the roles of heterogenous demographics playing in determing food loss.
- Generate implications on food-loss prevention policies that are aimed at particular food types, retail environment, and, more importantly, at particular household types.

Methods

We consider household food consumption as a production process, in which the output is body-mass. We employ the normal—half-normal stochastic frontier model used in productivity analysis.

The baseline model is as following:

$$\log BMI_h = \alpha_0 + \sum_{i=1}^{9} \alpha_i \log x_i + v_h - u_h$$

where BMI_h is the aggregate Body-mass index for household h. And x_i is the per household member consumption of group i food, according to USDA food category. v_h is normally distributed white noise and u_h is a half-normal heteroskedastic inefficiency term:

$$\sigma_{u_i}^2(d_h) = \exp(d_h'\gamma)$$

where d_h consists of income, diet quality, and food insecurity measure.

We also consider an additional model with employment status as proxy variable for **physical activities**. As the proxy may not capture all information, it might as well be endogenous. Thus, our last model uses SNAP benefit as an instrument and applies limited information maximum likelihood (LIML) technique.

The percentage food loss is calculated by:

$$\%loss = \left[1 - \exp\left(-\frac{\hat{u}}{\sum \alpha_i}\right)\right] * 100$$

Results

Table: Average Food Loss and Estimates of three models.

Description	Baseline Model	Employment as Proxy for Physical Activities	LIML, SNAP Benefit as Instrument
Average Food Loss	**35.7%**	**36.4%**	**37.7%**
Production Equation			
Employment Status		0.0635***	0.2206***
		(0.0106)	(0.0464)
Milk and Dairy	-0.0104**	-0.0103**	-0.0115**
	(0.0051)	(0.0051)	(0.0052)
Protein Foods	0.0466***	0.043***	0.0353***
	(0.0082)	(0.0082)	(0.0087)
Mixed Dishes	-0.0006	0.0055	0.0201**
	(0.007)	(0.007)	(0.0084)
Grains	-0.001	-0.0114	-0.015*
	(0.0089)	(0.0088)	(0.0091)
Snacks	0.0147*	0.0109	0.004
	(0.0085)	(0.0084)	(0.0089)
Fruit and Vegetables	0.0065	0.0045	0.0007
	(0.0067)	(0.0067)	(0.007)
Beverages	0.0129***	0.0155***	0.022***
	(0.0038	(0.0037)	(0.0043)
Condiments	0.0065	0.0055	0.0012
	(0.0076)	(0.0076)	(0.0079)
Infant formula	0.0193	0.0205	0.0238
	(0.0202)	(0.0201)	(0.0207)
Constant	3.2922***	3.2521***	3.1517***
	(0.0088)	(0.0101)	(0.0308)
White Noise σ_v^2	0.1767***	0.1752***	0.3262***
	(0.002)	(0.002)	(0.0014)
Inefficiency $\log(\sigma_u^2)$			
Income	0.00006	0.00003	-3.77e-06
	(0.00005)	(0.00005)	(0.00006)
Unhealthy Diet	-5.714239***	-5.9627***	-6.0443***
	(0.7245)	(0.7488)	(0.7389)
Food Insecurity	-3.216***	-2.6635**	-1.9367**
	(1.2483)	(1.1046)	(0.9047)
Constant	-2.5726***	-2.4223***	-2.392***
	(0.2857)	(0.2841)	(0.2754)

Major Findings:

1. Our models predict 35-37% average food loss.
2. SNAP households waste 17.5% less food.
3. Food insecure households waste significantly less, up to 60%.
4. Healthy diet leads to more food waste because of more fruit and vegetables consumption.
5. Household size does not significantly correlates with food loss, but larger household groups see smaller variation in loss, suggesting the role of allocation management.
6. Income does not play a key role in terms of determining loss.

Figure 1. Food Insecurity Leads Less Waste

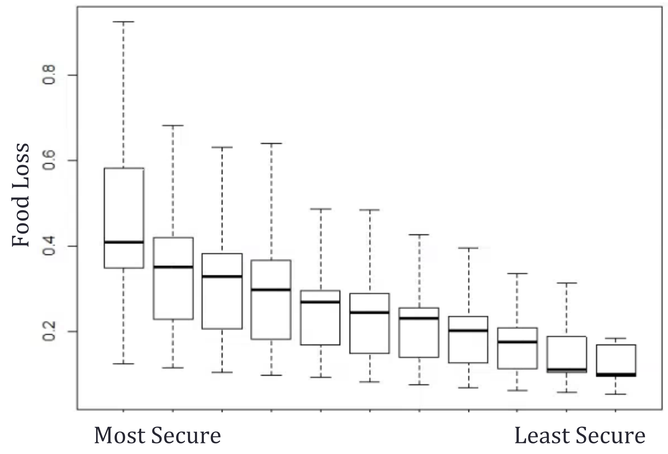


Figure 2. SNAP

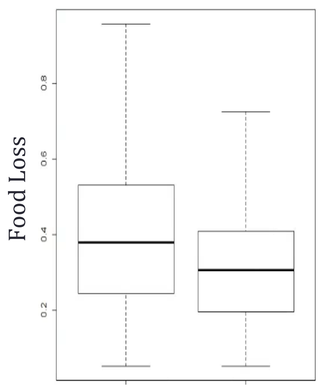
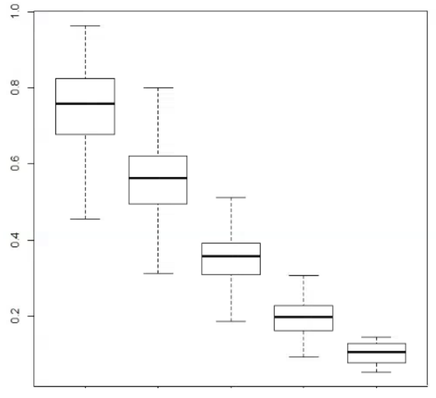


Figure 3. Healthy Diet, More Waste



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