

# **A new approach to quantify the impact of food prices and income on people's eating habits and weight**

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- Today we dine out more frequently. Calories coming from food away from home increased by over 120%.
- Relative price of food away from home decreased by 16.8%.
- Real income increased by 24% from 1971 and 2006.

# Literature Review

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- Previous empirical research in health economics shows that changes in food prices have little impact on individual's eating decisions and weight:
  - Schroeter, Lusk, and Tyner (2008)
  - Chouinard, Davis, LaFrance, and Perloff (2007)
  - Gelbach, Klick, and Stratmann (2007)
  - Chou, Grossman, and Saffer (2004)

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- Calculate *price per calorie* for food away from home and food consumed at home.
- Results:
  - Changes in food prices and income account for over 70 % of the increase in average weight of men and women.
  - Large differences in preferences for food/non-food, food away from home /at home across age and gender.

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- Food consumption,

- $c_t^f = (\eta a_t^\rho + (1 - \eta)h_t^\rho)^{\frac{1}{\rho}}$

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- Non-Food consumption,

- $c_t^{nf} = I_t - p_{at}a_t - p_{ht}h_t$

# Preferences

●  $U(c_t^f, c_t^{nf}) = \frac{[(c_t^f)^\alpha (c_t^{nf})^{1-\alpha}]^{1-\sigma} - 1}{1-\sigma}$  with  $\sigma > 0$  and  $\sigma \neq 1$

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- $\tilde{U}(c_t^f, c_t^{nf}) = \begin{cases} U(c_t^f, c_t^{nf}) & \text{if } c_t^f \geq \underline{c}^f \text{ and } c_t^{nf} \geq \underline{c}^{nf} \\ \underline{U} & \text{otherwise} \end{cases}$

- $\underline{c}_t^f$  - subsistence level of food

- $\underline{c}_t^{nf}$  - subsistence level of non-food consumption

- We assume that  $\underline{U} \leq U(\underline{c}^f, \underline{c}^{nf})$ .

# Weight Law of Motion

- $W_{t+1} = W_t + \lambda(a_t + h_t - c(W_t))$

- $\lambda > 0$  - relates calorie consumption to changes in weight
- $c(W_t)$  - is the calorie requirement to maintain a given weight

# Expected Discount Utility

•  $U(W_1) =$

$$c_1^{nf} + \mu \log(c_1^f) + \beta(\pi(W_2)(c_2^{nf} + \mu \log(c_2^f)) + (1 - \pi(W_2))\underline{U}) \\ + \beta^2 \pi(W_2)(\pi(W_3)(c_3^{nf} + \mu \log(c_3^f)) + (1 - \pi(W_3))\underline{U}) + \dots$$

- $\pi(W_t)$  is the survival probability given weight  $W_t$
- $\beta \in (0, 1)$  is the pure time discount factor.

# Agent's Maximization Problem

- In the first period, the representative agent chooses a sequence of
  - food consumption
  - non-food consumption
- to maximize the discounted expected utility in period one subject to
  - the budget constraint
  - the weight law of motion
  - non-negativity constraints.

# Stationary Equilibrium

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- All prices and quantities are constant over time so that for every  $t$ :

- $a_t = a^*$

- $h_t = h^*$

- $W_t = W^*$

- $p_{at} = p_a$

- $p_{ht} = p_h$

- $I_t = I$

# Stationary Equilibrium


- The first-order conditions evaluated at the steady state are given by:

- $$\frac{\eta\alpha}{a^*} - \frac{(1-\alpha)p_a}{I-p_a a^* - p_h h^*} = \frac{(1-\eta)\alpha}{h^*} - \frac{(1-\alpha)p_h}{I-p_a a^* - p_h h^*}$$

- $$(U(c^f, c^{nf})(1 - \sigma) + 1) \left( \frac{\eta\alpha}{a^*} - \frac{(1-\alpha)p_a}{I-p_a a^* - p_h h^*} \right) =$$
$$\lambda\beta\pi'(a^* + h^* - c(W^*)) (U(c^f, c^{nf}) - \underline{U})$$

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- $\lambda = \frac{0.1}{365} = 2.7397 \times 10^{-4}$

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- For men

- $c(W) = 662 - 9.53 \times \text{Age}[y] + \text{Activity} \times (7.23 \times \text{Weight}[lb] + 13.706 \times \text{Height}[in])$

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- For women

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## ● Activity

- 1 = sedentary
- 1.12 = low active
- 1.27 = active
- 1.45 = very active

# Probability of Survival and Hazard Rate

Estimate the hazard ratio  $hr(W_t)$

Hazard Rate	BMI
1.30	14.2
1.12	16.5
1.00	20.5
1.03	25.5
1.24	30.5
1.49	34.5
1.98	36.7

$$BMI = 703 \times \frac{weight[lb]}{height^2[in]}$$

Survival Probability:  $\pi(W_t) = 1 - \pi_a \times hr(W_t)$

$\pi_a = 0.01$  is death probability at age 45

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- Fix these parameters to match weight gain for various groups from 1971 to 1994.
- $\rho = 0.718$  which implies that food away from home and at home are substitutes.
- $\underline{U} = 0.959$ .

# Preferences Parameters

	$\eta$		$\alpha$	
	Men	Women	Men	Women
Age 25-34	0.559	0.519	0.085	0.053
Age 35-44	0.537	0.501	0.075	0.049
Age 45-54	0.508	0.477	0.071	0.050
Age 55-64	0.506	0.462	0.071	0.054

- $\eta$  - food away from home share
- $\alpha$  - food share

# Numerical Experiment

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- We start from the Steady State in 1971.
- Feed in the change in  $p_{at}$ ,  $p_{ht}$ ,  $I_t$ .
- See the effects on  $a_t$ ,  $h_t$ , *weight*, and fraction of calories consumed away from home.

# Model Prediction: Changes in mean weight

	Weight (lbs.)		
Year	1971-1975	1988-1994	2005-2006
<i>Men:</i>			
Age 25-34	174.9	181.7	193.3
Age 35-44	177.0	185.1	189.8
Age 45-54	177.9	185.4	188.8
Age 55-64	172.5	184.1	198.8
<i>Women:</i>			
Age 25-34	139.5	143.8	154.3
Age 35-44	146.1	150.4	153.6
Age 45-54	148.9	155.1	157.2
Age 55-64	150.8	175.3	184.8

# Model Prediction: Changes in BMI

	BMI		
Year	1971-1975	1988-1994	2005-2006
<i>Men:</i>			
Age 25-34	25.5	26.6	28.3
Age 35-44	25.9	26.9	27.4
Age 45-54	26.4	27.2	27.6
Age 55-64	26.5	27.3	29.8
<i>Women:</i>			
Age 25-34	23.9	24.6	26.1
Age 35-44	24.8	25.7	26.2
Age 45-54	25.8	26.6	27.0
Age 55-64	26.9	30.7	31.7

# Model Prediction: % of cal's away from home

	1971-1975	1988-1994	2005-2006
<i>Men:</i>			
Age 25-34	36.6	46.4	53.4
Age 35-44	32.8	42.8	48.7
Age 45-54	25.9	34.8	40.1
Age 55-64	22.4	27.3	29.8
<i>Women:</i>			
Age 25-34	21.6	29.9	36.7
Age 35-44	20.3	28.9	34.5
Age 45-54	17.5	24.6	29.4
Age 55-64	13.5	19.1	24.1

# Elasticities between 1971 and 2006

	$p_a$	$p_h$	$I$
<i>Men (Age 25-64)</i>			
<i>a</i>	-2.62	1.13	0.75
<i>h</i>	1.02	-0.81	-0.19
<i>W</i>	-0.11	-0.39	0.15
<i>Women (Age 25-64)</i>			
<i>a</i>	-3.40	0.82	0.88
<i>h</i>	0.73	-1.05	-0.08
<i>W</i>	-0.07	-0.46	0.22

# Future Work

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- Explore the impact of food prices and income in a model where agents have time-inconsistent preferences.