Why are Americans dining out so much?

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  - of men (age 45) increased from 180 to 192 lb
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- Men and women eat on average 300 more calories every day.
- They dine out more frequently. Calories coming from food away from home increased by 118%.
- Relative price of food away from home decreased by 60%.

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- Estimates of food price elasticity
  - French, Jeffery, Story et al. (1994, 1997, 2001)
  - Battle Horgen and Brownell (2002)
- Small impact of food prices on weight
  - Chou, Grossman, and Saffer (2004)
  - Schroeter, Lusk, and Tyner (2008)

Our Work

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- Results:
  - Changes in food prices and income account for over 90 % 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 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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    - σ - inter-temporal elasticity of substitution
- $\tilde{U}(c_t^f, c_t^{nf}) = \begin{cases} U(c_t^f, c_t^{nf}) & \text{if } c_t^f \geq \underline{c}^f \quad \text{and } c_t^{nf} \geq \underline{c}^{nf} \\ \underline{U} & \text{otherwise} \end{cases}$
    - $\underline{c}_t^f$ - 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

- $U(W_1) =$

  $$c_1^{nf} + \mu \log(c_1^f) + \beta(\pi(W_2)(c_2^{nf} + \mu \log(c_2^f)) + (1 - \pi(W_2))\bar{U})$$

  $$+\beta^2 \pi(W_2)(\pi(W_3)(c_3^{nf} + \mu \log(c_3^f)) + (1 - \pi(W_3))\bar{U}) + ...$$

  - $\pi(W_t)$ 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

Stationary Equilibrium

- 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:
  - $\frac{\eta\alpha}{a^*} - \frac{(1-\alpha)p_a}{I-p_a a^*-p_h h^*} = \frac{(1-\eta)\alpha}{h^*} - \frac{(1-\alpha)p_h}{I-p_a a^*-p_h h^*}$
  - $(U(c^f, c^{nf})(1-\sigma)+1)(\frac{\eta\alpha}{a^*} - \frac{(1-\alpha)p_a}{I-p_a a^*-p_h h^*}) =$

    $\lambda\beta\pi'(a^* + h^* - c(W^*))(U(c^f, c^{nf}) - \bar{U})$

Calibration

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- $\beta = 0.96$
- $\sigma = 2$
- $\lambda = \frac{0.1}{365}$

Calorie Requirement

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- For men
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  - $c(W) = 356 - 6.91 \times Age[y] + Activity \times (4.25 \times Weight[lb] + 18.44 \times Height[in])$
- 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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  - $\bar{U} = 0.805$. This implies $\eta = 0.234533$ and $\alpha = 0.157$ for men.
  - $\bar{U} = 0.805$. This implies $\eta = 0.285985$ and $\alpha = 0.106$ for women.

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	1977	1995	% Change
p_h	2.34×10^{-3}	2.14×10^{-3}	-9
p_a	4.69×10^{-3}	2.73×10^{-3}	-42
p_h/p_a	0.5	0.8	$+59$
I	82.28	93.07	$+13$

Model Prediction

Men:

Age = 45, Weight = 179.7lb, Height = 69.3”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	551				
h^*	2202				
W^*	179.7				
BMI^*	26.3				

Data: In 1995 Men: Weight = 191.7 lb and BMI = 27.8.

Model Prediction

Men:
Age = 45, Weight = 179.7lb, Height = 69.3”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	551	727			
h^*	2202	2074			
W^*	179.7	185.5			
BMI^*	26.3	27.1			

Data: In 1995 Men: Weight = 191.7 lb and BMI = 27.8.

Model Prediction

Men:
Age = 45, Weight = 179.7lb, Height = 69.3”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	551	727	541		
h^*	2202	2074	2234		
W^*	179.7	185.5	182.3		
BMI^*	26.3	27.1	26.6		

Data: In 1995 Men: Weight = 191.7 lb and BMI = 27.8.

Model Prediction

Men:
Age = 45, Weight = 179.7lb, Height = 69.3”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	551	727	541	573	
h^*	2202	2074	2234	2188	
$W*$	179.7	185.5	182.3	180.6	
BMI^*	26.3	27.1	26.6	26.4	

Data: In 1995 Men: Weight = 191.7 lb and BMI = 27.8.

Model Prediction

Men:
Age = 45, Weight = 179.7lb, Height = 69.3”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	551	727	541	573	719
h^*	2202	2074	2234	2188	2100
W^*	179.7	185.5	182.3	180.6	187.7
BMI^*	26.3	27.1	26.6	26.4	27.4

Data: In 1995 Men: Weight = 191.7 lb and BMI = 27.8.

Model Prediction

Women:
Age = 45, Weight = 148.8lb, Height = 63.9”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	415				
h^*	1658				
W^*	148.6				
BMI^*	25.6				

Data: In 1995 Women: Weight = 162.9 lb and BMI = 27.4.

Model Prediction

Women:
Age = 45, Weight = 148.8lb, Height = 63.9”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	415	565			
h^*	1658	1539			
W^*	148.6	154.3			
BMI^*	25.6	26.4			

Data: In 1995 Women: Weight = 162.9 lb and BMI = 27.4.

Model Prediction

Women:
Age = 45, Weight = 148.8lb, Height = 63.9”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	415	565	407		
h^*	1658	1539	1687		
W^*	148.6	154.3	152.1		
BMI^*	25.6	26.4	26.0		

Data: In 1995 Women: Weight = 162.9 lb and BMI = 27.4.

Model Prediction

Women:
Age = 45, Weight = 148.8lb, Height = 63.9", low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	415	565	407	434	
h^*	1658	1539	1687	1655	
W^*	148.6	154.3	152.1	151.2	
BMI^*	25.6	26.4	26.0	25.9	

Data: In 1995 Women: Weight = 162.9 lb and BMI = 27.4.

Model Prediction

Women:
Age = 45, Weight = 148.8lb, Height = 63.9”, low activity

	1977	Δp_a	Δp_h	ΔI	All
a^*	415	565	407	434	556.5
h^*	1658	1539	1687	1655	1561
W^*	148.6	154.3	152.1	151.2	157.2
BMI^*	25.6	26.4	26.0	25.9	26.9

Data: In 1995 Women: Weight = 162.9 lb and BMI = 27.4.

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- The share of income on food was 13.4% in 1977 and 10.6% in 1995.
- Our model predicts that the share of income on food goes from 9.4% to 6.9%.
- The share of “food income” spent on food away from home was 30.6% in 1977 and 39.6% in 1995.
- In our model the share on “food income” spent on food away from home declines from 33% to 31%.

Future Work

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- Derive optimal public health policy (sin tax) in a model with heterogenous agents.
- Explore the impact of food prices and income in a model where agents have time-inconsistent preferences.