How Much Are Food Price Changes to Blame for the Weight Increase of Americans?

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- Total daily calorie intake increased by 23%.
- Calories coming from products with added sugars, added fats, and flour and cereals increased by 37%, while the price of these items decreased by 16%.
- Calories coming from fruits and vegetables, dairy, and meat, eggs, and nuts increased by 4%, while the price of these items increased by 25%.

Literature Review

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- Experimental Papers
  - French, Jeffery, Story et al. (1994, 1997, 2001)
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- Econometric Analysis
  - Lakdawalla and Philipson (2002)
  - Chou, Grossman, and Saffer (2004)
  - Gelbach, Klick, and Stratmann (2007)
  - Schroeter, Lusk, and Tyner (2008)

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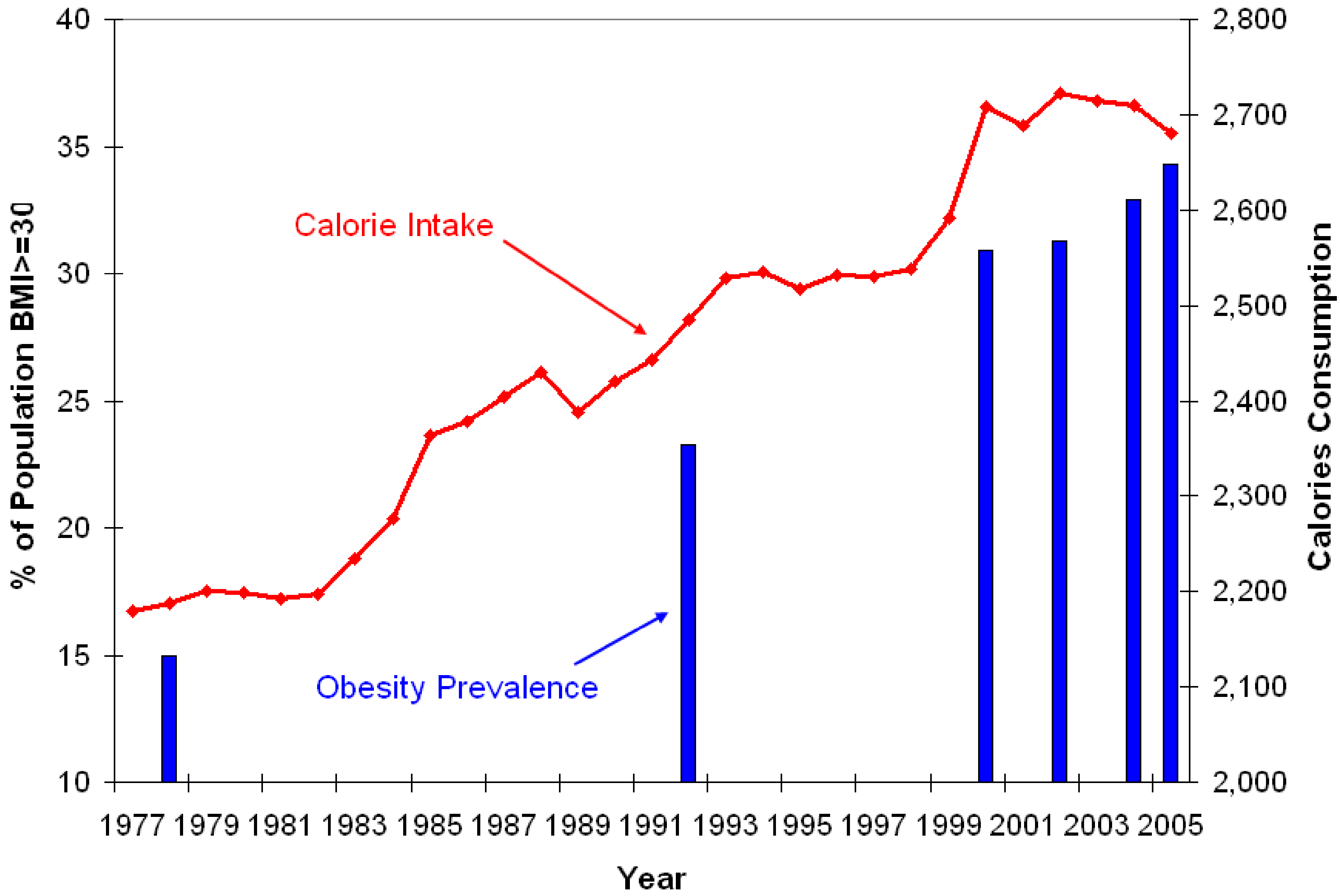
Our approach differs from existing studies in two main respects.

- We use a stochastic dynamic optimization model of eating decisions, where we make strong assumptions about agents' behavior and the functional form of preferences and survival probability, rather than a statistical or experimental approach.
- We use a different data set on food prices.

Main Result

After calibrating the model, we find that changes in food prices account for less than 10 % of the increase in average weight of Americans.

Total Calorie Intake Over Time



Two Food Categories

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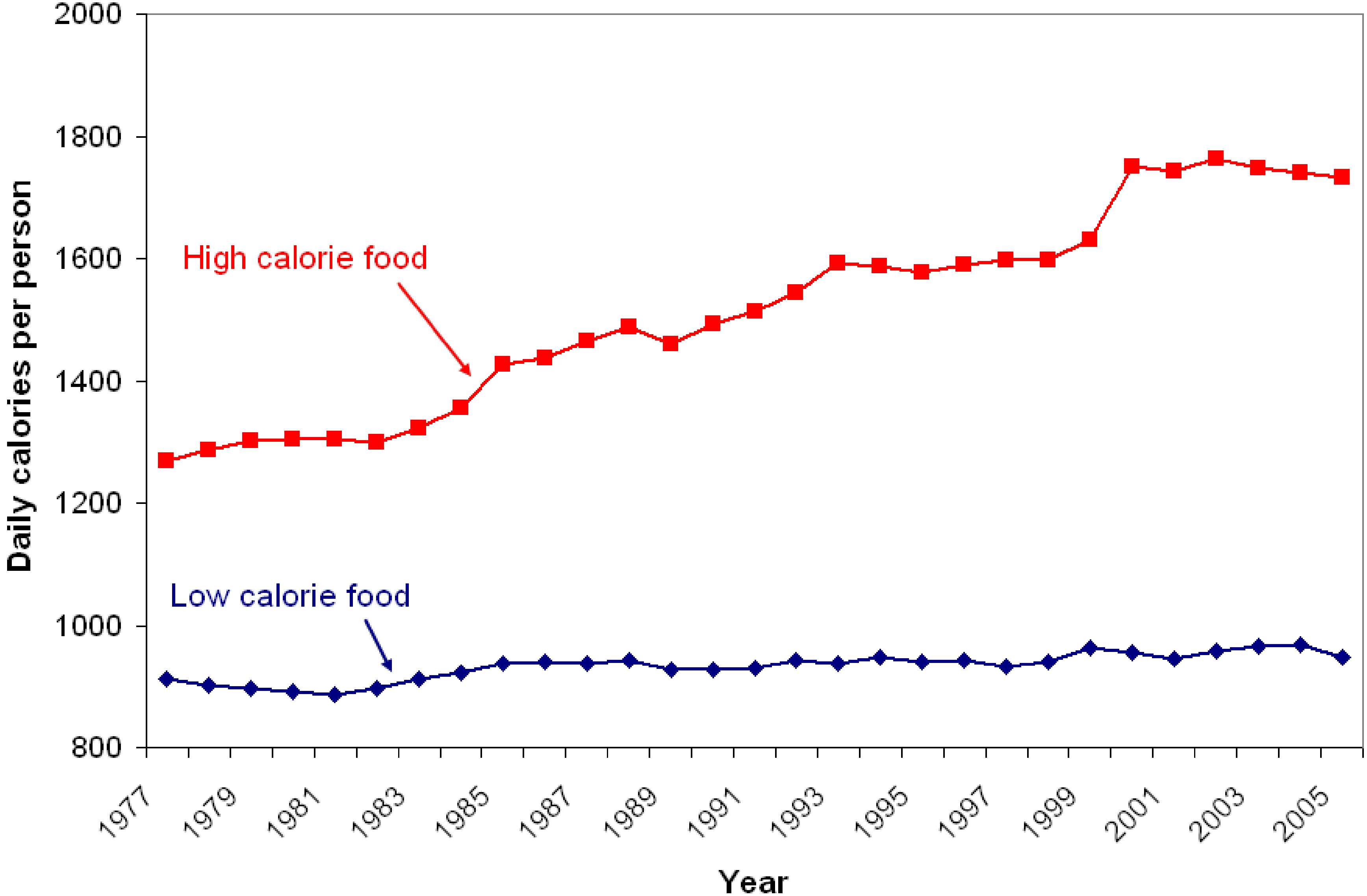
- Food Category 2 (“High calorie (dense) food”) includes:
  - Fats and oils,
  - Sugars and sweets, nonalcoholic beverages, and
  - Cereal and bakery products.

Change in Calorie Intake by Food Group



Price of Low and High Calorie Food

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$$p_{LF,t} = \frac{\alpha_{LF,t} I_t}{\text{Calories}_{LF,t}}$$

$\alpha_{LF,t}$ - expenditure share on low calorie food

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Price of High Calorie Food

$$p_{HF,t} = \frac{\alpha_{HF,t} I_t}{\text{Calories}_{HF,t}}$$

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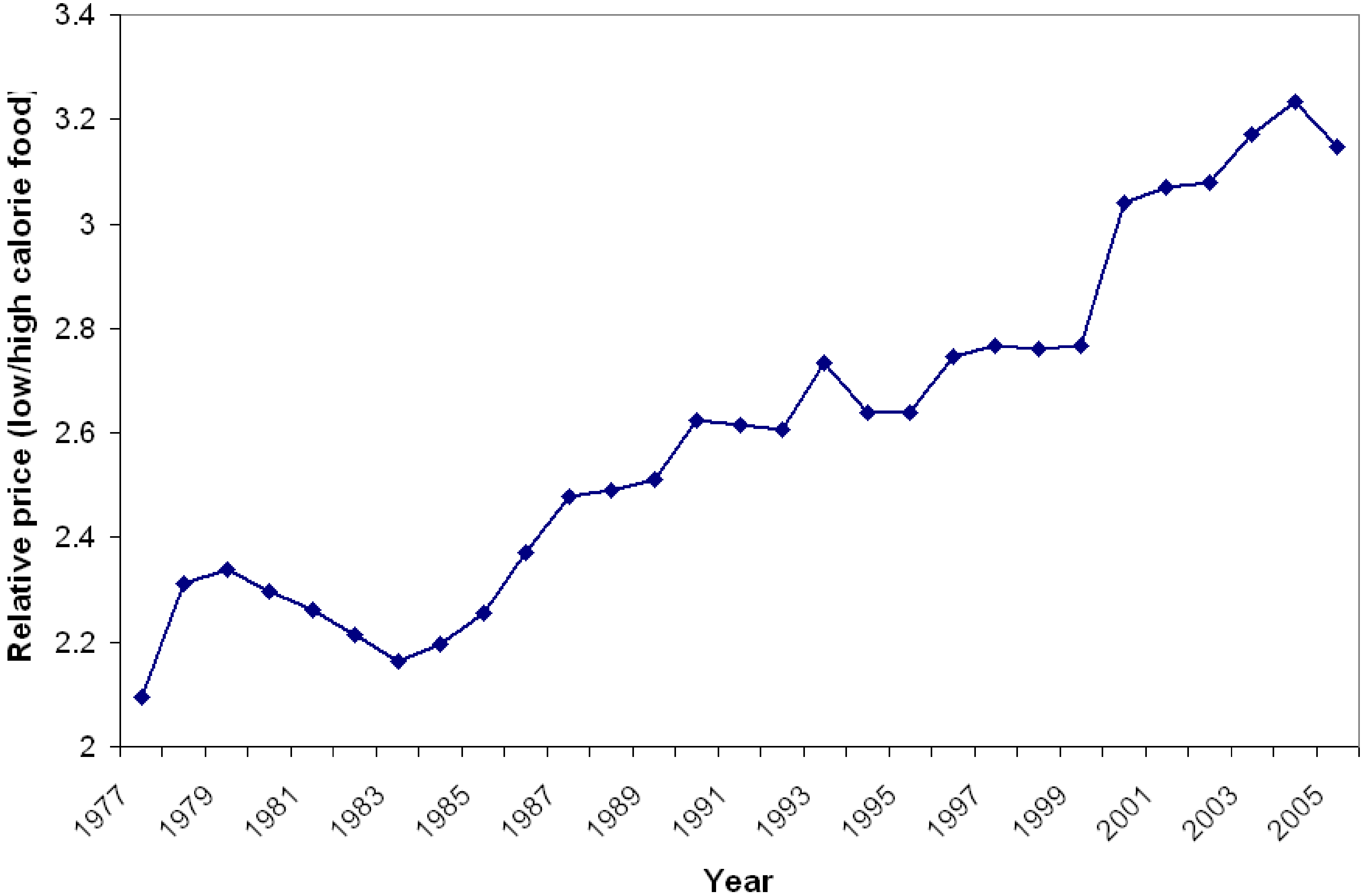
Change in Relative Price Over Time



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- Food consumption
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- Contemporaneous preferences
  - $U(c_t^f, c_t^{nf}) = \mu \log(c_t^f) + c_t^{nf}$
    - c_t^f - food
    - c_t^{nf} - non-food consumption

eight Law of Motion & Survival Probabili

- $W_{t+1} = (1 - \delta_w)W_t + \lambda(l_t + h_t)$
  - $\delta_w \in (0, 1)$ - daily depreciation of weight
  - $\lambda > 0$ - relates calorie consumption to changes in weight

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- A “special” coin is tossed which determines whether the representative agent survives the period or dies.
  - $\pi(W_t)$ is the time-invariant conditional probability of survival
  - $\bar{U}$ is the constant utility that agents receive from death

Households' Constraints

- Agents are endowed with income I_t
- Their budget constraint is given by:
  - $c_t^{nf} + p_{lt} l_t + p_{ht} h_t = I_t$

Expected Discount Utility

- We assume that the representative agent is alive with probability one in the initial period. Given the weight in period one, W_1, the expected discounted utility is equal to:

$$U(W_1) =$$

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

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

The parameter $\beta \in (0, 1)$ 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.

First-order Conditions

- $[l_t]: \quad p_{lt} - \frac{\mu\eta l_t^{\rho-1}}{\eta l_t^{\rho}+(1-\eta)h_t^{\rho}} = \lambda\beta\pi'(W_{t+1})\times$
  $(\frac{\mu}{\rho}\log(\eta l_{t+1}^{\rho}+(1-\eta)h_{t+1}^{\rho})+I_{t+1}-p_{lt+1}l_{t+1}-p_{ht+1}h_{t+1}-\bar{U})$

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  $(\frac{\mu}{\rho}\log(\eta l_{t+1}^\rho + (1-\eta) h_{t+1}^\rho) + I_{t+1} - p_{lt+1} l_{t+1} - p_{ht+1} h_{t+1} - \bar{U})$

Stationary Equilibrium

Stationary Equilibrium

- All prices and quantities are constant over time so that for every t:
  - $l_t = l^*$
  - $h_t = h^*$
  - $W_t = W^*$
  - $p_{lt} = p_l$
  - $p_{ht} = p_h$
  - $I_t = I$

Stationary Equilibrium

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

  - $p_l - \frac{\mu\eta l^{*\rho-1}}{\eta l^{*\rho}+(1-\eta)h^{*\rho}} = p_h - \frac{\mu(1-\eta)h^{*\rho-1}}{\eta l^{*\rho}+(1-\eta)h^{*\rho}}$

  - $p_l - \frac{\mu\eta l^{*\rho-1}}{\eta l^{*\rho}+(1-\eta)h^{*\rho}} = \lambda\beta\pi'(\frac{\lambda(l^*+h^*)}{\delta_w})(\frac{\mu}{\rho}\log(\eta l^{*\rho}+$
  $(1-\eta)h^{*\rho}) + I - p_l l^* - p_h h^* - \bar{U})$

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- $I = \$25.26$ per capita per day

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- $p_l = 1.28e^{-3}, \quad p_h = 6.12e^{-4}$

Calibration of Probability of Survival

- $\pi(W_t) = e^{-a(W_t - \bar{W})^2}$
  - $\bar{W}$ is the optimal weight at which the conditional survival probability is maximum and equal to one
  - a is a positive parameter

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  - $\bar{W}$ is the optimal weight at which the conditional survival probability is maximum and equal to one
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- Because of the squared term, the survival probability declines whenever the representative agent weight is not equal to $\bar{W}$.

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The increase in BMI represents a change in weight equal to $\Delta W = \frac{10 \times 65^2}{703} = 60$ pounds, where 65 is average height in 1977.

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- $\bar{U} = 0$ (the utility from death)

Calibration for μ and η

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  - $p_l - \frac{\mu\eta}{l^{*,1977}} = p_h - \frac{\mu(1-\eta)}{h^{*,1977}} = 0$
- $\mu = 1.9434$
- $\eta = 0.6004$

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	1977	2005	% Change
Price of Low Calorie Food	$1.28e^{-3}$	$1.61e^{-3}$	+25
Price of High Calorie Food	$6.12e^{-4}$	$5.11e^{-4}$	-16
Price Ratio (Low vs. High)	2.1	3.15	+47

Model Prediction

	$\Delta p_l(\uparrow)$	$\Delta p_h(\downarrow)$	All
Δl^*			
Δh^*			
ΔW^*			

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Δl^*	-18.31%		
Δh^*	7.89		
ΔW^*	-3.03		

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Δl^*	-18.31%	-4.06%	
Δh^*	7.89	8.61	
ΔW^*	-3.03	3.43	

Model Prediction

	$\Delta p_l(\uparrow)$	$\Delta p_h(\downarrow)$	All
Δl^*	-18.31%	-4.06%	-21.27%
Δh^*	7.89	8.61	16.56
ΔW^*	-3.03	3.43	0.65

Model Prediction

- Changes in prices of either low or high calorie food taken one at a time have a great impact on people's eating choices, which is in line with findings of the experimental economics literature (e.g., French et al., 2001)

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- Changes in prices of low and high calorie food taken altogether have offsetting effects on people's eating habits and thus have little impact on people's weight. This result is consistent with findings of the empirical economics literature (e.g., Chou et al., 2004)

Comparative Statics

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Comparative Statics

- In our baseline calibration, the elasticity of substitution between calorie consumption from low and high calorie food is equal to one (Cobb-Douglas function).
- We now look at case where low and high calorie food are complements (where $\rho = -5$ and $\eta = 0.2445$, $\mu = 1.9434$).
- In addition, we look at case where low and high calorie food are substitutes (where $\rho = +\frac{1}{2}$ and $\eta = 0.6395$, $\mu = 1.9434$).

Complements Case, $\rho = -5$

	$\Delta p_l(\uparrow)$	$\Delta p_h(\downarrow)$	All
Δl^*	-8%	1.21%	-5.81%
Δh^*	-3.08	3.55	1.18
ΔW^*	-5.16	2.58	-1.94

Substitutes Case, $\rho = +\frac{1}{2}$

	$\Delta p_l(\uparrow)$	$\Delta p_h(\downarrow)$	All
Δl^*	-27.74%	-9%	-33.88%
Δh^*	18.14	13.09	23.9
ΔW^*	-1.03	4.13	-0.39

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$a = 0$	$\Delta p_l(\uparrow)$	$\Delta p_h(\downarrow)$	All
Δl^*	-20.61%	0	-20.61%
Δh^*	0	19.64	19.64
ΔW^*	-9.03	11.61	2.58

Future Work

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- More theoretical work is needed to understand people's eating decisions, including assessing the importance of time-inconsistent preferences.

  Evidence from behavioral and neuroeconomics show that eating decisions are complex and heavily influenced by environmental factors.