Demand for Healthy and Unhealthy Food: Implications on Obesity

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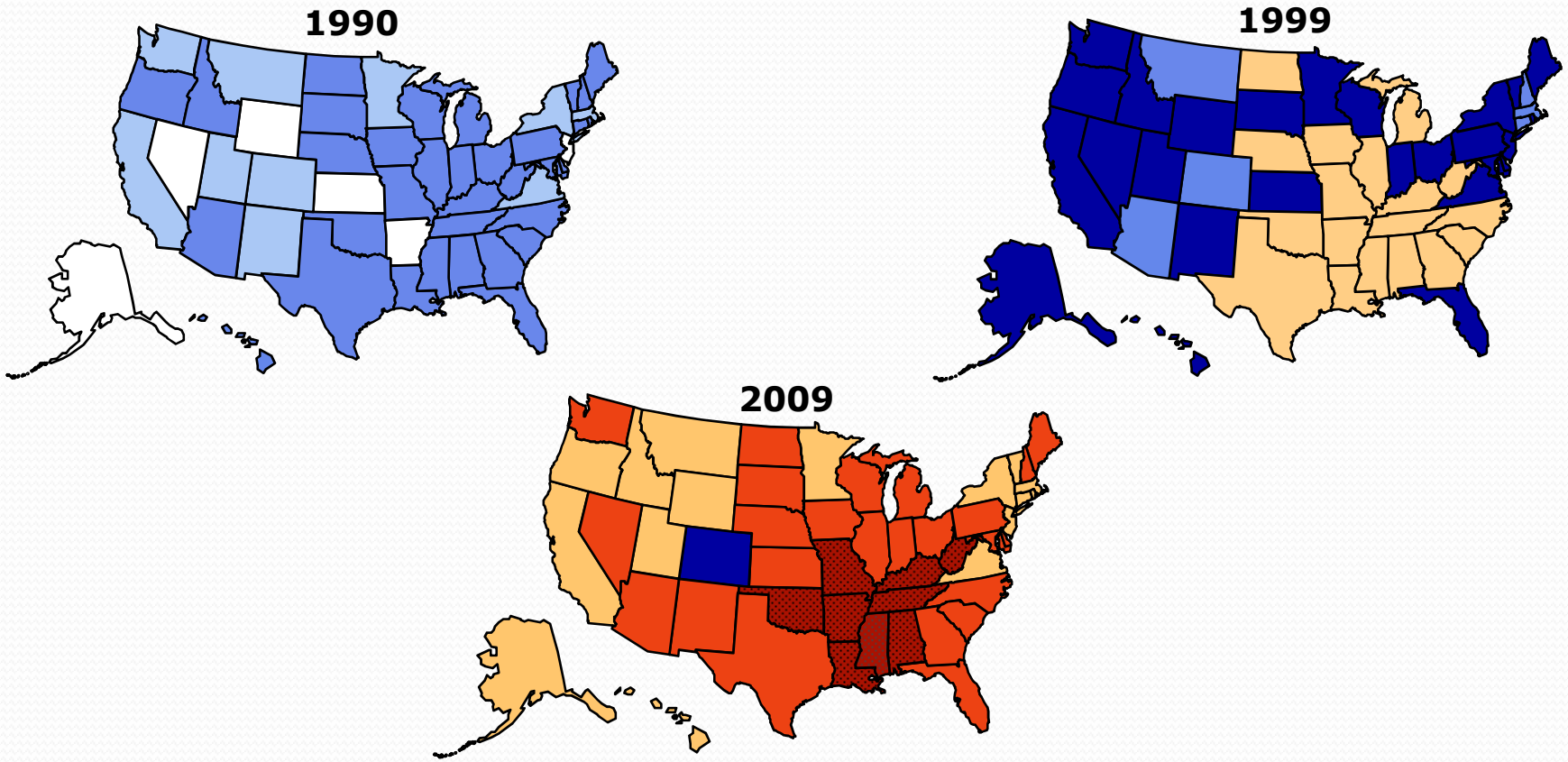
Introduction

- **The prevalence of obesity has become a worldwide challenge—a “global epidemic” (WHO, 1998).**
- **It is estimated that more than 68% of the U.S adult population (Flegal et al. 2010) and about 32% of the nation’s youth (Ogden et al. 2010) are considered to be overweight or obese.**

Obesity Trends* Among U.S. Adults

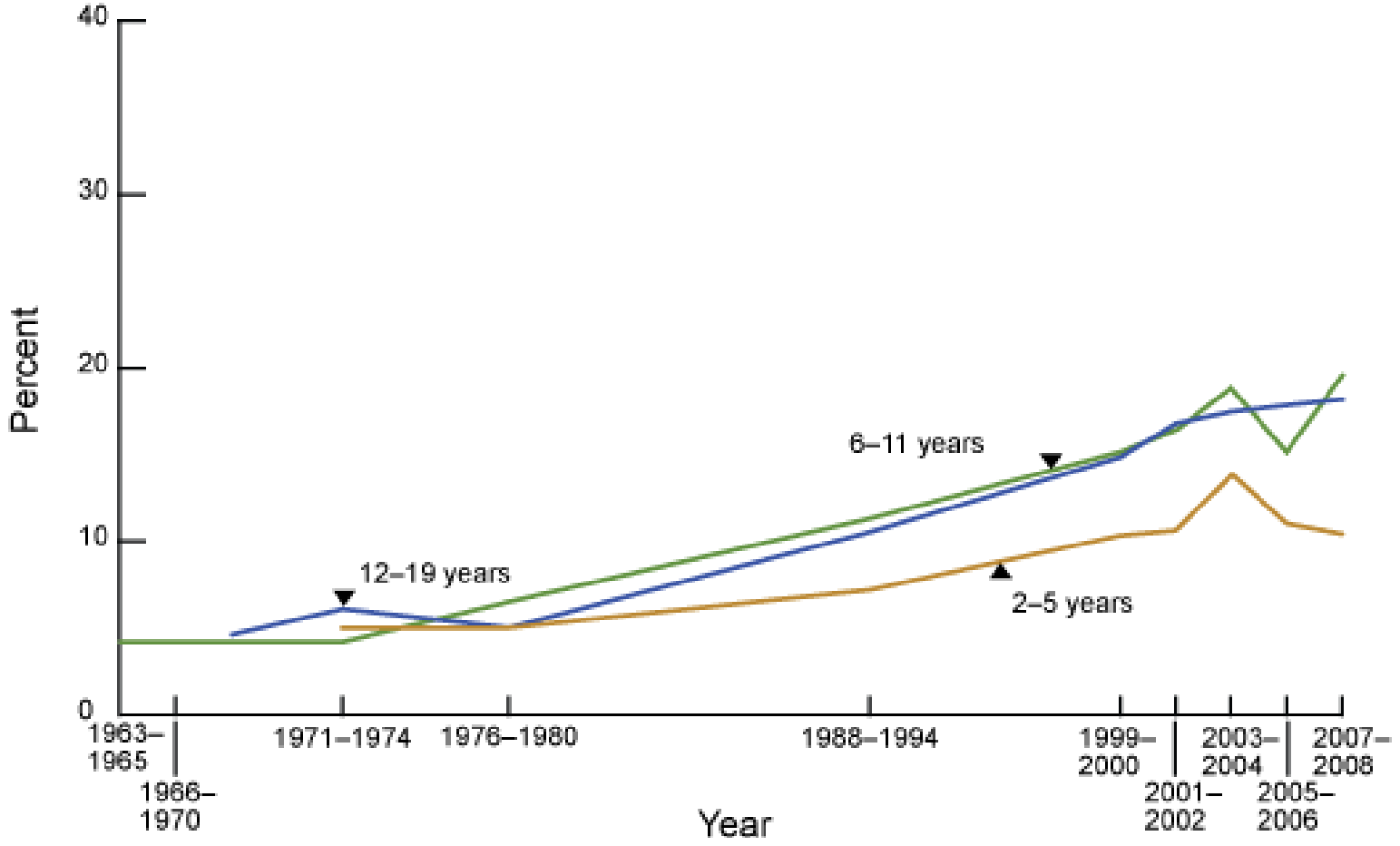
BRFSS, 1990, 1999, 2009

(*BMI ≥30, or about 30 lbs. overweight for 5'4" person)



Source: Behavioral Risk Factor Surveillance System, CDC.

Figure 1. Trends in obesity among children and adolescents: United States, 1963–2008



NOTE: Obesity is defined as body mass index (BMI) greater than or equal to sex- and age-specific 95th percentile from the 2000 CDC Growth Charts.
SOURCES: CDC/NCHS, National Health Examination Surveys II (ages 6–11), III (ages 12–17), and National Health and Nutrition Examination Surveys (NHANES) I–III, and NHANES 1999–2000, 2001–2002, 2003–2004, 2005–2006, and 2007–2008.

Introduction

- **Health risks include cardiovascular disease, type 2 diabetes, hypertension, osteoarthritis cancer, liver and gallbladder disease, and sleep and respiratory problems. . .**
- **Obesity-related medical costs account for 6-10% national health care expenditure, rising from $78.5 billion in 1998 to $147 billion in 2008.**

Introduction

- **Advanced technology and technical innovations have made agricultural production more efficient with expanded food supply at lower cost of calories.**
- **Technological change has also affected the life style and working habits of the population (more sedentary occupations and reduced physical activities).**

Previous Studies

- Binkley, Eales, and Jekanowski (2000).
- Lakdawalla and Philipson (2002).
- Finkelstein, Ruhm, and Kosa (2005).
- Gelbach, Klick, and Stratmann (2007).
- Schroeter, Lusk, and Tyner (2008).
- Nordström and Thunström (2010).

Objectives

- To examine the “price-effect” hypothesis on obesity by estimating a demand system that includes healthful and unhealthful foods, and other nonfood categories.
- Specifically, to provide empirical evidences from the underling demand relationships that may or may not support the contention that relatively cheaper food price contributes to the prevalence of obesity.

Theoretical Framework

- **The linear approximation of the AIDS (LA/AIDS) model in budget-share form is specified as:**

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{Y}{P}\right) + \varepsilon_i$$

where

$$\ln P = \sum_{j=1}^{n} w_j^0 \ln p_j$$

and w_j^0 is the mean budget share for good *j*.

Theoretical Framework

- **The following restrictions are imposed to ensure the model possess the desirable properties and are consistent with the theory:**

$$\sum_{i=1}^{n} \alpha_i = 1, \quad \sum_{i=1}^{n} \beta_i = 0, \quad \sum_{j}^{n} \gamma_{ij} = 0, \text{ and } \gamma_{ij} = \gamma_{ji}, \forall\, i \neq j \ .$$

Theoretical Framework

- **The Marshallian price elasticities for the model are calculated as:**

$$e_{ij} = \left(\frac{\gamma_{ij}}{w_i}\right) - \beta_i \left(\frac{w_j}{w_i}\right) - \delta, \quad \text{where } \delta = 1 \text{ if } i = j, \ = 0 \text{ if } i \neq j$$

and the expenditure elasticity is:

$$\eta_i = 1 + \frac{\beta_i}{w_i}$$

Theoretical Framework

- **The Hicksian price elasticities are obtained by adjusting the Marshallian price elasticities with the product of expenditure elasticity and budget share, i.e.,**

$$h_{ij} = e_{ij} + \eta_i w_j$$

Data

- **The required data were obtained from various sources:**
  - **U.S. Department of Labor's *CPI Detailed Report***
  - **U.S. Department of Agriculture's *Agricultural Statistics***
  - **U.S. Department of Commerce's *Survey of Current Business***
  - **Putnam and Allshouse (1999).**
- **The data collected for the study cover a period of 56 years from 1953 to 2008.**

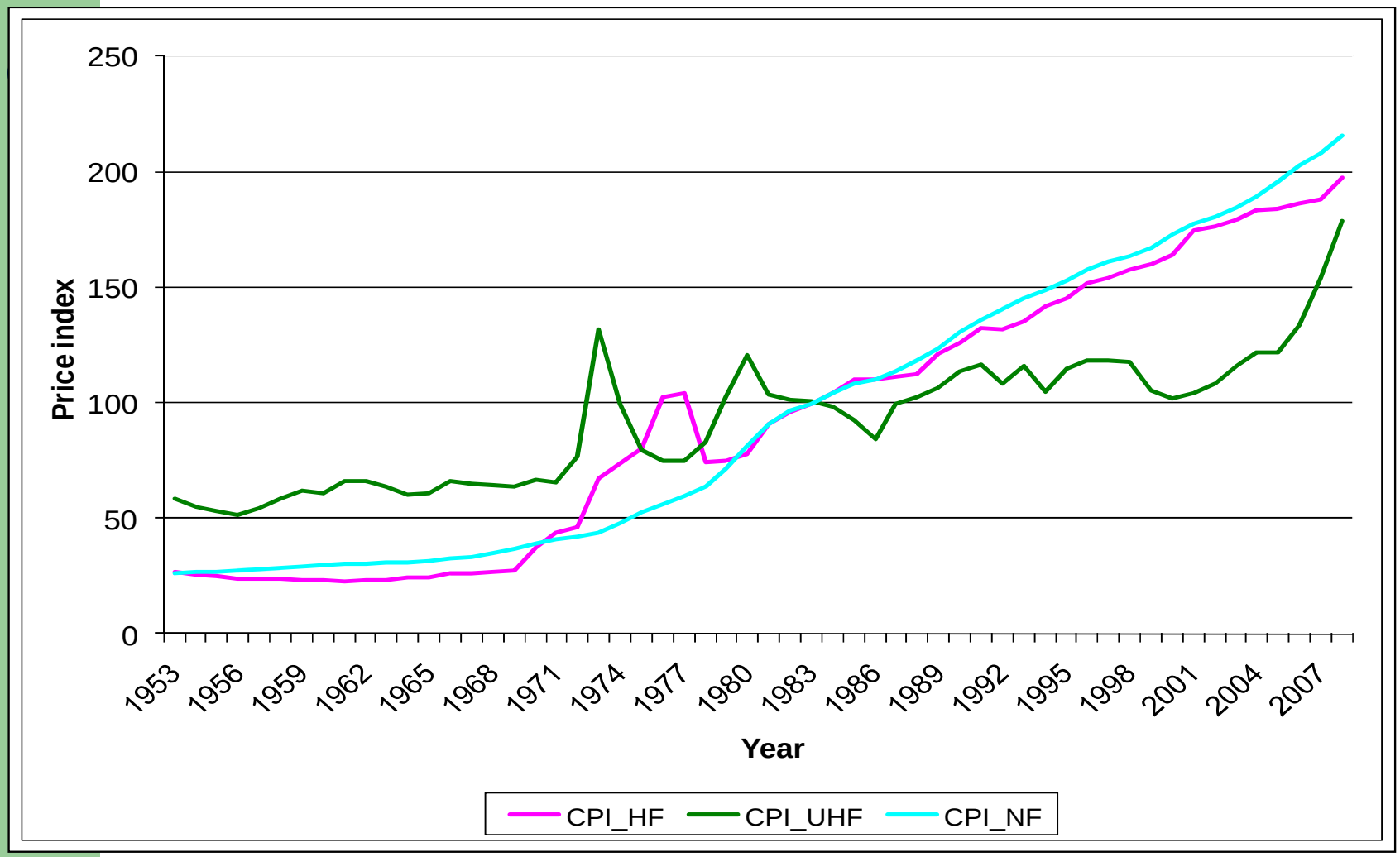
Table 1. Classification of Foods

Healthful Foods	Unhealthful Foods
Poultry	Beef and veal, pork, and other meats
Fresh fish and seafood	Eggs
Processed fish and seafood	Fluid and evaporated milk, and cheese
Fresh fruits and vegetables	Butter, margarine, and other fats and oils
Processed fruits and vegetables	Ice cream, and other frozen dairy products
	Wheat flour and rice
	Sugar and sweeteners
	Coffee and tea

Data

- **Price indices for healthful and unhealthful foods were constructed as weighted average of the consumer price index for individual food product.**
- **The weight being the expenditure share of each product within the food group.**

Figure 1. Price of Healthy Foods, Unhealthy Foods, and Nonfood, 1953-2008.



Estimation Procedure

- First, the time-series properties of the data is examined to identify the number of unit roots or the order of integration for each individual data series.
- Second, a dynamic AIDS with error correction model (ECM) is formulated and estimated to test for the H_0 that each budget share and the set of independent variables are cointegrated.

Table 2. Tests for Unit Root and Cointegration

	Unit Root Test		
Variable	Level	First Difference	Cointegration Test
W_1	-3.08	-9.78	-4.63
W_2	-1.79	-6.89	-3.89
W_3	-2.18	-7.84	-3.39
$ln(p_1)$	-1.70	-5.70	
$ln(p_2)$	-3.65	-6.63	
$ln(p_3)$	-1.27	-2.55	
$ln(Y/P)$	-2.18	-5.83	

Note: The tabulated critical values at the .10 significance level are -3.13 and -4.43 for unit root and cointegration tests, respectively. SHAZAM version 8.0 was used to perform the tests.

Estimation Procedure

- **The ECM version of the AIDS is given as:**

$$\Delta w_i = \delta_i \Delta w_{it-1} + \sum_{j=1}^{n} \gamma_{ij} \Delta ln p_j + \beta_i \Delta ln\left(\frac{Y}{P}\right) + \lambda_i u_{it-1} + \epsilon_i$$

where Δ denotes the difference operator, $u_{it\text{-}1}$ are the lagged residuals and λ_i is expected to be negative.

- **If the H_0: $\lambda_i = 0$ is rejected, then the series is cointegrated.**

Empirical Results

- The estimated λ_i coefficients are negative as expected and statistically significantly different from zero at the less than 5% significance level.
- All the estimated coefficients on price and real expenditure are statistically significant at the less than 1% level, except for the cross-price effect between healthy and unhealthy foods, which is significant at the less than 10% level.

Table 3. Estimated Parameters of an AIDS-ECM of Demand for Healthy and Unhealthy Food

Variable	Healthy Food	Unhealthy Food	Nonfood
$\Delta w_{it\text{-}1}$	-0.181**	0.233**	-0.052
Δlnp_1	0.012***		
Δlnp_2	-0.002*	0.024***	
Δlnp_3	-0.010***	-0.022***	0.031***
$\Delta ln(Y/P)$	-0.021***	-0.074***	0.095***
$u_{it\text{-}1}$	-0.563***	-0.110*	
R^2	0.681	0.660	
System weighted R^2 = 0.697			

Note: ***, **, and * denote the estimated coefficients are statistically significantly different from zero at the 1%, 5%, and 10% significance level, respectively.

Table 4. Estimated Demand Elasticities of the AIDS-ECM Model

Category	Healthy Food	Unhealthy Food	Nonfood	Expenditure Elasticities
		Uncompensated price elasticities		
Healthy Food	-0.59	0.001	0.30	0.29
Unhealthy Food	0.001	-0.69	0.42	0.27
Nonfood	-0.01	-0.04	-1.06	1.11
		Compensated price elasticities		
Healthy Food	-0.58	0.03	0.55	
Unhealthy Food	0.01	-0.66	0.65	
Nonfood	0.02	0.08	-0.09	

Empirical Results

- The results show that healthy and unhealthy foods are substitutes, although the degree of substitution between them seems limited.
- The Hicksian cross-price elasticity between healthy and unhealthy foods is about three times larger than that between unhealthy and healthy foods.

Empirical Results

- **The Hicksian cross-price elasticity between unhealthy food and nonfood is larger than that between healthy food and nonfood, suggesting the degree of substitution is generally in favor of unhealthful foods.**
- **Food, healthy or otherwise, is a necessity while nonfood category is considered a luxury good.**

Conclusions

- Own-price elasticities are all negative and all expenditure elasticities are positive as to be expected.
- The demand for food is less elastic than demand for nonfood with respect to both price and expenditure.
- The results suggest that both healthy and unhealthy foods are necessities while nonfood is a luxury.

Conclusions

- **The demand for food is price inelastic with the own-price effect for unhealthy food tend to be greater than that of healthy food.**
- **The study find little support of the price-effect hypothesis that substitution between healthful and unhealthful foods is an important factor contributing to the obesity epidemic in the United States.**

Conclusions

- **Finally, based on our findings, we would consider the use of so-called “sin-taxes” or “fat-taxes” as a policy instrument to reverse the prevalence of obesity, perhaps, ineffective.**
- **Such a policy may reduce the consumption of unhealthful food to some extent, it does not seem likely to induce any significant changes in increasing consumption of healthy foods.**

THANK YOU!

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