HEAT OR EAT?

The Expenditure Implications of the LIHEAP Program in Low-Income Households

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF AGRICULTURAL & RESOURCE ECONOMICS

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

2015

STATEMENT BY AUTHOR

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Acknowledgements

Thank you Dr. Lester Taylor, Dr. Dennis Cory, Dr. Bruce Beattie, and Dr. Gary Thompson for all the countless hours of reviewing, editing, and general advising you provided me with throughout this process.

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Abstract

The “Heat or Eat” dilemma postulates that low-income households sacrifice food expenditure in response to increased heating fuel costs. To address this public health issue, the Federal Government created the Low-Income Home Energy Assistance Program (LIHEAP). A correlative relationship between food and fuel expenditure exists. However, there is no theoretical reason why expenditure choices within these two categories should be directly linked. Therefore, the issue is an empirical question, one which has never before been evaluated. Using data from the Consumer Expenditure Survey (CES), LIHEAP’s impact on low-income households’ expenditures is assessed. By evaluating the effect LIHEAP has on low-income households, this research aims to test the “Heat or Eat” dilemma and the appropriateness of resulting political response.

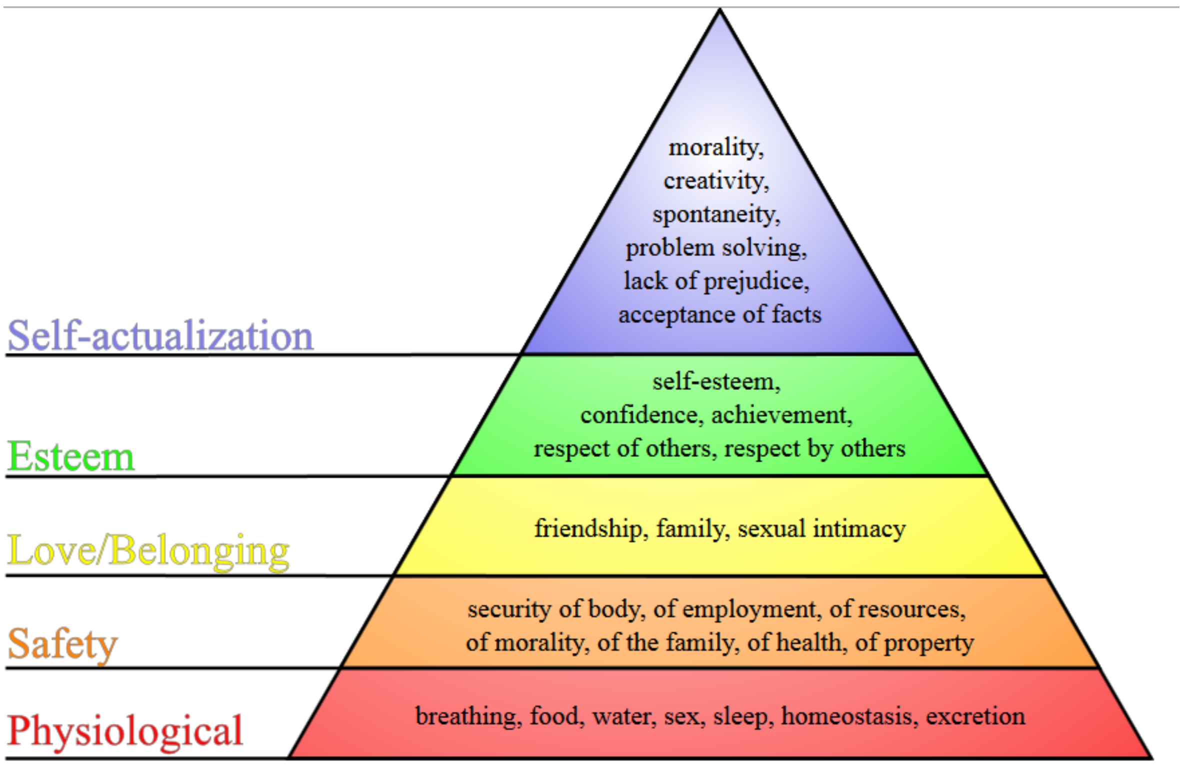
I. Introduction

The purpose of this research is to evaluate the relationship between fuel and food expenditures for low-income households in the U.S. There are a variety of qualitative and correlative arguments to support the contention that fuel and food are substitutes in consumption for low-income households. This phenomenon has come to be known as the “Heat or Eat” dilemma: as fuel expenditures rise, food expenditures must fall. A summary of the evidence supporting this hypothesis is presented in section II. In response to the concern that rising real energy prices may jeopardize the nutrition and overall health of low-income households, the federal government has initiated a fuel subsidy program known as the Low-Income Home Energy Assistance Program or LIHEAP. The intent of this initiative is to promote low-income household health by subsidizing fuel expenditures to bolster or help maintain food expenditures. A brief description of the federal LIHEAP program is presented in section III. It is unclear in practice that fuel and food expenditures function as substitutes in consumption. In fact, economic theory would suggest that the relationship between fuel and food is entirely an empirical question. An overview of theoretical considerations and the testable hypothesis that are generated is presented in section IV. The methodology employed to test the “Heat or Eat” contention is then discussed in section V. Followed in section VI by a presentation of the empirical results based upon survey data collected by the Bureau of Labor Statistics. Conclusions and suggestions for future research are then discussed in section VII.

II. Heat or Eat: The Policy Concern

Throughout psychological and sociological literature the notion of basic human needs is a widely varying and complex topic. Although there are diverse views, one of the most commonly referenced models of need is Maslow's Hierarchy of Needs (Maslow, 1943). Maslow illustrates human need with a pyramid in which the base consists of basic human needs and subsequent levels involve more complex levels of need fulfillment (see Figure 2.1).

Figure 2.1: Maslow's Hierarchy of Needs



Physiological needs comprise the base level and include things like air, food, water, shelter, warmth, and sleep, which represent human sustainment at its most fundamental level[1]. Maslow argues that only when the lower levels are fulfilled, can the higher levels of need also be reached

[1] See McLeod (2007) for an informative overview of the hierarchy and needs and their motivation.

and satisfied. Therefore, only after satisfying the most basic of human needs can one focus on the higher levels of satisfaction in life, involving love, esteem, and self-actualization.

For low income households around the world and in the United States, the satisfaction of physiological needs is often a financial struggle. In 2012 the average American household's largest areas of expenditure to meet basic needs included food, housing, apparel, transportation, and health care. The distribution of funds among each of these categories is shown in Table 2.1:

Table 2.1: Average American Spending on the Essentials, 2012

Area	Dollar ($) Expenditure	Percentage (%) of Total Expenditure	Percentage (%) of Income
Housing	16,887	33	26
Transportation	8,998	17	14
Food	6,599	13	10
Health Care	3,556	7	5
Apparel	1,736	3	3
Total	37,776	73	58

* *Consumer Expenditures in 2012,* U.S. Bureau of Labor Statistics (U.S. Bureau of Labor Statistics, 2014)

In 2012 the average American household made $65,596 before taxes and expended $51,442 for various goods and services. The proportion of total household income and expenditures allocated to essentials illustrates their comparative importance in family budgeting. Viewed in this light, funding housing items is the preeminent challenge in providing for basic needs, followed closely by securing transportation and food products.

An alternative measure of consumption priority is provided by the U.S. Bureau of Labor Statistics "Relative Importance" score, in which points are allocated out of a total of 100 to consumption categories based on their importance to consumers. In the August of 2012 CPI, housing had a relative importance of 41, transportation came in second at 16.9, and food had a relative importance score of 14.3 (U.S. Bureau of Labor Statistics, 2012). On the whole, this shows that American households spend over half of their annual pretax income on the essentials. This spending on essentials also accounts for three quarters of their total expenditures.

In contrast, for United States households earning the lowest 20% of income, the allocation of funds within the expenditure areas shifts. In this group the average pretax income is only $9,988, and average expenditure is $22,154 (U.S. Bureau of Labor Statistics, 2014). The difference between expenditure and income is attributable to government benefits and entitlements as well as credit card usage and loans used to meet living expense. The distribution of expenditure for this income group across categories of consumption is shown in Table 2.2:

Table 2.2: Lowest 20% of Income Spending on Essentials 2012

Sector	$ Expenditure	Percentage of Total Expenditure	Percentage of Income
Housing	8,836	40	88
Food	3,502	16	35
Transportation	3,447	16	35
Health Care	1,677	8	17
Apparel	759	3	8
Total	18,221	82	182

* *Consumer Expenditures in 2012*, U.S. Bureau of Labor Statistics (U.S. Bureau of Labor Statistics, 2014)

Here, the three essential living expenses, housing, food, and transportation, are still the highest proportion of expenditure. However, the proportion of income spent on just the essentials increases by over threefold from 10% to 35% in food, and from 26% to 88% in housing.

When the housing section of the CPI is broken down, the highest expenditure outside of rent or shelter costs, is fuels and utilities. A similar cost in fuel is seen within the transportation expenditure category, in which fuel is slightly less than the cost of vehicle payments. Altogether, energy and fuel prices account for 10% of total expenditures in the CPI, or a relative importance score of 9.68 (U.S. Bureau of Labor Statistics, 2012). From 1990 to 2013 the CPI for the 4 major categories of energy the increase (not adjusted for inflation) is shown in Table 2.3:

Table 2.3: Energy Price Increase 1990- 2013

Energy Source	Jan 1990 CPI	Dec 2013 CPI	Percent (%) Change	Percent (%) Annual Change
Fuel Oil	1.259	3.772	200	15.3
Gasoline	1.090	3.333	206	15.8
Utility Gas	0.599	0.998	67	5.1
Electricity	0.081	0.131	62	4.7

* U.S. Bureau of Labor Statistics: Databases, *Tables & Calculators by Subject* (U.S. Bureau of Labor Statistics, 2014)

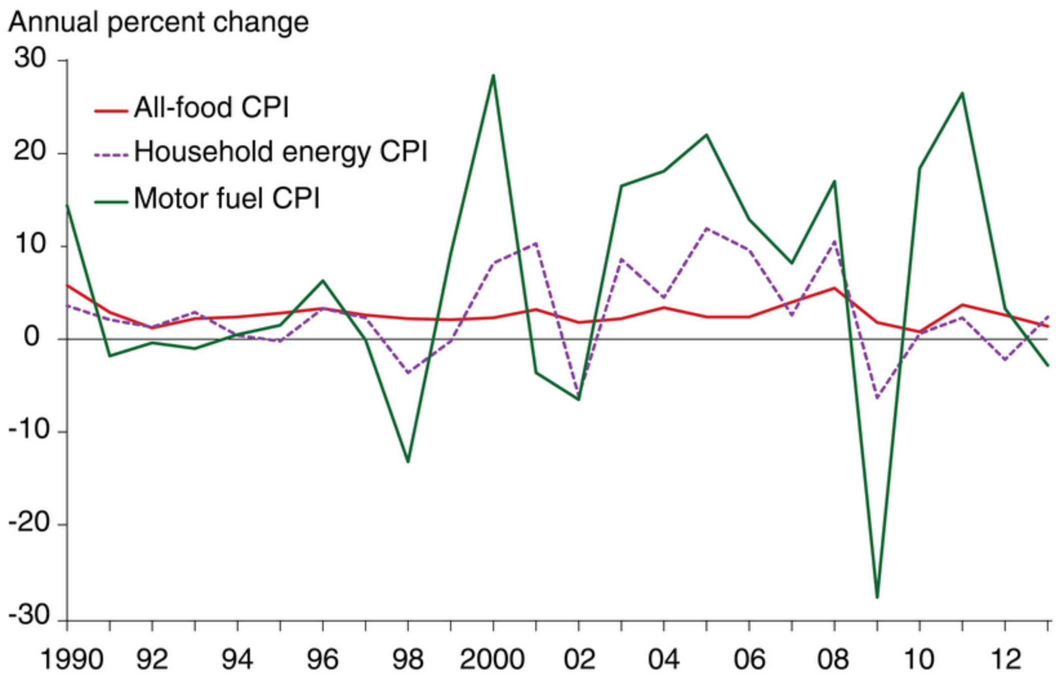
This significant annual change and total increase in energy prices indicates volatility in the market. In the year 2008, fuel oil fluctuated 42% and gasoline fell 57% in five months (U.S. Bureau of Labor Statistics, 2012). This material rise and fall in energy prices alone creates uncertainty for families on a budget and may pull money away from other areas of expenditure when prices suddenly rise.

Food is the second largest area of necessity expenditure for families in the lowest 20% of income. The USDA reported in 2013 that food prices had increased from 1990 to 2013 by an average of 2.7% annually (United States Department of Agriculture, 2014). In the report the relationship between income and share of income spent on food is detailed. Middle income families spend about 13.1% on food while families in the lowest quintile of income spend 36.2% on food (United States Department of Agriculture, 2014). This increasing trend in the budget share of food shows the effect that steady growth in food prices has had on low income households. With this increase, a significant burden is placed on low income families trying to meet basic physiological needs. Therefore, a substantially higher proportion of their income is needed to meet basic needs, while simultaneously, they often cannot survive on their earnings alone.

In 2013 the USDA also highlighted a relationship between the movement of food prices and consumer energy prices in the CPI. Energy prices are more volatile than food prices, but serve as a reliable indicator of movement in future food prices. Because fuel is required to harvest, process, and transport food, the two are invariably linked, as shown in Figure 2.4[2]:

[2] The assumption is that food and fuel are not complementary nor are they supplementary goods. In the figure the solid green line of Motor fuel CPI influences the lagged movement of the solid red line of All-food CPI. However, they do not move in a systematically opposite or joined pattern. This reinforces the notion that the two are not consumed directly with one another or as trade-offs for one another.

Figure 2.4: Changes in Food and Energy Prices, 1990- 2013



* USDA, Economic Research Service using data from the U.S. Bureau of Labor Statistics (USDA, 2015)

Another way in which food and energy are linked is in the way they are treated within Bureau of Labor Statistics' CPI analysis. When comparing trends in CPI the government often removes measures of food and energy from their analysis and does a separate estimation known as the "Core CPI" (Greenlees *et al*, 2008). This is due to "…the belief that food and energy prices are volatile and are subject to price shocks that cannot be damped through monetary policy." Because these are two of the most critical areas of consumer expenditure, with a relatively volatile nature, that influence one another's prices, the two have a (seemingly) substitutive relationship in consumption choices. When price of fuel rises so, after a brief lag period, does the price of food. This tradeoff between food and fuel has led to the idea of "Heat or Eat" and has established itself as a public health issue in academic literature and policy construction.

"Heat or Eat" is based on the economic relationships shown above as well as several socioeconomic studies. Most of these studies focus on the members of the United States population that suffer greatest when exposed to cold and lack of sufficient caloric intake, particularly young children and the elderly. One of the most commonly cited papers on this topic is (Bhattacharya, DeLeire, Haider, & Currie, 2003), the authors find several correlations in the relationship between heating fuel cost and caloric intake among rich and poor families. Using the Consumer Expenditure Survey, the authors construct a multivariate model of log expenditures in four food and fuel categories, with dummy and interaction terms included. They estimate the effects a shock in each category would have on the expenditure of other related categories for each consumer. Their analysis reveals that a drop in temperature of 10 degrees Fahrenheit results in a $9 decrease in food expenditure for poor families and no change for rich families. When this expenditure decrease is correlated to caloric intake via the Healthy Eating Index[3], "Adults consumed 147 fewer calories during the winter than during the summer (a 7.9% decline), adults with children consumed 241 fewer calories (an 11.6% decline), and poor children consumed 197 fewer calories (a 10.9% decline)" (Bhattacharya, DeLeire, Haider, & Currie, 2003). This research indicates that, as a whole, poorer families swap heating money for food and decrease their caloric intake in response to an increase in heating requirements.

When considering the effects on small children in particular, Cook, et al., (2008) best addresses the influence fuel insecurity has on food insecurity. In this cross-sectional study the authors used data from the Children's Sentinel Nutrition Assessment Program (C-SNAP) from January 2001 to December 2006. Information detailing children's weight and height as well as home energy

[3] Refer to http://www.cnpp.usda.gov/healthyeatingindex for a full summary on the Healthy Eating Index and its components.

security was also collected. The authors found that households with moderate energy insecurity have an increased likelihood of food insecurity by >233%. They also found that living in severe energy insecurity increases the odds of food insecurity by >300%. The probability of food insecurity experienced by only children in these households also increases 79% in moderate energy insecurity and 350% in those households with sever energy insecurity. Child developmental concerns also significantly increased, by 82%, in households that were severely energy insecure.

Lastly, the other segment of the population that is directly affected by the "Heat or Eat" dilemma is the elderly. There are two key characteristics of elderly Americans heating, cooling, and eating behavior that make them particularly vulnerable to energy and food price shifts. The first is that they use a significantly higher amount of energy than do other age groups on a per capita basis. In 2001 elderly Americans between 65 and 74 years of age used 49.6 million British thermal units (Btus) in space heating, while the age group 75+ used 54.2 million Btus (Tonn & Eisenberg, 2006). In comparison, the age groups of 35-44 years old and under 25 years old only used 30.4 million Btus and 24.9 million Btus respectively. There is a significant disparity in demand between elderly and younger age groups where the oldest age groups is demanding, on average, 117% more space heating energy than their younger counterparts. The difference in demand is only exacerbated by the fact that a majority of elderly individuals are on a fixed income, with 50% of the poorest elderly relying solely on their Social Security benefits.

The second factor that illustrates the vulnerability of elderly Americans to the Heat or Eat Dilemma is food vulnerability. In Kantor & Nord (2006) the author's measure the probability of very low food security or, food vulnerability. They then compare summer and winter food vulnerability in states with high cooling demand (hot states) and high heating demand (cold states). For the elderly in hot states, probability of food vulnerability is 27% higher in summer than in winter. In cold states the probability of food vulnerability is 43% lower in summer than in winter (Kantor & Nord, 2006). Lending credence to the notion that, the elderly have the highest seasonal food vulnerability.

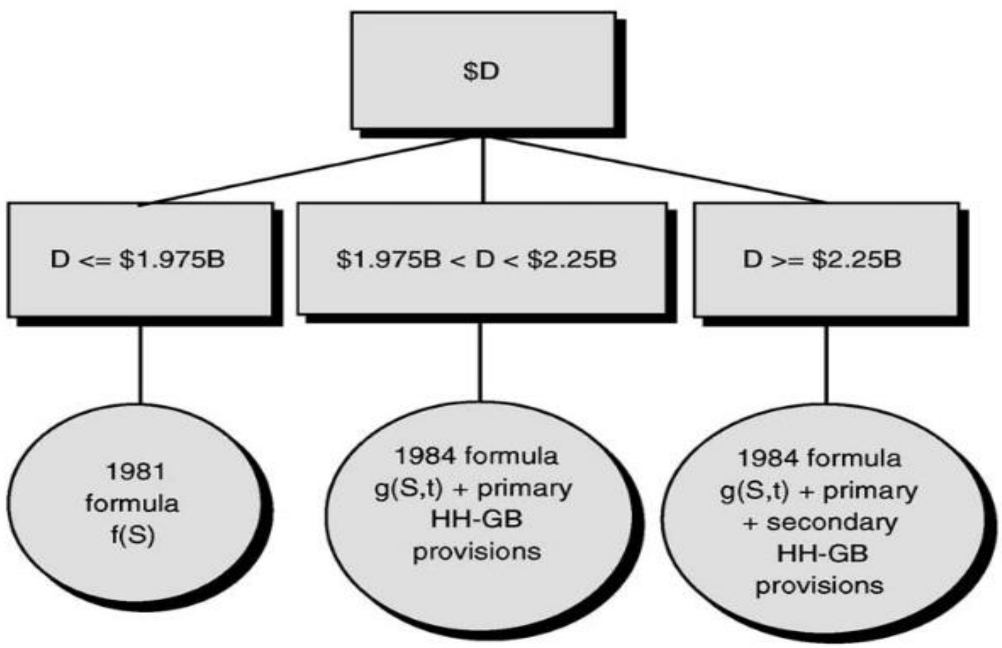
The "Heat or Eat" dilemma is both far reaching and complex, with several government programs that address the needs of households stressed by basic heating and food requirements. The two main responses have been food stamps and cash or direct utility benefits. The newest food stamp program is known as the Supplemental Nutrition Assistance Program (SNAP) and is strongly tied to the LIHEAP program, which confers payments for heating and cooling costs. The next section will focus on LIHEAP and its mission, and structure.

III. Heat or Eat: The Federal LIHEAP Program

In 2011, the mean energy expenditure for all households was $2,205, this translated into an average of 7% of income for an average American household (U.S. Department of Health and Human Services, 2014). For low-income households, in the bottom quintile of income, average energy expenditure was $1,913, or 13.4% of total expenditure (U.S. Department of Health and Human Services, 2014). Based on this comparison, the energy expenditure burden for low income households is almost double that of the national average. In 2009 an American household with an income at or below the poverty line expended $1,671 on energy (U.S. Energy Information Administration, 2012) while those above 150% of the poverty line expended $2,134, 21% more than their poorer counterparts (U.S. Energy Information Administration, 2012). This sugests that those on the lower economic spectrum are at a severe disadvantage on the whole, with energy expenditures falling greatly at lower levels of poverty. Because the low-income segment of the population struggles with energy costs on such a grand scale, in 1981 the U.S. government, under the Omnibus Budget Reconciliation Act, established the Low-Income Home Energy Assistance Program (LIHEAP) (Congressional Research Service, 2013).

LIHEAP acts as a conduit for distributing federal funds to states to help ease the income burden of heating on low-income households, in the hope that this benefit will free funds for other essentials and increase the overall quality of life for poor Americans. The manner in which these funds are distributed is based on the total amount of money requested by all states in that year ($D in Figure 3.1), the total distribution method is shown below in Figure 3.1:

Figure 3.1: Allocation of LIHEAP Funds



Source: (Pulsipher, 2002)

$D or total funds dispersed fall within one of three thresholds, less than $1.975 billion, between $1.975 billion and $2.25 billion, or above $2.25 billion. Each threshold then triggers a different dispersment formula based on combinations of the "old" 1981 formula and the "new" 1984 formula with different "hold harmless" provisions built in as well (Pulsipher, 2002). The "old"

1981 formula for funding allocation followed a multi-level approach that ultimately gave more money to cold weather states due to the relative hardship of winter. This "old" formula did not take into account cooling costs, more recent population data, and energy usage data per household (U.S. Department of Health and Human Services, 2014). The formation of the 1981 formula was influenced heavily by political considerations, and "…the formula is extremely complex and represented the outcome of a political process as opposed to being based on good science" (Kaiser & Pulsipher, 2005). The 1981 formula has been the main formula used for many years and only when total funds exceed $1.975 billion is any other method used. When this occurs the 1984 formula is used, because cooling is just as important as heating in some states, the money shifts with the new formula to more warm weather states (Congressional Research Service, 2013). To offset this change, Congress enacted "hold harmless" provisions that prevent over-allocation to some states and guarantee a percentage of funds to others (Congressional Research Service, 2013). The "Hold Harmless" provisions are shown as HH, and "Give-Back" shown as GB. The HH provision sets a "Statutory Floor" or a minimum percentage of funds to states based on the 1981 formula. With the GB provision if a state is allotted more than they need based on the 1984 formula, then the difference is given to the states that were shorted when transitioning from the 1981 to 1984 formulas.

Once the allocation method to the states has been decided and the states receive their funds, it is up to the states to distribute these funds to households. They first set thresholds for qualifying for the LIHEAP benefit. The two most common thresholds are an income level at 150% of the federal poverty level, or 60% of the state's median income (Department of Health and Human Services, 2015). Once this criteria has been established, the states accept applications to the LIHEAP program by households. These applications are either accepted or rejected and funds are then applied to the utility bills of households approved.

The goal of this program is the offset the common notion of a “Heat or Eat” dilemma in low-income U.S. households. The assumption is that reducing fuel burden will increase food consumption and reduce the need for a food and fuel trade off in cold and/or hot months. The effectiveness of the LIHEAP program to achieve this goal and eliminate a food or fuel trade-off is tested in the subsequent sections of this paper.

IV. Heat or Eat: Theoretical Considerations

The Consumer’s Constrained Utility Maximization Problem

As for all households, economists presume that low-income households make choices on what to purchase based on constrained utility maximization. That is, they choose the combination of goods and services that makes them best off given their ability to pay. The low-income household’s ability to maximize utility is constrained by its income including some amount of benefits. As discussed earlier, low-income households’ consumption exceeds their actual (“earned”) income by a significant amount. Utility is maximized when the household spends an amount up to, but not exceeding, total income and benefits. In our data set, households must spend some non-negative amount in every category of goods and services, as there is no such thing as negative expenditure. This restriction, that $x_i \geq 0$, is referred to as the Kuhn-Tucker condition.

Our utility maximization problem is given as

$$\underset{(x)}{maxU} = U(x_1, x_2, \ldots, x_n)$$

(4.1)

$$s.t. \sum_i p_i x_i \leq y \; and$$

$$x_i \geq 0 \sim Kuhn \; Tucker$$

where U= utility, $x_i(i = 1, \dots, n)$ is an expenditure (goods and services) category, p_i is the price of x_i, y is income (including benefits), and $i = 1, \dots, n$.

The consumer's problem is to maximize

$$\mathcal{L}\, U = U(\,(x_1, x_2, \dots, x_n) + \; \lambda\left(y - \sum_i p_i x_i\right) \tag{4.2}$$

where the Lagrangian multiplier, λ, represents the marginal utility of income. First-order conditions for maximization of (4.2) are

$$\frac{\partial \mathcal{L}}{\partial x_i} = \frac{\partial U}{\partial x_i} - \lambda p_i \leq 0 \; ; \; x_i \geq 0 \; ; \; \frac{\partial \mathcal{L}}{\partial x_i} x_i = 0 \; \forall \; i \tag{4.3}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = y - \sum_i p_i x_i \leq 0; \; \lambda \geq 0; \lambda \left(\frac{\partial \mathcal{L}}{\partial \lambda}\right) = 0 \tag{4.4}$$

Because this study focuses on low-income households, some assumptions are made that simplify the mathematics. Those assumptions are that: (1) low-income consumers spend all of their income plus some benefit on meeting their consumption needs; (2) some amount of money will be expended in every expenditure category of the CPI; and (3) marginal utility of income for a low-income household, like all households, is always positive. The assumption is that low-income households spend all of their income. While not a strong assumption it centers on the fact that low-income households struggle to pay their bills and therefore are often left with no extra money to set aside for savings. From the general form, (4.3) and (4.4) alters the first inequality restriction with respect to change in expenditure category to a strict equality set at zero. In the general form expenditure in a given category must be greater than or equal to zero, assuming that some consumers may choose not to consume specific items. But, because the CPI's consumption categories are so large and all encompassing, it is nearly impossible for a consumer to spend zero within a category. The assumption is therefore made that for each expenditure category there must be some spending greater than zero. The final alteration from the general equation to a representative low-income household involves the complementary slackness condition. Complementary slackness requires that either expenditure in a category, or change in the Lagrangian with respect to expenditure category must be equal to zero. The previous assumption of positive consumption in an expenditure category eliminates the first possibility of zero consumption in complementary slackness. Thus the final form of the first-order conditions, used in this paper is

$$\frac{\partial \mathcal{L}}{\partial x_i} = \frac{\partial U}{\partial x_i} - \lambda p_i = 0\ ;\ x_i > 0\ ;\ \frac{\partial \mathcal{L}}{\partial x_i} x_i = 0\ \forall\ i\ and$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = (y) - \sum_i p_i x_i = 0;\ \lambda > 0; \lambda\left(\frac{\partial \mathcal{L}}{\partial \lambda}\right) = 0 \qquad (4.5)$$

The assumptions of low-income expenditures being equal to income (including benefits), positive expenditure occurring in each category, and positive marginal utility of income for the representative household are all intuitively plausible for low-income households.

Comparative Statics

Assuming a two good world with a budget constraint:

$$\mathcal{L}(U) = U(x_1, x_2) + \lambda(y - p_1x_1 - p_2x_2) \tag{4.6}$$

Recall, the first order necessary conditions rely on the maximization of the Lagrangian and are as follows:

$$\frac{\partial \mathcal{L}}{\partial x_1} = u_1 - \lambda p_1 = 0 \; where \; u_1 = \frac{\partial U}{\partial x_1}$$

$$\frac{\partial \mathcal{L}}{\partial x_2} = u_2 - \lambda p_2 = 0 \; where \; u_2 = \frac{\partial U}{\partial x_2} \tag{4.7}$$

$$y - p_1x_1 - p_1x_2 = 0$$

With first-order and second-order conditions satisfied, optimal quantities of good one and good two (Marshallian demands) are defined as x_1^* and x_2^* respectively. To determine the change of these quantities with respect to a change in an exogenous variable like income or price, we totally differentiate the first order conditions:

$$u_{11}dx_1^* + u_{12}dx_2^* - p_1d\lambda^* - \lambda dp_1 + 0dp_2 + 0dy = 0$$

$$u_{21}dx_1^* + u_{22}dx_2^* - p_2d\lambda^* + 0dp_1 - \lambda dp_2 + 0dy = 0$$

$$-p_1dx_1^* - p_2dx_2^* + 0d\lambda^* - x_1dp_1 - x_2dp_2 + dy = 0 \tag{4.8}$$

Moving to the exogenous variables to the right hand side of the equality, yields

$$u_{11}dx_1^* + u_{12}dx_2^* - p_1d\lambda^* = \lambda dp_1$$

$$u_{21}dx_1^* + u_{22}dx_2^* - p_2d\lambda^* = \lambda dp_2$$

$$-p_1dx_1^* - p_2dx_2^* = x_1dp_1 + x_2dp_2 - dy$$

(4.9)

Now we can solve for the endogenous variable changes ($dx_1^*, dx_2^*,\ d\lambda^*$) using Cramer's Rule. For example,

$$dx_1^* = \frac{\begin{vmatrix} \lambda dp_1 & u_{12} & -p_1 \\ \lambda dp_2 & u_{22} & -p_2 \\ (x_1 dp_1 + x_2 dp_2 - dy) & -p_2 & 0 \end{vmatrix}}{\begin{vmatrix} u_{11} & u_{12} & -p_1 \\ u_{21} & u_{22} & -p_2 \\ -p_1 & -p_2 & 0 \end{vmatrix}} \tag{4.10}$$

The denominator determinant is the bordered Hessian for the two good case $|\bar{H}|$. The second-order condition for a maximum of equation (4.1) requires that $|\bar{H}|$ be positive for convex indifference curves. By LaPlace expansion of equation (4.4) along the third row of the numerator and replacing the denominator with the more compact bordered Hessian notation yields

$$dx_1^* = \frac{(x_1 dp_1 + x_2 dp_2 - dy)\begin{vmatrix} u_{12} & -p_1 \\ u_{22} & -p_2 \end{vmatrix} + p_2 \begin{vmatrix} \lambda dp_1 & -p_1 \\ \lambda dp_2 & -p_2 \end{vmatrix} + 0}{|\bar{H}|}$$

$$dx_1^* = \frac{(x_1 dp_1 + x_2 dp_2 - dy)(-p_2 u_{12} + p_1 u_{22}) + p_2(-p_2\ \lambda dp_1 + p_1 \lambda dp_2)}{|\bar{H}|} \tag{4.11}$$

Now consider the first comparative statistic result for the change in x_1^* when income (y) changes and all other exogenous variables are held constant (ceteris paribus). This is known as the uncompensated income effect:

$$\frac{dx_1^*}{dy} = \frac{p_2 u_{12} - p_1 u_{22}}{|\bar{H}|} \tag{4.12}$$

Based on the assertion that consumer's indifference curves are convex, $|\bar{H}| > 0$, the sign of uncompensated income effect depends on whether $p_2 u_{12} - p_1 u_{22} \substack{> \\ = \\ <} 0$ which cannot be unambiguously signed. If $dx_1^*/dy > 0$, $x_1$is said to be a "normal good"; if $dx_1^*/dy < 0$, x_1 is said to be an inferior good.

Knowing the change in x_1^* with respect to a change in income, the change in x_1^* with respect to a change in p_1, the own-price effect, when $dp_2 = dy = 0$ is

$$dx_1^* = \frac{x_1(-p_2u_{12} + p_1u_{22})dp_1 - \lambda p_2^2 dp_1)}{|\bar{H}|}$$

$$\frac{dx_1^*}{dp_1} = -\frac{\lambda p_2^2}{|\bar{H}|} - \frac{x_1(p_2u_{12} - p_1u_{22})}{|\bar{H}|} \begin{matrix} > \\ = \\ < \end{matrix} 0 \tag{4.13}$$

Again, because (4.13) cannot be signed, the sign of dx_1^*/dp_1 is ambiguous in general. However, if the good is a normal good an increase in income results in increased consumption of that good. That is, the sign of (4.12) is positive. In this case,

$$\frac{dx_1^*}{dp_1} = -\frac{\lambda p_2^2}{|\bar{H}|} - x_1[uncompensated\ income\ effect] < 0 \tag{4.14}$$

This illustrates that for normal goods, an increase in price of that good will lead to a decrease in consumption of that good. For inferior goods, consumers prefer less of those goods when income increases, also known as a negative income effect. This leaves ambiguity in the signing of dx_1^*/dp_1. However, in most cases dx_1^*/dp_1will be negative. Only, if the uncompensated income effect dominates $-\lambda p_2^2/|\bar{H}|$ will the own-price effect be positive, the case of a Giffen good (positively sloped demand curve).

Lastly, it is important to address cross-price effects. In a two-good world that would be the effect a change in the price of good two has on the consumption of good one and vice versa, ceteris paribus. As shown below when $dp_1 = dy = 0$,

$$dx_1^* = \frac{x_2(-p_2u_{12} + p_1u_{22})dp_2 + p_2p_1\lambda dp_2}{|\bar{H}|}$$

(4.15)

$$\frac{dx_1^*}{dp_2} = \frac{p_1p_2\lambda}{|\bar{H}|} - \frac{x_2(+p_2u_{12} - p_1u_{22})}{|\bar{H}|} = \frac{p_1p_2\lambda}{|\bar{H}|} - x_2[uncompensated\ income\ effect]$$

In the normal good case the sign of this equation is ambiguous depending on which right hand side term dominates. For an inferior good, because the uncompensated income effect is negative, then both right hand side terms are positive giving rise to a cross price effect that is unambiguously positive. That is, when p_2 increases the consumer will decrease his/her consumption of x_2 and increase consumption of x_1. While not obvious for (4.15), it can be further established that in a two-good world, the two goods cannot be compliments. This is because not all goods can be pairwise complementary see Henderson & Quandt (1958).

The above logic can be generalized to an *n* good world where consumers have several choices beyond just two goods. That is, the utility function depends on the levels of *n* goods:

$$U = U(x_1, x_2, \dots, x_n) \text{ with the budget constraint } y \tag{4.16}$$

Because there are now *n* alternatives for choice, the formation of the Lagrangian for maximization problem is

$$\mathcal{L} = U(x_1, x_2, \dots, x_n) + \lambda(y - p_1x_1 - p_2x_2 - \dots - p_ix_i) \tag{4.17}$$

The first-order conditions for maximization of the Lagrangian with respect to change in each of the *n* categories is given by

(4.18)

$$\frac{\partial \mathcal{L}}{\partial x_1} = \frac{\partial U}{\partial x_1} - \lambda p_1 = 0$$

$$\frac{\partial \mathcal{L}}{\partial x_2} = \frac{\partial U}{\partial x_2} - \lambda p_2 = 0$$

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$$\frac{\partial \mathcal{L}}{\partial x_n} = \frac{\partial U}{\partial x_n} - \lambda p_n = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = I - p_1 x_1 - p_2 x_2 - \ \dots - p_i x_j = 0 \tag{4.19}$$

The effects of income, own-price, and cross price can also be generalized to the n-good case. The uncompensated income effect takes into account how the consumption of a good changes with respect to an increase in income. In the normal good case, this is positive; in the inferior good case this is negative. The own price effect for the *n* good case also depends on the categorization of the good itself. If it is a normal good, the own-price effect is negative. The cross price effect then indicates how the price of a good effects its consumption within a category of the n good consumption bundle. The effect these cross prices have on the consumption of a specified good varies based on the relationship of the good to the prices changed in the consumption bundle. The generalization of these comparative statistic expressions can be found in (Henderson & Quandt, 1958).

Testable Hypothesis

The above theoretical considerations give rise to three testable hypothesis with regard to the "Heat of Eat" dilemma and LIHEAP's expenditure implications. If the LIHEAP benefit for a representative household is eliminated: 1) all adjustments occur in a trade-off between increased fuel expenditures and decreased food expenditures, then economic theory would predict that food and fuel are substitutes; or 2) if this does not occur and all other expenditure categories change, then it is unclear whether food and fuel are complements or substitutes; and 3) if all other categories change, then security spending may be significantly impacted as well. This evaluation aims to address the policy relevant implications of the LIHEAP benefit on low-income households. The following sections use data from the Bureau of Labor Statistics to simulate expenditure changes that results from the LIHEAP benefit elimination.

V. Heat or Eat: The Estimation Methodology

The previous sections have shown that food and fuel have a significant relationship to one another in several correlative ways. Some research has been conducted into why this may occur, however, no publication has explored the direct influence one category has on the other in U.S. household expenditures. In this study, a methodology is employed to simulate how changes in benefits received affect the consumption of food and fuel for households in the lowest quintile of income. The model, developed by Taylor (2014), estimates how change in expenditure or income within 14 categories of the Consumer Expenditure Survey (CES) affects the rest of the consumption bundle for households from the first quarter of 1996 to the fourth quarter of 2005. As Taylor notes,

> "…income data collected by the U.S. Census Bureau and expenditure data collected by the U.S. Bureau of Labor Statistics. The U.S. Census Bureau collects data on the total money income earned by U.S. individuals, families, and households. Households consist of all people who occupy a housing unit, regardless of whether they are related to each other by birth, marriage, or adoption, or not.[4] Mean consumption expenditures for all income quintiles are compiled by the U.S. Bureau of Labor Statistics (BLS) for 14 exhaustive categories of spending."

(Taylor, 2014). These categories are defined in Table 1.

Table 5.1: BLS Consumption Expenditure Categories

1. ***Food*** includes expenditures on food at home referring to expenses for grocery stores and food by the consumer on trips; food away from home accounting for all meals at fast food, take-out, delivery, concession stands, buffet and cafeteria, full-service restaurants, vending machines, and mobile vendors; and other miscellaneous venues.
2. ***Alcoholic beverages*** includes beer and ale, wine, whiskey, gin, vodka, rum, and other alcoholic beverages.
3. ***Housing*** includes expenditures on owned dwellings like interest on mortgages, property taxes, and repairs and maintenance; rented dwellings like rent and maintenance, utilities like natural gas and electricity; fuels like fuel oil and coal; public services like water, garbage and telephone; housekeeping supplies; household textiles; furniture; floor coverings; major and small appliance; and other miscellaneous equipment purchases.
4. ***Apparel*** includes expenditures on men's and boy's apparel; women's and girl's apparel; apparel for children under 2; footwear; and other apparel products and services.
5. ***Transportation*** includes expenditures for vehicle purchases; vehicle finance charges; gasoline and motor oil; maintenance and repairs; vehicle insurance; public transportation; and vehicle rental, leases, licenses, and other charges.
6. ***Health Care*** includes expenditures on health insurance; medical services like hospital services and physicians' services; eye and dental care; lab tests and X-rays, convalescent and nursing home care; medical appliances and equipment; and both non-prescription and prescription drugs.

[4] In 2012, the average total money income for U.S. households was $71,274, with a median value of $51,017. For the bottom quintile of household income in that year, the mean level was only $11,490.

7. ***Entertainment*** includes expenditures on fees and admissions; television, radio, and sound equipment; pets, toys, hobbies, and playground equipment; and other miscellaneous entertainment equipment and services like bicycles, hunting and fishing equipment, boats, photographic equipment and supplies, fireworks, electronic video games, etc.
8. ***Personal care products and services*** includes products for the hair, oral hygiene products, shaving needs, cosmetics and bath products, electric personal care appliances, other personal care products, and personal care services for males and females.
9. ***Reading*** includes subscriptions for newspapers and magazines; books through book clubs; and the purchase of single-copy newspapers, magazines, newsletters, books, and encyclopedias and other reference books.
10. ***Education*** includes tuition; fees; and textbooks, supplies, and equipment for public and private nursery schools, elementary and high schools, colleges and universities, and other schools.
11. ***Tobacco products and smoking supplies*** includes cigarettes, cigars, snuff, loose smoking tobacco, chewing tobacco, and smoking accessories (such as cigarette or cigar holders, pipes, flints, lighters, and pipe cleaners).
12. ***Miscellaneous*** includes safety deposit box rental, checking account fees and other bank service charges, credit card memberships, legal fees, accounting fees, funerals, cemetery lots, union dues, occupational expenses, expenses for other properties, and finance charges other than those for mortgages and vehicles.
13. ***Cash contributions*** includes cash contributed to persons or organizations outside the consumer unit, including alimony and child support payments; care of students away from home; and contributions to religious, educational, charitable, or political organizations.
14. ***Personal insurance*** includes expenditures on life insurance; endowments; mortgage insurance; and other premiums for personal liability, accident, and disability, and other non-health insurance other than for homes and vehicles.

Source: U.S. Bureau of Labor Statistics, available at http://www.bls.gov/cex/csxgloss.htm

In this simulation, the relationships for individual categories of consumption expenditures to one another are investigated through a sequence of least-squares regression equations. The specific categories for analysis are pulled from sub-categories of the CES survey. Because food and fuel are the two foci of this paper, six subsets of the larger categories are specified. They include *fdhome* and *fdaway,* which capture food expenditure at and away from home, as well as *elctrc*, *ntlgas*, and *fuloil* which capture all energy sources that could be used for heating, and *hous1* which encompasses all other housing expenses except *elctrc, ntlgas,* and *fuloil*. *Hous1* includes expenses like telephone, water, childcare, furniture, flooring, etc. From the original 14 category list, total food expenditure is replaced with *fdhome* and *fdaway*, and housing is replaced with *hous1* this adds four new categories for analysis and takes the total categories to 18.

Taylor's model allows us to examines how a change in heating expenditure diffuses onto expenditures in other categories. The model enables estimation of a matrix of mean "intra-budget" regression coefficients for 18 (exhaustive) categories of expenditure from the 48 BLS Quarterly Consumer Expenditure Surveys for 2001 to 2012. Let $y_1, \ldots, y_{18}$ denote an exhaustive 18-category breakdown of expenditures on one of the BLS Quarterly Expenditures Surveys and let

$$y_i = \alpha_i + \sum_{j \neq i} \beta_{ij}\, y_j + u_i, \qquad i, j = 1, \ldots, 18, \tag{5.1}$$

represent the least-squares regression equation of expenditures in the *i*th category on expenditures in the other 17 categories. Eq. (5.1) is estimated for each of the 18 categories for each of 48 BLS Quarterly Consumer Expenditure Surveys for 2001Q1 to 2012Q4.

To simplify notation, let y = $(y_1, \ldots, y_{18)}$ denote a (column) vector of expenditures and let B be the 18 × 19 matrix:

$$\mathrm{B} = [\mathrm{z}, \mathrm{A}], \tag{5.2}$$

Where z denotes the intercepts as a column vector and A denotes the *transpose* of the 18 × 18 sub-matrix of "intra-budget" coefficients from that table, but with -1s on the diagonal replaced by 0s. Hence,

$$y = z + Ay, \tag{5.3}$$

or

$$[I - A]y = z, \tag{5.4}$$

so that

$$y = [I - A]^{-1}z. \tag{5.5}$$

Expressions (5.3) and (5.5) are referred to as the *structural* and *reduced-form* representations of the framework, respectively. The *structural* form will be used in the estimations that follow, as changes in expenditures are assumed to be *exogenous*. “Exogenous,” in this context, will refer to a change in z. Results for the estimations reported in the text are measured against a “base” vector of expenditures that is obtained from equation (5.5) using intercepts from the last row for z. Details on computing own- and cross-price elasticities in this framework are presented in Appendix B.

VI. Heat or Eat: Evidence from BLS Surveys

This analysis is based on the interaction between fuel expenditures and food consumption. To test how consumption choices change with regard to “Heat or Eat”, the low-income population is represented by the lowest quintile of expenditure in the data set. This low-expenditure population is isolated in the data set as the total sample for analysis. Because the “Heat or Eat” dilemma assumes that an increase in fuel cost perturbs food spending, a simulated elimination of fuel benefit is utilized. This benefit elimination is valued at the amount of the government LIHEAP benefit that is given to a representative household. This is due to the fact that LIHEAP benefits significantly subsidize the fuel spending of low-income families. By removing this benefit, the simulation shows the implications of the subsidy across expenditure categories.

The most recent legislatively mandated summary of LIHEAP benefits on a regional and national scale is from 2009, in which “heating benefits” represent all heating and cooling benefits received that year. The regional variation is shown in table 6.1.

Table 6.1: Average LIHEAP Benefit, 2009

Census Region	Average LIHEAP benefit for heating costs
Midwest	$522.00
Northeast	$490.00
South	$458.00
West	$603.00
U.S. Average	$505.00

Source: Low-Income Energy Assistance Program Report to Congress for Fiscal Year 2009 (see http://www.acf.hhs.gov/programs/ocs/resource/liheap-report-to-congress-fy-2009)

These figures are used as a benchmark for adjusting the newest data available from the LIHEAP Action Center website[5]. Here, each state reports its own summary statistics including, but not limited to, the number of households receiving benefits, total block grant, and in most cases, average benefit distributed. To calculate the national average benefit for 2013, each states summary statistics are aggregated into one data set available in Appendix A. Of the 51 states (including District of Columbia) 28 of them reported an average annual benefit for 2013. Of the states that did not report this value, 16 provided a range of benefit values. For these states, their median benefit is used. The remaining seven states either reported a minimum, maximum, or no

[5] The LIHEAP Action website is the stand alone site for the LIHEAP program. It contains various publications on the program as well as an interactive U.S. map that includes state by state data and “Fact Sheets”.

benefit value. For these states, the total block grant is divided by the number of households receiving benefits in that state. Based on the above conditions, the average benefits for 2013 are shown below:

Table 6.2: Average Estimated LIHEAP Benefit 2013

Census Region	Average LIHEAP benefit for heating costs
Midwest	$538.04
Northeast	$468.56
South	$423.03
West	$474.91
Total	$471.35

Source 1: LIHEAP Action Center Website (see http://liheap.org/)

LIHEAP Expenditure Implications: The Representative Low-Income Household

The first area to analyze is the lowest quintile of expenditure as a whole. For this group the $471.35 of estimated LIHEAP benefit is removed from assumed received benefits. This in turn acts as a surcharge in the heating expenditures for electricity, natural gas, and fuel oil. To simulate proportional changes in each category, the surcharge on electricity, natural gas, and fuel oil are increased by the percentage they represent within fuel expenditure. For instance, electricity is 74% of base fuel expenditures its price is therefore increased by 74% of $471.35 or $348.80. The simulation yields a new expenditure y vector of base expenditures shown below:

Table 6.3: Effects of a $471.35 Annual Increase in Expenditures for Heating by Households in the Bottom Quintile of Total Expenditure with Total Expenditure Held Constant

Expenditure Class	Category	Expenditures ($)			
		Base	After Increase	Category Change	Class Change
Housing Spending Adjustments	Electricity	733.22	1,043.06	309.84	149.28/yr (12.44/mo)
	Natural Gas	232.75	359.95	127.20	
	Fuel Oil	26.22	49.56	23.35	
	Housing (less *elctrc*, *ntlgas*, and *fuloil*)	4,147.36	3,836.25	-311.11	
Food Spending Adjustments	Food Away	506.41	448.24	-58.17	-33.92/yr (-2.83/mo)
	Food Home	2,402.36	2,426.61	24.25	
Discretionary Spending Adjustments	Alcoholic Beverages	96.43	73.47	-22.96	-103.14/yr (-8.60/mo)
	Apparel	294.06	247.44	-46.62	
	Transportation	1,268.64	1,254.25	-14.39	
	Tobacco	197.66	186.78	-10.88	
	Entertainment	502.29	499.44	-2.85	
	Cash Contributions	242.97	237.53	-5.44	
Security Spending Adjustments	Health	1,016.35	1,088.81	72.45	-3.74/yr (-0.32/mo)
	Education	98.85	46.00	-52.85	
	Personal Insurance	660.76	637.42	-23.34	
Unaffected Spending Adjustments	Personal Care	88.95	86.19	-2.76	-8.48/yr (-0.71/mo)
	Reading	37.85	36.16	-1.69	
	Miscellaneous	74.94	70.91	-4.03	
Total		12,628.07	12,628.07	0.00	0.00

For the representative lowest-quintile household, the annual expenditure change in the expenditure classes are particularly notable. The first is the significant reduction in housing expenditure without electricity, fuel oil, and natural gas utilities excluded. Expenditures in this category include furnishings, home repair, appliances and other flexible spending categories that can adapt to changes in expenditure. Second, there is reduced spending in food, food away from home falls by the second largest amount of any category and food spending at home actually increases. The third notable change in consumption choices is in the security group. Within this bundle health spending increased while education and personal insurance spending both fall.

To examine how low-expenditure households accommodate a fuel surcharge of $471.35, it is helpful to examine how the percentages of total expenditure in each category change.

Table 6.4: Percentage Changes by Expenditure Class after Fee Increase

Expenditure Class	Base Expenditure %	After Increase Expenditure %	Change in Expenditure %
Housing	40.7	41.9	1.2
Food	23	22.8	-0.2
Discretionary	20.6	19.8	-0.8
Security	14.1	14	-0.1
Unaffected	1.6	1.5	-0.1
Total	100	100	0

Table 6.4 shows that there are trivial changes in the percentage of expenditure in each expenditure class. If a true "Heat or Eat" trade-off were occurring, then the food response for a fuel surcharge should be dramatic. Low-expenditure consumers in this simulation respond with a 0.2% decrease in annual food expenditure. Even this seemingly inconsequential decrease in food expenditure is misleading, as it represents a trade-off of more expensive food away from home for cheaper food at home[6]. By way of contrast, the largest area of expenditure change is a 1.2% decrease in housing expenditures. This marginal change in response to the surcharge documents an inelastic demand

[6] Based on 2008 data from the USDA, the number of daily calories at home per dollar is 252.15 and daily calories away from home per dollar is 122.67. Therefore, food away from home on a per calorie bases 51% cheaper than food away. (see http://www.ers.usda.gov/data-products.aspx)

for fuel. The dollar increase in fuel expenditure in response to this $471.35 surcharge is $460.39. That is, very little of the lost housing benefit is accommodated through conservation. Increased fuel consumption expenditures restore 97.7% of the dollar surcharge. Households shift money from lower priority categories of spending.

Table 6.5 shows the manner in which money is shifted from other categories to adjust for the remaining $460.39 increase in fuel expenditures:

Table 6.5: Expenditure Changes Accounting for Increase in Fuel Cost

Category	Amount Change	Percentage
Housing (less fuel)	-$311.11	67.6
Food	-$33.92	7.4
Discretionary	-$103.14	22.4
Security	-$3.74	0.8
Unaffected	-$8.48	1.8
Total	-$460.39	100

Here, 99.8% of the $460.39 increase in fuel expenditure is covered by reductions in other category's spending. The salient result is that 90% of the accommodation is taken from just the housing less fuel category and the discretionary spending category. As for the "Heat or Eat" dilemma only 7.4% of the increase in expenditure is accounted for with food spending decreases. In monthly expenditures this only reduces food expenditure by $2.83 per month. Spending on education and personal insurance also decline by modest amounts to accommodate health spending rising, from 8.0% of total expenditures to 8.6%.

To Summarize:

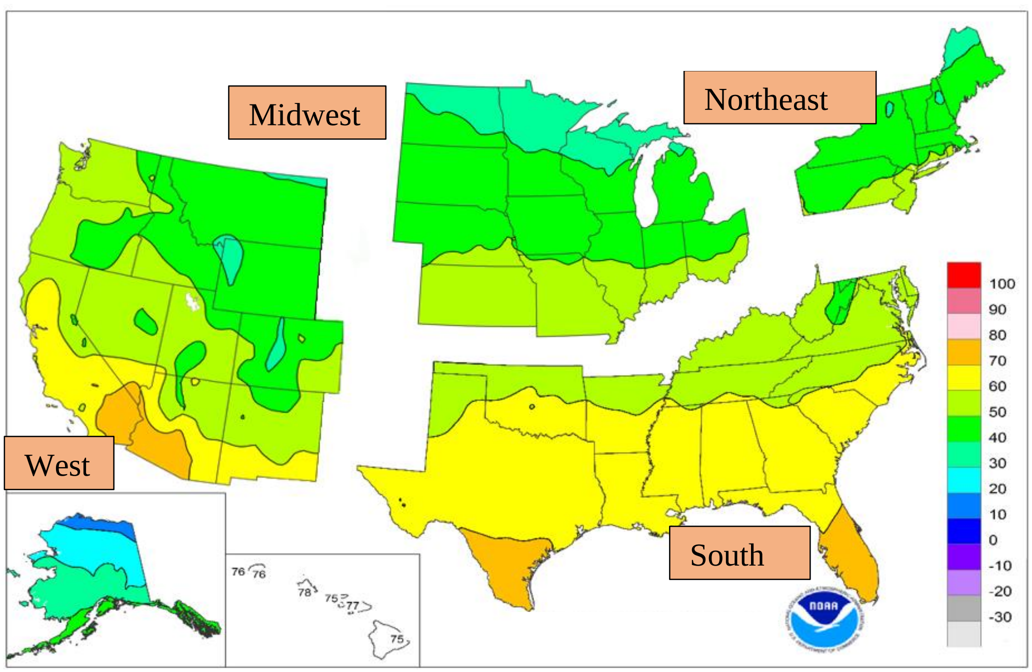
Removing the fuel benefit results in a few specific expenditure and consumption responses. The first is little to no fuel conservation; households' demand for fuel is relatively inelastic[7], and therefore a surcharge on fuel does little to disturb their demand. The second response is in the housing (less fuel) costs, where a significant amount of funds are removed. This category is large and includes several elastic consumption choices, therefore it accounts for the largest accommodation of fuel expenditure increase. Third, there is no empirical evidence to support the "Heat or Eat" dilemma. There is a modest decline in food expenditures as a whole ($2.83/month) that represents a substitution from expensive food away from home for cheaper food at home. Finally, expenditures on health-related goods and services increase by 0.6%, as a percentage of total household expenditures, as expenditures in education and personal insurance decrease.

[7] Price elasticity measures range from -0.73 to -1.13 using data from the Residential Energy Consumption Survey. (Fell, Li, & Paul, 2012)

LIHEAP Expenditure Implications: Regional Variations

Now that the lowest quintile on a national level has been examined, the regional differences in expenditure are also examined. The census regions are divided mainly by convention. The first Census map, "…divided the United States into four regions, which were based on major drainage systems." (Census History Staff, 2014) The regions have been altered significantly since then and in 1984 the most recent map seems to group by climate similarities. As temperature and seasonal changes vary with state, so too does the energy demand for households. Figure 1 shows the United States average annual temperature broken into census regions. The Northeast and Midwest regions have lower average temperatures than their Western and Southern counterparts. From a heating benefit perspective, it follows that these regions carry a heavier income burden for fuel costs. To test the differences between regions they are examined individually.

Figure 6.1: Average Annual Temperature (ºF) By Census Region (2014)



Regional Variations: Midwest

The first region to be examined specifically, is the Midwestern region of the United States. Table 6.6 shows the poverty and descriptive statistics for this region. The Midwest is average in most categories of descriptive statistics with fewer than ten million individuals in poverty, and median income similar to the national mean. It does have a slightly higher total percentage of children in poverty, at 6.6%, and the highest combined percentage of children and elderly in poverty. The main way in which Midwest households differ from those in any other region is in the number of households using utility gas. Utility gas is easily stored in remote areas and requires less infrastructure than electricity. The Midwest region includes the most states with harsh winters and mild summers, therefore the amount of heating benefit is larger than any other region. The average regional benefit, as calculated from the national average method, in 2013 was $538.04.

Table 6.6: Midwest Regional Descriptive Statistics 2013

State	Poverty, All Ages	State Poverty (%)	Median Income ($)	Median Age	(%) of Children 0-5	(%) of Elderly 65+	Occupied housing units	Avg. home size of owned unit	Avg. home size of rented unit	Homes using utility gas (%)	Homes using electricity (%)	Homes using fuel oil (%)
Illinois	1,841,996	14.6	56,212	37.2	6.4	12.9	4,772,723	2.73	2.42	14.61	2.65	0.04
Indiana	1,008,411	15.8	47,508	37.4	6.6	13.3	2,481,793	2.63	2.36	5.85	2.59	0.10
Iowa	377,037	12.6	52,286	38.1	6.5	15.1	1,226,547	2.52	2.16	3.02	0.87	0.03
Kansas	391,718	13.9	50,892	36.0	7.1	13.5	1,110,440	2.61	2.30	2.91	0.91	0.00
Michigan	1,646,038	17.0	48,200	39.5	5.9	14.2	3,823,280	2.60	2.34	11.35	1.17	0.22
Minnesota	592,526	11.2	60,664	37.7	6.6	13.3	2,107,232	2.59	2.18	5.42	1.27	0.23
Missouri	928,778	15.8	46,905	38.2	6.4	14.4	2,360,131	2.56	2.28	4.74	3.00	0.02
Nebraska	234,742	12.9	51,502	36.2	7.1	13.7	725,787	2.59	2.22	1.77	0.71	0.01
North Dakota	81,055	11.6	56,800	35.3	6.6	14.4	287,270	2.49	1.97	0.46	0.42	0.04
Ohio	1,793,523	15.9	48,138	39.3	6.1	14.4	4,557,655	2.56	2.28	11.74	3.78	0.48
South Dakota	114,291	14.0	49,200	36.8	7.1	14.5	323,136	2.54	2.25	0.60	0.34	0.03
Wisconsin	753,709	13.5	51,474	39.0	6.2	14.1	2,288,332	2.55	2.17	5.74	1.27	0.29
Summary	9,763,824	14.1	51,648	37.6	6.6	14.0	26,064,326	2.58	2.24	68.22	18.98	1.53

Source: *Small Area Income and Poverty Estimates: State and County Estimates for 2013, US Census Bureau*
Selected Housing Characteristics: 2009-2013 American Community Survey 5-Year Estimates, US Census Bureau

In Table 6.7 the effects of a $538.04 surcharge in fuel is simulated:

Table 6.7 Effects of a $538.04 Annual Increase in Expenditures for Heating by Households in Bottom Quintile of Expenditure in Midwest Region with Total Expenditure Held Constant

Expenditure Class	Category	Expenditures ($)			
		Base	After Increase	Category Change	Class Change
Housing Spending Adjustments	Electricity	625.20	960.10	334.90	259.74/yr (21.65/mo)
	Natural Gas	357.40	592.89	235.49	
	Fuel Oil	8.62	20.22	11.60	
	Housing (less *elctrc*, *ntlgas,* and *fuloil*)	3,944.90	3,622.64	-322.25	
Food Spending Adjustments	Food Away	540.44	461.92	-78.51	-33.95/yr (-2.83/mo)
	Food Home	2,117.20	2,161.76	44.56	
Discretionary Spending Adjustments	Alcoholic Beverages	130.12	86.95	-43.16	-210.32/yr (-17.53/mo)
	Apparel	310.65	232.04	-78.62	
	Transportation	1,260.80	1,204.92	-55.87	
	Tobacco	204.91	192.39	-12.51	
	Entertainment	511.45	485.15	-26.30	
	Cash Contributions	257.31	263.45	6.14	
Security Spending Adjustments	Health	1,130.20	1,289.13	158.93	-6.57/yr (-0.55/mo)
	Education	179.54	59.85	-119.69	
	Personal Insurance	666.51	620.71	-45.81	
Unaffected Spending Adjustments	Personal Care	91.15	86.80	-4.35	-8.89/yr (-0.40/mo)
	Reading	46.24	43.95	-2.29	
	Miscellaneous	79.52	77.26	-2.25	
Total		12,462.16	12,462.16	0.00	0.00

It is worth noting that base expenditures in this region are lower than the national average, even though the average temperature is lower than the average. The regional effects on housing spending adjustments are the highest in the Midwest. Housing less fuel spending falls by $322.25 annually, but not enough to offset the dramatic increase in utility costs. Overall, this leads to a

$259.74 increase in annual housing expenditures. In food spending, food away from home falls and food at home increases at almost the exact same proportion as the national average. Security spending drops farther than the national average and particularly, education expenditure significantly decreases. All other categories follow this trend as well and decline more than the national average, notably in apparel purchases and transportation. The Midwest also takes the hardest hit in discretionary spending, as households scramble to cut costs to cover utility increases. This reinforces the assumption that the Midwest is disproportionately burdened by utility surcharge.

Regional Variations: Northeast

The next region that is analyzed is the Northeast, shown in Table 6.8. The Northeast is a region of extremes with regard to their descriptive statistics. It has the smallest proportion of individuals in poverty of any region, as well as the largest median income level. It also have the largest proportion of elderly individuals in poverty at 14.7%. The Northeast also has the oldest population on average and the second largest household size of own-occupied housing. Finally, there is also the largest number of households using fuel oil, which is the least commonly used fuel expenditure. The Northeast is another region that is disproportionately burdened by cold weather in relation to other geographic regions.

Table 6.8: Northeast Regional Descriptive Statistics 2013

State	Poverty Estimate, All Ages	State Poverty (%)	Median home Income ($)	Median Age	(%) of Children 0-5	(%) of Elderly 65+	Occupied housing units	Avg. home size of owned unit	Avg. home size of rented unit	Homes using utility gas (%)	Homes using electricity (%)	Homes using fuel oil (%)
Connecticut	373,387	10.7	67,262	40.5	5.5	14.5	1,355,849	2.68	2.30	2.08	0.99	2.99
Maine	181,386	14.0	47,095	43.9	5.1	16.5	553,823	2.44	2.06	0.13	0.12	1.80
Massachusetts	770,922	11.9	66,794	39.4	5.5	14.1	2,530,147	2.69	2.22	5.91	1.68	3.80
New Hampshire	115,146	9.0	64,064	42.3	5.2	14.2	518,245	2.59	2.17	0.49	0.19	1.20
New Jersey	995,390	11.4	70,224	39.4	6.1	13.8	3,186,418	2.82	2.51	11.21	1.72	1.78
New York	3,068,230	16.0	57,255	38.2	6.0	13.8	7,234,743	2.76	2.44	19.13	3.39	9.46
Pennsylvania	1,687,854	13.7	52,005	40.7	5.7	15.7	4,958,427	2.60	2.21	12.06	4.88	4.59
Rhode Island	148,275	14.7	55,015	39.9	5.3	14.8	410,058	2.61	2.23	0.99	0.17	0.70
Vermont	73,947	12.3	52,511	42.4	5.0	15.2	257,004	2.44	2.08	0.19	0.06	0.57
Regional Total	7,414,537	12.6	59,136.11	40.7	5.5	14.7	21,004,714	2.63	2.25	52.20	13.21	26.89

Source: *Small Area Income and Poverty Estimates: State and County Estimates for 2013, US Census Bureau*
Selected Housing Characteristics: 2009-2013 American Community Survey 5-Year Estimates, US Census Bureau

In Table 6.9 the effects of a $468.55 surcharge in heating utilities is simulated:

Table 6.9 Effects of a $468.55 Annual Increase in Expenditures for Heating by Households in Bottom Quintile of Expenditure in Northeast Region with Total Expenditure Held Constant

Expenditure Class	Category	Expenditures ($)			
		Base	After Increase	Category Change	Class Change
Housing Spending Adjustments	Electricity	528.49	743.54	215.05	167.85/yr (13.99/mo)
	Natural Gas	304.84	511.35	206.50	
	Fuel Oil	104.62	206.20	101.58	
	Housing (less *elctrc*, *ntlgas,* and *fuloil*)	4,506.49	4,151.20	-355.28	
Food Spending Adjustments	Food Away	461.65	401.44	-60.21	-91.25/yr (-7.60/mo)
	Food Home	2,388.52	2,357.49	-31.04	
Discretionary Spending Adjustments	Alcoholic Beverages	100.99	77.11	-23.87	-107.88/yr (-8.99/mo)
	Apparel	320.88	261.42	-59.47	
	Transportation	1,036.92	1,021.82	-15.10	
	Tobacco	179.72	163.03	-16.68	
	Entertainment	526.74	525.19	-1.55	
	Cash Contributions	211.76	220.55	8.79	
Security Spending Adjustments	Health	1,043.48	1,153.90	110.42	35.33/yr (2.94/mo)
	Education	72.88	34.08	-38.81	
	Personal Insurance	558.39	522.11	-36.28	
Unaffected Spending Adjustments	Personal Care	99.79	98.28	-1.50	-4.05/yr (-0.34/mo)
	Reading	50.59	52.86	2.26	
	Miscellaneous	76.86	72.05	-4.81	
Total		12,573.61	12,573.61	0.00	0.00

With regard to housing expenditures, the Northeast is the second hardest hit by increases utility costs. The decrease in housing (less fuel) spending is the second largest of any region at $355.28, but does little to offset the large increase in fuel costs. This is also the only region in which food at home is decreased in response to the surcharge. The decrease in food spending at home is small, at only 1.3%, but it is anomalous compared to other regions. However, this decrease in food at home does not lead to an overall large decrease in total food expenditure as this region only has the second largest decrease in this category. Health expenditure increases by $110.42 and leads to an overall increase in security spending of $35.33 annually, which is the second largest of any region.

Regional Variations: South

The next region that is analyzed is the South, shown in Table 6.10. The South region has, by far, the highest proportion of poverty as well as the lowest median income level. It does not have the highest of either vulnerable population in children and elderly. With a majority of its states in warmer climates, there is less of a need for energy diversity to offset fuel costs. Therefore, it has the highest proportion and number of households using electricity as their main heating source. With this lower income and low fuel demand combination, the south receives only $423.03 in average benefits.

Table 6.10: South Regional Descriptive Statistics

State	Poverty Estimate, All Ages	State Poverty (%)	Median home Income ($)	Median Age	(%) of Children 0-5	(%) of Elderly 65+	Occupied housing units	Avg. home size of owned unit	Avg. home size of rented unit	Homes using utility gas (%)	Homes using electricity (%)	Homes using fuel oil (%)
Alabama	889,091	18.9	42,882	38.40	6.3	14.2	1,838,683	2.58	2.46	1.27	2.61	0.01
Arkansas	557,399	19.4	40,605	37.70	6.7	14.7	1,129,723	2.56	2.46	1.07	1.22	0.003
Delaware	115,774	12.9	58,244	39.50	6.2	14.9	335,707	2.66	2.57	0.31	0.24	0.13
D.C.	115,096	18.8	66,326	33.80	5.9	11.4	263,649	2.29	2.13	0.37	0.21	0.02
Florida	3,268,130	17.1	46,021	41.50	5.6	17.8	7,158,980	2.60	2.63	0.76	15.38	0.04
Georgia	1,849,944	19.0	47,765	35.90	6.9	11.1	3,518,097	2.74	2.67	3.38	4.23	0.02
Kentucky	803,044	18.8	43,307	38.50	6.4	13.7	1,694,996	2.56	2.37	1.53	1.96	0.04
Louisiana	897,284	20.0	44,234	36.10	6.8	12.6	1,707,852	2.66	2.48	1.44	2.39	0.002
Maryland	591,457	10.2	72,482	38.20	6.3	12.7	2,146,240	2.75	2.46	2.23	1.97	0.53
Mississippi	692,058	23.9	38,191	36.50	6.9	13.2	1,088,073	2.65	2.65	0.79	1.36	0.004
North Carolina	1,711,331	17.8	45,946	38.10	6.5	13.4	3,715,565	2.56	2.46	2.15	5.13	0.41
Oklahoma	624,209	16.7	45,724	36.20	7.0	13.8	1,444,081	2.59	2.46	1.84	1.16	0.003
South Carolina	858,553	18.5	44,310	38.60	6.4	14.2	1,780,251	2.56	2.53	0.98	2.84	0.06
Tennessee	1,128,618	17.8	44,268	38.50	6.3	13.9	2,475,195	2.57	2.42	1.93	3.40	0.03
Texas	4,531,427	17.5	51,714	34.00	7.5	10.7	8,886,471	2.93	2.63	7.77	11.94	0.02
Virginia	941,059	11.7	62,745	37.60	6.3	12.6	3,022,739	2.65	2.49	2.39	3.64	0.45
West Virginia	331,674	18.4	41,195	41.90	5.6	16.5	741,390	2.50	2.25	0.72	0.73	0.06
Regional Total	19,906,148	17.5	49,174.06	37.71	6.4	13.6	42,947,692	2.61	2.48	30.93	60.41	1.85

Source: *Small Area Income and Poverty Estimates: State and County Estimates for 2013, US Census Bureau*
Selected Housing Characteristics: 2009-2013 American Community Survey 5-Year Estimates, US Census Bureau

In Table 6.11 the effects of a $423.03 fuel surcharge is simulated:

Table 6.11 Effects of a $423.03 Annual Increase in Expenditures for Heating by Households in Bottom Quintile of Expenditure in the South Region with Total Expenditure Held Constant

Expenditure Class	Category	Expenditures ($)			
		Base	After Increase	Category Change	Class Change
Housing Spending Adjustments	Electricity	996.50	1,296.25	299.75	143.75/yr (11.98/mo)
	Natural Gas	159.17	229.18	70.01	
	Fuel Oil	12.52	22.64	10.12	
	Housing (less *elctrc*, *ntlgas,* and *fuloil*)	3,850.66	3,614.53	-236.13	
Food Spending Adjustments	Food Away	498.94	451.81	-47.12	-28.33/yr (-2.36/mo)
	Food Home	2,579.01	2,597.79	18.79	
Discretionary Spending Adjustments	Alcoholic Beverages	76.90	61.93	-14.97	-93.08/yr (-7.76/mo)
	Apparel	268.70	242.98	-25.72	
	Transportation	1,403.78	1,377.28	-26.50	
	Tobacco	215.03	198.31	-16.71	
	Entertainment	498.57	501.26	2.70	
	Cash Contributions	261.08	249.20	-11.88	
Security Spending Adjustments	Health	1,022.86	1,050.81	27.95	-11.58/yr (0.97/mo)
	Education	41.53	24.26	-17.28	
	Personal Insurance	725.69	703.44	-22.25	
Unaffected Spending Adjustments	Personal Care	89.12	85.69	-3.43	-10.73/yr (-0.89/mo)
	Reading	27.88	27.04	-0.84	
	Miscellaneous	71.94	65.48	-6.46	
Total		12,799.88	12,799.88	0.00	0.00

It is clear, that in this region the effect of the benefit removal is less than in any other. The decrease in housing expenditure is far less than any other region, and increase in fuel costs is less. The total housing adjustments are the second lowest of any region at $143.75 annually. Because the overall burden is less and fuel costs factor in less than other regions, the offsetting effect of food spending is also smaller than any other region. This same effect carries through to security spending, where health increases far less than any other region and total security spending drops marginally as a whole at $11.58. Southern states also have the smallest amount of their discretionary spending influenced by this benefit removal as well.

Regional Variations: West

The next region that is analyzed is the West, shown in Table 6.12. The West region is a bit of a miscellany with relation to geography. Some states truly characterize the west like Utah, Arizona, and Montana, but others are included by default, like Alaska and Hawaii. The West is the youngest region, with a median age of only 36.4 with the highest percentage of children 0-5. It also has the largest average owner occupied house at 2.75 members per home. Because the geography is spread between warm and cold states the average regional benefit for the West is second highest at $474.9

Table 6.12: West Region Descriptive Statistics

State	Poverty Estimate, All Ages	State Poverty (%)	Median home Income	Median Age	(%) of Children 0-5	(%) of Elderly 65+	Occupied housing units	Avg. home size of owned unit	Avg. home size of rented unit	Homes using utility gas (%)	Homes using electricity (%)	Homes using fuel oil (%)
Alaska	72,643	10.1	70,058	33.20	7.5	8.2%	251,899	2.85	2.59	0.48	0.11	0.31
Arizona	1,206,948	18.6	48,504	36.80	6.9	14.4%	2,370,289	2.66	2.69	3.23	5.43	0.01
California	6,328,064	16.8	60,185	35.80	6.7	11.8%	12,542,460	2.98	2.88	32.34	12.49	0.14
Colorado	665,351	12.9	58,942	36.40	6.6	11.4%	1,977,591	2.59	2.42	5.62	1.48	0.01
Hawaii	153,375	11.2	67,798	38.00	6.5	14.8%	449,771	3.11	2.77	0.04	0.56	0.0004
Idaho	246,708	15.6	46,621	35.50	7.4	12.9%	579,797	2.72	2.60	1.16	0.74	0.05
Montana	159,248	16.1	46,893	39.90	6.1	15.3%	405,525	2.46	2.24	0.87	0.33	0.02
Nevada	433,267	15.8	51,250	37.20	6.7	12.6%	999,016	2.70	2.69	2.45	1.22	0.03
New Mexico	437,923	21.4	44,026	36.90	6.8	13.8%	761,938	2.71	2.55	2.00	0.46	0.006
Oregon	637,505	16.5	50,228	39.00	6.0	14.5%	1,516,456	2.55	2.41	2.27	2.90	0.18
Utah	360,119	12.6	59,715	30.20	9.2	9.3%	886,770	3.23	2.86	2.95	0.37	0.01
Washington	963,088	14.1	58,431	37.50	6.5	12.8%	2,629,126	2.63	2.39	3.62	5.49	0.28
Wyoming	62,118	10.9	58,424	36.80	6.9	12.7%	222,846	2.54	2.40	0.52	0.19	0.003
Regional Total	11,726,357	14.8	55,467.31	36.40	6.9	12.7%	25,593,484	2.75	2.58	57.55	31.75	1.04

Source: *Small Area Income and Poverty Estimates: State and County Estimates for 2013, US Census Bureau*
Selected Housing Characteristics: 2009-2013 American Community Survey 5-Year Estimates, US Census Bureau

In Table 6.13 the effects of a $474.91 fuel surcharge is simulated:

Table 6.13 Effects of a $474.91 Annual Increase in Expenditures for Heating by Households in Bottom Quintile of Total Expenditure in the West Region with Total Expenditure Held Constant

Expenditure Class	Category	Expenditures ($)			
		Base	After Increase	Category Change	Class Change
Housing Spending Adjustments	Electricity	520.87	900.23	379.36	126.79/yr (10.57/mo)
	Natural Gas	167.34	300.40	133.06	
	Fuel Oil	6.52	20.69	14.17	
	Housing (less *elctrc*, *ntlgas*, and *fuloil*)	4,742.32	4,342.52	-399.80	
Food Spending Adjustments	Food Away	532.82	428.12	-104.69	-64.83/yr (-5.40/mo)
	Food Home	2,440.56	2,480.43	39.86	
Discretionary Spending Adjustments	Alcoholic Beverages	92.98	73.05	-19.92	-96.52/yr (-8.04/mo)
	Apparel	316.70	260.24	-56.46	
	Transportation	1,286.17	1,297.55	11.38	
	Tobacco	165.96	150.73	-15.23	
	Entertainment	499.67	514.67	14.99	
	Cash Contributions	233.23	201.95	-31.28	
Security Spending Adjustments	Health	868.36	1,024.50	156.14	35.81/yr (2.98/mo)
	Education	122.50	31.25	-91.25	
	Personal Insurance	643.60	614.52	-29.08	
Unaffected Spending Adjustments	Personal Care	84.80	84.03	-0.78	-1.24/yr (-0.10/mo)
	Reading	41.71	39.36	-2.35	
	Miscellaneous	75.61	77.50	1.89	
Total		12,841.73	12,841.73	0.00	0.00

The West region has the highest expenditure in housing excusive of utilities, and in response to the surcharge has the largest total decrease in housing less other heating utilities spending. Strangely enough, they are moderately reliant on electricity for heating, but increase expenditures in this category by the largest percentage. Western region households also decrease their food away from home expenditure by almost double that of the national average. To offset this large decrease, they increase food at home by the most of any region. Health spending in the west is also over double that of the national average and 50% larger than the next region, the northeast. This actually leads to an overall increase in security spending, the most of any region. Now to examine the regions all together.

Regional Variations: Total Regional Differences

Regional descriptive statistics are shown in Table 6.14. The Midwest is characterized by relatively average poverty, age, and greater reliance on utility gas consumption. The Northeast has the lowest poverty and highest median income. This may be due to the fact that it is also the oldest region with a median age of 40.7 years. With this high median age it also has the lowest percentage of young children and the highest percentage of elderly over the age of 65 years. It also has the fewest total occupied housing units with only half that of the South. With regard to the heating source mix, it is the most balanced region as far as heating type. On the whole the South is poorer than any other region, with the highest poverty percentage and lowest median income. The South also has near average age and housing size with the most occupied housing units of any region. The South has the least diverse mixture of heating sources with mainly electricity. The West region is the youngest of any other with the highest percentage of young children and the lowest percentage of elderly adults. It also has the largest household size for both owned and rented units. Finally, the West consumes the least amount of fuel oil for any region. When comparing all regional totals together some differences are apparent. The first being the difference between the South compared to the Northeast. The Northeast has a higher median income and less poverty than its southern counterpart. This disparity in personal wealth can be explained by the difference in earnings by occupation. The Northeast has the highest regional earnings per occupation in 2013 at

$58,243.11 and the South has the lowest at $53,498.59. The West and the Northeast are also different in many ways as the West is significantly younger and larger in family size than the more antiquated Northeast. Next, the regional differences in how households respond to the subsidy removal are shown in Table 6.15:

Table 6.14: Regional Comparison of Total Descriptive Statistics

Region	Poverty Estimate, All Ages	Regional Poverty (%)	Median home Income ($)	Median Age	(%) of Children 0-5	(%) of Elderly 65+	Occupied housing units	Avg. home size of owned unit	Avg. home size of rented unit	Homes using utility gas (%)	Homes using electricity (%)	Homes using fuel oil (%)
Midwest	9,763,824	14.1	51,648.42	37.60	6.6	14.0%	26,064,326	2.58	2.24	68.22	18.98	1.53
Northeast	7,414,537	12.6	59,136.11	40.70	5.5	14.7%	21,004,714	2.63	2.25	52.20	13.21	26.89
South	19,906,148	17.5	49,174.06	37.71	6.4	13.6%	42,947,692	2.61	2.48	30.93	60.41	1.85
West	11,726,357	14.8	55,467.31	36.40	6.9	12.7%	25,593,484	2.75	2.58	57.55	31.75	1.04

Source: Small Area Income and Poverty Estimates: State and County Estimates for 2013, US Census Bureau
Selected Housing Characteristics: 2009-2013 American Community Survey 5-Year Estimates, US Census Burea

Table 6.15: Regional Expenditure Decreases by Category Dollars and (Percent)

Region	Subsidy Eliminated	Response with conservation	Remaining Fuel Cost Decrease	Housing (less fuel)	Food Spending	Discretionary Spending	Security Spending	Unaffected
Midwest	538.04	581.99 (108.2)	-43.95 (-8.2)	322.25 (59.9)	33.95 (6.0)	210.32 (39.1)	6.57 (1.2)	8.89 (1.7)
Northeast	468.55	523.13 (111.6)	-54.58 (-11.6)	355.28 (75.8)	91.25 (19.5)	107.88 (23.0)	-35.33 (-7.5)	4.05 (0.9)
South	423.03	379.88 (89.8)	43.15 (10.2)	236.13 (55.8)	28.33 (6.7)	93.08 (22.0)	11.58 (2.7)	10.73 (2.5)
West	474.91	526.59 (110.9)	-51.68 (-10.9)	399.8 (84.2)	64.83 (13.7)	96.52 (20.3)	-35.81 (-7.5)	1.24 (0.3)
US	471.35	460.39 (97.7)	10.96 (2.4)	311.11 (67.6)	33.92 (7.4)	103.14 (21.9)	3.74 (0.8)	8.48 (1.8)

When regions are compared to the U.S. as a whole, the differences in their response to the surcharge application are highlighted. The Midwest region receives the largest benefit and pulls the smallest amount from food spending. To offset this minor decrease in food, they also take the hardest hit in discretionary spending, with this change accounting for 39.1% of the surcharge. The Midwest also is only one of two regions that remove funds from security spending, albeit at a modest 1.2%. The Northeast increases its fuel consumption in response to the surcharge more than any other region. This may be due to the cold weather that is prevalent in the Northeast and the inelasticity of heating demand for households as a whole. To offset this the Northeast covers more than 75.8% of this new expenditure with funds from housing (less utilities), perhaps reflecting the fact that the median house value is highest in this region. The Northeast also draws the largest amount of funds from food. The South is, once again, the least effected region for this benefit elimination. They are the only one that does not increase fuel expenditures at a level higher than the benefit removal, and a rate which is significantly less than the national average. The South also offsets the smallest proportion of fuel increase from housing (less fuel) fuel, at just over 55%. They seem to draw money less from categories that other regions do, and more from security spending and unaffected than any other region. The West is a region receives the second highest LIHEAP benefit, where households respond by covering 97.9% of this benefit removal with housing and discretionary spending reductions. They also increase fuel expenditures to 111% of benefit reduction, possibly due to the fact that the West includes states such as Alaska, Washington, Montana, and Colorado. The West also increases security spending at the highest rate in the nation in response to this fuel price increase.

To Summarize:

The main ways in which a fuel surcharge is accommodated is not in conservation of fuel or reduction in food expenditure. The level of conservation ranges from 10.2% in the South, to an increase in fuel expenditure of 11.6% in the Northeast. This is once again due to the inelastic nature of fuel expenditure for households, especially low-income households. With regard to a substitution effect of food and fuel, the decrease in food expenditures ranged from $28.33 in the South to $91.25 in the Northeast. The way in which LIHEAP is most effective is in reducing housing (less fuel) expenditures, it is least effective in expenditures of personal care, reading, and miscellaneous. Overall LIHEAP benefits are not increasing the food security of the households it aims to help, and in some cases is actually drawing a marginal amount of money away from food spending. In general, the increase in fuel costs is accommodated by decreases in housing (less fuel) and discretionary spending. Housing (less fuel) decreased from 6.1% in the South to 8.4% in the West, and discretionary spending fell from 3.7% in the West to 7.8% in the Midwest.

LIHEAP Expenditure Implications: Income Quintile Comparisons

Now that all of the geographic regions have been isolated, and comparisons made across them, a comparison is made to middle-expenditure households. The reason for this final comparison is to explore the assumption that middle expenditure families have more inelastic spending changes in response to a heating fuel surcharge. Because they can access savings, or offset other spending more easily, middle income households may be more insulated from shocks in necessities. Middle income is defined in this model as households that fall within the third quintile of expenditure. With this distinction made, the national average LIHEAP benefit of $471.35 was surcharged to fuel, as in the lowest quintile simulation. The results are below:

Table 6.16 Effects of a $471.35 Annual Increase in Expenditures for Heating by Households in Third Quintile of Total Expenditure with Total Expenditure Held Constant

Expenditure Class	Category	Expenditures ($)			
		Base	After Increase	Category Change	Class Change
Housing Spending Adjustments	Electricity	1,231.23	1,516.35	285.12	135.51/yr (11.29/mo)
	Natural Gas	415.84	554.68	138.85	
	Fuel Oil	74.32	123.26	48.95	
	Housing (less *elctrc*, *ntlgas*, and *fuloil*)	10,846.20	10,508.79	-337.41	
Food Spending Adjustments	Food Away	1,656.03	1,602.41	-53.62	100.10/yr (8.34/mo)
	Food Home	4,344.16	4,497.89	153.72	
Discretionary Spending Adjustments	Alcoholic Beverages	278.62	250.51	-28.11	-147.86/yr (-12.32/mo)
	Apparel	866.19	837.98	-28.22	
	Transportation	4,540.67	4,494.14	-46.53	
	Tobacco	367.00	377.65	10.65	
	Entertainment	1,532.04	1,513.35	-18.69	

	Cash Contributions	1,060.70	1,023.74	-36.96	
Security Spending Adjustments	Health	2,483.01	2,536.09	53.09	-70.86/yr (-5.91/mo)
	Education	278.90	201.22	-77.68	
	Personal Insurance	3,804.27	3,758.01	-46.27	
Unaffected Spending Adjustments	Personal Care	240.31	240.71	0.40	-16.89/yr (-1.41/mo)
	Reading	104.50	101.61	-2.89	
	Miscellaneous	365.02	350.62	-14.40	
Total		34,489.01	34,489.01	0.00	0.00

As one might expect, the effect of the benefit removal is noticeably less than the other regions of analysis. Housing (less fuel) costs change by less than half the national average for change in low-expenditure households and the percentage of fuel cost within housing is also less. The middle quintile increase in total heating burden is only 27%, compared to the lowest quintile increase of 46%. Middle income homes can also decrease their housing less fuel expenditure more than low-income households to offset the increased fuel costs, leading to the lowest total change in housing spending adjustments. Food spending is also very different in the middle expenditure category. There is a decrease in food away spending, as expected, but the response of increase in food at home is large compared to low-income homes. Instead of a $33.92 decrease in total food expenditure, middle expenditure homes increase this number by $100.10, or $8.34 per month. The most notable departure from low expenditure spending is in the security spending category. Middle expenditure families are more insulated to increases in fuel, so the normal response of increased health spending is muted for them. They do decrease education and personal insurance spending, but when viewed as a percentage of these two categories, the decrease is only 3%, compared to 10% in the lowest quintile. The discretionary spending group is another in which there are stark differences. Transportation base expenditures are more than triple the lowest quintile average, and are the largest base expenditure difference between the groups. However, when the fuel surcharge is applied, the response in transportation spending is less than 1% in middle expenditure. Spending in flexible areas of expenditure as a whole are also less affected by this increased utility burden.

To see how percentages of expenditure in each category change, the percentages of shift between categories is shown in Table 6.17.

Table 6.17: Expenditure Percentage Changes

Spending Category	Base Expenditure %	After Increase Expenditure %	Change in Expenditure %
Housing	36.4	36.8	0.4
Food	17.4	17.7	0.3
Discretionary	25.1	24.6	-0.4
Security	19.0	18.8	-0.2
Other	2.1	2.0	-0.05
Total	100	99.9	0.05

Here, as expected, the largest areas of change are in housing and discretionary spending. Both change percentage of expenditure a mere 0.4% and perfectly offset one another.

When the $471.35 fuel surcharge is applied to the middle income households, they react with a $472.92 increase in fuel expenditures. This is a $1.57 annual increase in fuel consumption, which almost perfectly accounts for the surcharge. Middle-income households decrease expenditures in response to this fuel cost increase, in all categories except for food, where there is a $100.10

increase. The total increase in expenditure is then fuel plus food, which sums to $571.45. To account for this total increase in expenditure, the dollar increase as well as their percentage of expenditure increase accounted for is shown below:

Table 6.18: Expenditure Changes Accounting for Increase in Fuel Cost and Food Expenditure

Category	Amount Change	Percentage
Housing (less fuel)	-$337.41	58.9
Discretionary	-$147.86	25.8
Security	-$70.86	12.4
Unaffected	-$16.89	2.9
Total	-$1.57	100

Again, like the low-income category, the middle income group offsets nearly the entire fuel surcharge from shifts in housing (less fuel) and discretionary spending. In the low-income case only 89.8% of the surcharge is covered, as the middle income responds by accounting for 84.7% of the surcharge. The middle-income group increases fuel expenditures by 100.3% this is due to a couple different things, first is the odd way in which middle expenditure households increase food expenditure in response to this fuel price change. This $100.10 food expenditure seems large on the whole, but when examined from a real world perspective, this only leads to an $8.34 monthly increase. For a family expending $34,489 annually, this is a de minimus change in food expenditure.

To Summarize:

For the representative middle-expenditure household, when the $471.35 fuel surcharge was applied, they had no conservation response. The amount that they expended in fuel almost perfectly offset the increase in fuel surcharge by the benefit removal. If this were a "Heat or Eat" issue for the middle-income household, there would be a food for fuel trade-off. They do increase food expenditure by a modest $8.34 per month, but on a percent basis, this is only a 1.7% annual increase in food expenditure. Therefore, there is little to no impact on food expenditures. As in the low-income household case, the LIHEAP benefit loss is accommodated mainly in the housing less fuel category and the discretionary spending class. With housing less fuel and discretionary spending accounting for 84.7% of the fuel expenditure increase. The difference between the middle-expenditure and lowest-quintile expenditure classes is in the non-discretionary and housing categories. In the middle-expenditure group there is a more comprehensive shift in these categories that isn't seen in the lowest quintile group. This may be due to the spending flexibility as a whole, that middle-income has over low-income households.

VII. Conclusions

The U.S. Department of Health & Human Services states that LHEAP is meant for, "….assistance in managing costs associated with: home energy bills, energy crises, and weatherization and energy-related home repairs". However, because LIHEAP assists with heating costs, it has been tied to the "Heat or Eat" dilemma through several qualitative findings. After careful consideration of the economic mechanisms associated with consumer utility maximization, there is no theoretical basis to expect either a direct substitutive or complementary relationship between fuel expenditures and food expenditures. To evaluate a possible "Heat or Eat" connection in expenditures, the representative low-expenditure household has their 2013 LIHEAP fuel benefit of $471.35 removed. In response to this benefit removal, there is little to no fuel conservation as households increase their fuel expenditure by $460.39. To overcome these increased in fuel costs, households reallocate funds from housing (less fuel) and discretionary spending. These two expenditure categories account for 89.9% of the fuel cost increase and offset a significant majority of the increased fuel expenditure. In comparison, food spending decreases account for 7.4% of the fuel cost increase, which removes a modest $2.83 a month from total food expenditures. This result highlights that there is no "Heat or Eat" relationship in expenditure choices among low-income households. From the representative household to regional effects, the variation in LIHEAP benefit elimination is largest between the Northeast and South regions. As in the aggregate case, fuel conservation is not the primary response, with only a 10.2% decrease in fuel consumption the South, and 11.6% in the Northeast. With regard to regional "Heat or Eat" effects, the South has the smallest decrease in food expenditures at $28.33 and the largest decrease came in the coldest region at $91.25 in the Northeast. This may seem like a large difference based on region, but when viewed as a percentage of total food expenditure the South sacrifices just 0.2% of total food expenditure and the Northeast cuts back by 0.7%. The largest decrease in expenditure category came in housing (less fuel) at 6.1% in the South and 8.4% in the West. The second largest decrease in expenditure in response to the fuel surcharge is in discretionary spending from 3.7% decrease in the West to 7.8% in the Midwest. For a representative low-income household the manner in which they account for a fuel surcharge is reasonable for any homeowner. Low-income households don't immediately slash food spending, they decrease flexible spending like housing (less fuel) and discretionary spending. They also decrease meals away from home and eat more food at home, which is cheaper on a per calorie basis.

To compare the expenditure choices of low-income and middle-income households, the $471.35 LIHEAP surcharge is applied to a representative middle-income household. The way in which middle-income households account for the fuel surcharge is similar to low-income ones. The fuel expenditure response was an almost exact offset of 100.3% for middle-expenditure households. With regard to food, middle-income households increase this category by $100.10 annually, a seemingly large amount, until it is shown that this is only a 1.7% increase in food expenditures. Middle-income households account for 84.7% of this fuel cost increase by decreasing expenditures in housing (less fuel) and discretionary spending. The way in which the middle-income group differs from the low-income is in the way they change their security spending, when the surcharge is applied the middle-income household accommodates 12.4% of it with security spending cuts. This seems like a significant amount until it is shown that this is only a 0.2% decrease in total expenditures, or $5.91 a month. With these results in mind it is clear that LIHEAP fails to address the "Heat or Eat" dilemma, mainly because this dilemma does not exist. There is no true one-to-one trade-off between any categories in this analysis. The policy concern at this point needs to shift from "Heat or Eat" to another pairing of more empirically connected expenditure categories.

Future Research Directions

There is significant room for future research on this topic. The first manner in which the analysis could be furthered is by examining seasonal changes in regression results for each region. The current analysis takes into account all quarterly data from Q12001 to Q42012 influencing the findings with summer, spring and autumn data. Because LIHEAP is primarily a winter program, the CES data could be censored to only Q4 (October, November, and December) or Q4 of the current year and Q1 (January, February, and March) of the next year. This may reduce some of the noise created by including non-winter months in which LIHEAP funding is not actively distributed to households. It may also emphasize the differences in regions such as the Northeast and the South and capture a more dramatic shift in expenditure categories to cover fuel expenditures. A second area for future research is isolating heating and cooling benefits into separate categories. This would be immensely beneficial in evaluating the comparative effectiveness of the LIHEAP program in cold weather and hot weather states. The current analysis lumps cooling benefits and heating benefits together, as they are often aggregated in state reports. If data were obtained on specific cooling benefits and heating benefits for a large enough number of states, one could analyze the direct effect each type of benefit has on specific regions. Finally, the research presented above only concerns itself with the endpoints and not the manner in which households make difficult choices to try and account for the money lost to the fuel surcharge. A question that has yet to be answered with this research is, "What is the expenditure transition like for the low-income households during the winter months after this benefit elimination?" This point is a serious one, as it is important to understand how households adapt to this new hardship and in what manner they sacrifice, reallocate, and change in response. To understand these internal mechanisms is to better comprehend the true struggle of the low-income households expenditure decisions.

APPENDIX A: CALCULATION OF LIHEAP REGIONAL BENEFITS

State	Federal Block Grant Funding	Households Receiving Benefits	State Benefit (Block / households)	Reported Heating Benefit	Heating Benefit Used
Alabama	$48,300,000	60,594	$797.11	$320	$320.00
Alaska	$17,200,000	19,000	$905.26	$787	$787.00
Arizona	$23,300,000	16,000	$1,456.25	$75-$640	$357.50
Arkansas	$26,700,000	120,700	$221.21	$61-$359	$210.00
California	$145,400,000	194,189	$748.76	$424	$424.00
Colorado	$44,300,000	96,009	$461.42	$302	$302.00
Connecticut	$76,000,000	100,709	$754.65	$350-$575	$462.50
Delaware	$12,600,000	17,737	$710.38	$300-$700	$500.00
DC	$9,900,000	21,189	$467.22	$250-$1500	$875.00
Florida	$76,400,000	44,592	$1,713.31	$150-$300	$225.00
Georgia	$60,400,000	156,649	$385.58	$345	$345.00
Hawaii	$5,400,000	9,859	$547.72	$526	$526.00
Idaho	$19,200,000	45,000	$426.67	$40-$532	$286.00
Illinois	$160,200,000	322,756	$496.35	$100	$496.35
Indiana	$72,400,000	133,595	$541.94	$285	$285.00
Iowa	$51,300,000	85,777	$598.06	$400	$400.00
Kansas	$31,400,000	47,117	$666.43	$489	$489.00
Kentucky	$43,500,000	130,481	$333.38	$263 fuel oil $206 natural gas $182 electric	$217.00
Louisiana	$40,900,000	27,654	$1,478.99	$150-$600	$375.00
Maine	$37,400,000	44,556	$839.39	$556	$556.00
Maryland	$70,400,000	113,787	$618.70	$496	$496.00
Massachusetts	$132,700,000	190,432	$696.84	$450-$750 deliverable fuels $260-$430 natural gas and electric	$345.00
Michigan	$165,600,000	623,300	$265.68	$850 max	$265.68
Minnesota	$109,300,000	147,636	$740.33	$500	$500.00
Mississippi	$29,300,000	31,644	$925.93	no max	$925.93
Missouri	$66,600,000	145,617	$457.36	$450 max	$450.00
Montana	$22,500,000	20,697	$1,087.11	$541	$541.00

Nebraska	$28,200,000	37,605	$749.90	minimum $121 electric natural gas coal $202 fuel oil kerosene $211 propane $165 wood	$749.90
Nevada	$10,900,000	26,088	$417.82	$684	$684.00
New Hampshire	$24,300,000	36,805	$660.24	$500	$500.00
New Jersey	$124,500,000	276,841	$449.72	$160-$275	$217.50
New Mexico	$15,900,000	68,462	$232.25	$32-$224	$128.00
New York	$350,200,000	1,457,448	$240.28	$338	$338.00
North Carolina	$87,700,000	88,260	$993.66	$200-$400	$300.00
North Dakota	$25,700,000	13,036	$1,971.46	$1,034	$1,034.00
Ohio	$144,800,000	454,520	$318.58	$292	$292.00
Oklahoma	$35,900,000	92,531	$387.98	$55	$55.00
Oregon	$24,300,000	69,301	$350.64	$400-$550	$475.00
Pennsylvania	$190,800,000	391,461	$487.40	$100-$1,000	$550.00
Rhode Island	$23,900,000	27,731	$861.85	$390	$390.00
South Carolina	$38,300,000	33,086	$1,157.59	$225-$500	$362.50
South Dakota	$19,900,000	24,943	$797.82	$334-$1,983	$1,158.50
Tennessee	$56,900,000	72,776	$781.85	$450	$450.00
Texas	$127,100,000	26,870	$4,730.18	$1,000 max	$1,000.00
Utah	$22,900,000	42,871	$534.16	$317	$317.00
Vermont	$18,200,000	27,457	$662.85	$858	$858.00
Virginia	$78,900,000	137,324	$574.55	$306	$306.00
Washington	$56,400,000	71,592	$787.80	$450	$450.00
West Virginia	$27,700,000	90,627	$305.65	$229	$229.00
Wisconsin	$98,400,000	214,966	$457.75	$336	$336.00
Wyoming	$9,100,000	10,153	$896.29	$1,163 max	$896.29

APPENDIX B: CALCULATION OF OWN AND CROSS-PRICE ELASTICITIES FOR FOOD OR FUEL

In general, it is not possible (short of heroic assumptions concerning the structure of preferences) to estimate price elasticities using data in household surveys of consumer expenditures. Interestingly, however, such is possible in the present framework, for both own- and cross-price elasticities can be deduced. Deriving the needed formulae, together with tabulation of a full array of own- and cross-elasticities associated with the three price scenarios analyzed in the text, is the purpose of this appendix. For comparison, elasticities are also calculated for the middle and top quintiles of the total-expenditure distribution.

To begin with, the total-expenditure constraint, in an obvious notation, will be given by

$$p_i q_i + \sum_{j \neq i} p_j q_j = y \tag{1}$$

Thus, for a change, Δp_i, in the price of q_i, with total expenditure, y, held constant:

$$\Delta(p_i q_i) + \sum_{j \neq i} p_j \Delta q_j = 0 \tag{2}$$

Division by $p_i q_j$ then yields:

$$\frac{\Delta(p_i q_i)}{p_i q_i} + \sum_{j \neq i} \frac{p_j \Delta q_j}{p_i q_i} = 0 \tag{3}$$

Consequently in elasticities (since $\Delta p_i / p_i = q_i \Delta p_i / p_i q_i$):

$$\frac{\Delta(p_i q_i)}{p_i q_i}\Big/\frac{q_i \Delta p_i}{p_i q_i} + \sum_{j \neq i}\left(\left(\frac{p_j \Delta q_j}{p_j q_j}\Big/\frac{\Delta p_i q_i}{p_i q_i}\right)\frac{p_j q_j}{p_i q_i}\right) = 0 \tag{4}$$

So that (after cancellations):

$$\frac{\Delta(p_i q_i)}{q_i \Delta p_i} + \sum_{j \neq i}\left(\frac{p_j \Delta q_j}{q_i \Delta p_i}\right) = 0 \tag{5}$$

Since all of the terms in the last expression are observable, cross-price elasticities, η_{ji}, with respect to the price of qi will be given by

$$\eta_{ji} = \frac{q_i \Delta p_i}{q_i \Delta p_i} \tag{6}$$

The own-price elasticity, on the other hand will be given by

$$\eta_{ji} = \frac{\Delta(q_i p_i)}{q_i \Delta p_i} - 1 \tag{7}$$

Note that the own-price elasticity is measured from expenditure after the price change (rather than from the base expenditure), since, with no change in quantity demanded, thisis what expenditure (as given by $qi\Delta pi$) would be in the absence of a non-zero elasticity. However, a non-zero (negative) elasticity causes some of the revenue [specifically, $qi\Delta pi - \Delta(piqi) = (pi - \Delta pi)\Delta qi$] in effect to "melt" away because of the higher price. Hence the need for a subtraction of 1 in expression (7). For cross-elasticities, however, since prices of other goods are not changed, calculations are made from base expenditures.

On the other hand, the elasticities can alternatively (and equivalently) be calculated in *real terms* by assuming Δy in expression (2) to be equal to $qi\Delta pi$ rather than zero, in which case the numerator in expression (7) will be $(pi - \Delta pi)\Delta qi$ (which represents the "melt" in expenditures for qi from its higher price) rather than $\Delta(piqi)$. Cross-elasticities, however, are calculated from expression (6) as before.

Finally, it is to be noted that, since from expression (6), , it follows from expressions (4) and (5) that, as a consequence of the budget constraint, the sum of own- and cross-price elasticities in this framework is necessarily equal to -1.

References

Bhattacharya, J., DeLeire, T., Haider, S., & Currie, J. (2003). Heat or Eat? Cold-Weather Shocks and Nutrition in Poor American Families. *American Journal of Public Health*, 1149-1154.

Bishaw, A. (2012). *Poverty: 2010 and 2011.* Washington D.C.: United States Census Bureau.

Bureau of Labor Statistics. (2015, 3 25). *Consumer Expenditure Survey*. Retrieved from bls.gov: http://www.bls.gov/cex/pumdhome.htm

Bureau of Labor Statistics. (2015, 2 15). *Consumer Expenditure Survey*. Retrieved from Bureau of Labor Statistics: http://www.bls.gov/cex/csxgloss.htm

Census History Staff. (2014, 3 31). *Regions and Divisions.* Retrieved from History: https://www.census.gov/history/www/programs/geography/regions_and_divisions.html

Climate Prediction Center NOAA. (2015). *Twelve Month Extreme Average Temperature.* Retrieved from National Weather Center: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/us_12-month_avgt.shtml

Congressional Research Service. (2013). *The LIHEAP Formula: Legislative History and Current Law.* Washington D.C.: Congressional Research Service.

Cook, J. T., Frank, D. A., Casey, P. H., Rose-Jacobs, R., Black, M. M., Chilton, M., . . . Cutts, D. B. (2008). A Brief Indicator of Household Energy Security: Associations With Food Security, Child Health, and Child Development in US Infants and Toddlers. *Journal of the American Academy of Pediatrics*, 867-875.

Department of Health and Human Services. (2015). *About LIHEAP*. Retrieved from Office of Community Service: http://www.acf.hhs.gov/programs/ocs/programs/liheap/about

Fell, H., Li, S., & Paul, A. (2012). *A New Look at Residential Electricity Demand Using Household Expenditure Data.* Golden, CO: Colorado School of Mines.

Henderson, J. M., & Quandt, R. E. (1958). *Miscroeconomic Theory: A Mathematical Approach.* New York: McGraw-Hill.

John S. Greenlees, Robert B. McClelland. (2008). Addressing Misconceptions about the Consumer Price Index. *Monthly Labor Review*, 3-19. Retrieved from Bureau of Labor Statistics.

Kaiser, M. J., & Pulsipher, A. G. (2005). Science and Politics: The 1981 and 1984 LIHEAP Distribution Formulas. *Socio-Economic Planning Sciences*, 15-51.

Kantor, L. S., & Nord, M. (2006). *Seasonal Variation in Food Insecurity Is Associated with Heating and Cooling Costs among Low-Income Elderly Americans.* Retrieved from The Journal of Nutrition: http://jn.nutrition.org/content/136/11/2939.full#xref-ref-12-1

LiHEAP. (2014). *LIHEAP Report to Congress FY 2009.* Washington D.C.: U.S. Department of Health and Human Services.

Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review*, 370-396.

Nichols, G. A. (2006). *An Assessment of the Income and Expenses of America's Low-Income Families Using Survey Data from the National Survey of America's Families.* Washington D.C.: The Urban Institute.

Pulsipher, M. J. (2002). LIHEAP as a Textbook Case of Government Befuddlement. *The Electricity Journal*, 70-92.

State Data Center. (2014). Retrieved from Campaign for Home Energy Assistance: http://liheap.org/

Taylor, L. D. (2014). *The Internal Structure of U.S. Consumption Expenditures.* New York: Springer International Publishing.

Tonn, B., & Eisenberg, J. (2006). The aging US population and residential energy demand. *Energy Policy*, 743-745.

U.S. Bureau of Labor Statistics. (2012). *CPI Detailed Report: Data for August 2012.* Washington D.C.: U.S. Bureau of Labor Statistics.

U.S. Bureau of Labor Statistics. (2014). *Consumer Expenditures in 2012.* Washington D.C.: U.S. Bureau of Labor Statistics.

U.S. Bureau of Labor Statistics. (2014). *Tables & Calculators by Subject*. Retrieved from Databases: http://www.bls.gov/data/#prices

U.S. Department of Health & Human Services. (2014, September 17). *Office of Community Services*. Retrieved from LIHEAP Fact Sheet: http://www.acf.hhs.gov/programs/ocs/resource/fact-sheet-0

U.S. Department of Health and Human Services. (2014). *LIHEAP Home Energy Notebook.* Washington D.C.: APPRISE Incorporated.

U.S. Energy Information Administration. (2011). *How does EIA estimate energy consumption and end uses in U.S. homes?* Washington D.C.: U.S. Energy Information Administration.

U.S. Energy Information Administration. (2012). *Summary Household Site Consumption and Expenditures in the U.S. - Totals and Intensities, 2009.* Washington D.C.: U.S. Energy Information Administration.

United States Census Bureau. (2014). *Data.* Retrieved from American Community Survey: http://www.census.gov/acs/www/data_documentation/data_main/

United States Census Bureau. (2014). *Small Area Income and Poverty Estimates.* Retrieved from SAIPE Main: http://www.census.gov/did/www/saipe/

United States Department of Agriculture. (2014). *Food Prices Less Volatile than Fuel Prices.* Washington D.C.: USDA.

USDA. (2015). *Food Prices and Spending.* Washington D.C.: USDA.