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Elasticity of Food Demand by Outlet: Effects of the Nutrition Labeling Provision of the Affordable Care Act

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ABSTRACT. Since 1984, the ratio of demand for food away from home to demand for food at home in the United States has increased significantly. The relative increase in the demand for food away from home may be a major contributing factor to the growing obesity problem in the United States. To address this problem, the government passed a law requiring restaurants to report caloric values on their menus. I estimate an almost ideal demand system to investigate whether the Nutritional Labeling Provision of the Affordable Care Act has been effective in increasing the demand for food at home relative to the demand for food away from home. I do not find evidence that the Nutritional Labeling Provision has had the intended effect.

I. Introduction

The Bureau of Economic Analysis divides food expenditures into two groups: food at home, which consists of groceries, and food away from home, which consists of eating out at schools, full service restaurants, fast food places, and other eating places. About 29% of United States food expenditures were considered food away from home in 1984. By 2009, 41% were considered food away from home (Okrent and Alston 2012, 1). The large and rapid increase in food away from home may be contributing to the growing obesity problem in the United States. Many studies have found food away from home is less healthy than food at home (Mancino 2004; Todd, Mancino, and Lin 2010; Okrent and Alston 2012). To encourage healthier eating, the United States government passed a law requiring restaurants and similar establishments to post nutritional information. The law was passed as a part of the Affordable Care Act. The government hoped that consumers would consume fewer calories when calorie content and other nutritional facts were posted (Reese 2014). Previous research supports the intuition that when consumers are more educated about their health and the nutritional value of food, they are more likely to eat healthier (Feng and Chen 2000). Other research suggests the law would not reduce calorie intake. Some economists argue that consumers eating away from home are less likely to choose healthy foods even with more nutritional information (Mancino 2004).

This paper attempts to see if demand for food by outlet was changed because of the Affordable Care Act. To see if the Affordable Care Act successfully encouraged healthy eating, I constructed a system of demand equations and compare the elasticities of food demand by type of outlet before and after the Affordable Care Act. If the Affordable Care Act increased the price elasticity of less healthy foods, like those from certain food away from home outlets, it can be argued that the law was effective. Increases in the elasticity of demand for food away from home would likely decrease the price elasticity of healthier foods, like those typically associated with food at home, which would also be encouraging.

I do not find evidence that the Affordable Care Act changed food demand by outlet. Instead, a six-outlet model suggests that consumers purchased a smaller fraction of food from each outlet and spent more on non-food goods after the Affordable Care Act was passed. A three-outlet model suggest the opposite. After the Affordable Care Act was passed consumers purchased a larger percentage of goods from both food-at-home outlets and food-away-from-home outlets, but a smaller percentage from non-food outlets. Inconsistencies in the results mean that there is no evidence that the Nutrition Labeling Provision was successful in increasing demand for food at home and decreasing the demand for food away from home.

II. Literature Review

There is a small amount of literature that suggests that more health and nutrition information leads to healthier eating. Feng and Chern (2000) used a linear approximate almost ideal demand system to estimate price elasticities of food demand for food deemed "healthy or unhealthy." An almost ideal demand system is a system of demand equations that uses a list of assumptions derived from consumer demand theory. Originally developed by Deaton and Muellbauer (1980), the system offers many advantageous features over previous demand systems including the properties of aggregating consumer behavior and being relatively simple to estimate. Feng and Chern (2000) tested the effectiveness of health information by including the fat and cholesterol information index from a biomedical journal collection called MEDLINE. Using monthly consumer expenditure surveys from the Bureau of Labor Statistics during the years 1981 to 1995, they showed that increases in the fat and cholesterol information index reduce the consumption of foods considered unhealthy like bakery products. Increases in the fat and cholesterol information index also increased the consumption of healthy foods like fresh fruits and vegetables.

While Feng and Chern (2000) suggested that health information encourages healthy eating, there is more evidence suggesting health information does not affect consumer eating habits as much as other factors. Hamrick and Okrent (2014) used multivariate statistical analysis on the American Time Use Survey from 2003-2011 to show that other factors, such as higher income, more education, and more work hours, are better determinants of unhealthy eaters. They also found that food demand at limited service outlets (fast food) remains unchanged in recessions. Stewart et al., (2004) conducted a statistical analysis on the consumer expenditure surveys for the years 1998, 1999, and 2000. They found that increased income and household size are more important than the level of health information in determining a person's eating habits. They found higher income, single persons, and households containing multiple adults without live-at-home children are more likely to eat food away from home than other groups. Mancino (2004) found that as long as consumers are consuming food away from home, they are unlikely to choose healthy options. She found that as food away from home increases, fat and caloric consumption increase, decreasing diet quality. This result was consistent no matter the level of health information a consumer has. These studies show that there are many factors that determine food demand, not just the level of health information available. For this reason, the remainder of this paper focuses on if the Affordable Care Act can redirect demand from unhealthy food away from home to healthier food at home.

Nayga and Capps (1992) was one of the first to investigate food demand by outlet using the almost ideal demand system. Their study used monthly data from the Business Statistics and Survey of Current Business reports by the Bureau of Economic Analysis from 1970 to 1989. They divided outlets into three categories: food away from home, food at home, and non-food. The non-food outlet consisted of all expenditures not related to food. An additional variable included was women's labor force participation rate. Because women in the United States are traditionally more likely to stay home to prepare meals than men, women's labor force participation rate is a relevant variable to include. As more women work more, they have less time to prepare food and have more income to purchase food away from home. As women's labor force participation rate increases, demand for food at home should decrease and demand for food at away from home should increase. As expected, the coefficient for women's labor force participation rate had a negative sign for food at home and a positive sign for food away from home. Nayga and Capps (1992) also calculated price and expenditure elasticities for food at home, food away from home, and non-food. The own-price elasticities for the three groups were each negative. This means as the price of one of the groups increases, the percentage of goods purchased from that group decreases. Demand for food away from home was found to be more price inelastic than food at home. The expenditure elasticities were each positive, meaning an increase in total expenditures increases the percentage of goods purchased in each outlet. All compensated cross-price elasticities were also positive. This implies that each outlet is generally a substitute for the others. As the price of one outlet increases, the demand for goods in the other outlets also increases.

Okrent and Alston (2012) used a similar method to evaluate different food outlets. Instead of breaking the consumption outlets into food at home, food away from home, and non-food, they split the groups into food at home, full service food away from home (sit-down restaurants), limited service food away from home (fast food), other food away from home, and alcoholic beverages. They found demand for full service food away from home was more price elastic than demand for food from limited service food away from home. This means price increases at fast food restaurants affect demand less than price increases at sit-down restaurants. Food away from home was also found to be much more income elastic than food at home. Okrent and Alston (2012) further separated the groups into specific foods. They found demand for foods normally considered "healthy" was more price inelastic than demand for "unhealthy" foods. Since their model used so many foods that were interrelated as complements and substitutes, Okrent and Alston (2012) were unable to produce conclusions about substitutability of foods by outlet.

III. Model

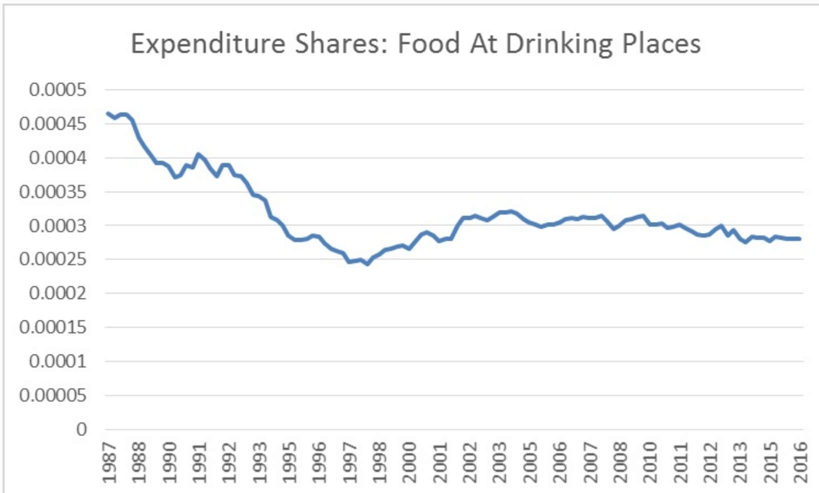
My data are from the Bureau of Economic Analysis and is quarterly from 1987 to 2015. Both the use of quarterly data and newer data differentiate my research from past literature. Although it cannot be proven that the Affordable Care Act caused the changes in demand coefficients and elasticities, a statistically significant dummy variable for the Affordable Care Act suggests that the Affordable Care Act may have been effective.

I use a model based on the framework developed by Nayga and Capps (1992) and Okrent and Alston (2012). Outlets are distributed into six groups: food at home, food at schools, food at limited service eating places, food at drinking places, food at other eating places, and non-food. Since there are six outlets, six different demand equations are calculated. I consider prices at each outlet, the unemployment rate, labor force participation of women, the percentage of the United States population under fifteen years old, and the percentage of the population aged 18 to 26 as independent variables. To see the effect of the Affordable Care Act, I also include a dummy variable. The dummy is zero for all quarters prior to April 2010 and one for all quarters after.

Plots of the demand for each variable show demand for each variable by outlet to be approximately linear, with the exception of demand for food at drinking places. The demand for food at drinking places declined sharply in the 1990s, but has leveled off since (Figure 1). To account for underlying factors that may explain the extreme change in demand and avoid possible bias in the estimation of the almost ideal demand system, the percentage of population aged 18 to 26 is included in the model. People aged 18 to 26 are one of the more likely groups to consume food at drinking places. Since a plot of the percentage of population aged 18 to 26 is similar to the plot of the demand for food at drinking places and it reasonably explains why the demand may have changed, including this variable should avoid bias in the almost ideal demand system. The variable for percentage of the United States population under fifteen years old is also included as a proxy for household structure.

Since there is a large amount of multicollinearity among the variables and several variables are endogenous, ordinary least squares cannot be used to estimate each equation individually. To solve this problem, all six systems are solved at once using an almost ideal demand system and a process called Seemingly Unrelated Regressions. In order to solve the system, three restrictions must be assumed. The elasticities must be homogenous, symmetric, and the dependent variables must sum to one. Homogenous and symmetric restrictions are built into the Seemingly Unrelated Regression program. To satisfy the last condition, expenditure shares are used as the dependent variable.

Figure 1.



Expenditure shares are calculated by dividing each outlet expenditure by total expenditures. The descriptive statistics for these variables are listed in Table 1. Prices for each quarter were collected from a price index on the website for the Bureau of Economic Analysis and have a base period of 1982-1984.

TABLE 1–Variables and Sample Means

Variable	Mean	Standard Dev.	Minimum	Maximum
Expenditure share food at home	0.0844	0.010109	0.072349	0.10736
Expenditure share food at schools	0.002123	0.000157	0.001819	0.002316
Expenditure share food at limited service eating places	0.022889	0.001801	0.020561	0.026205
Expenditure share food at drinking places	0.000316	0.000051	0.000244	0.000465
Expenditure share food at other eating places	0.021298	0.001065	0.019872	0.023676
Expenditure share non-food	0.868974	0.012813	0.842703	0.881471
Price level of food at home (as an index)	83.23072	16.03893	56.876	111.184
Price level of food at schools	82.05453	18.48497	53.874	121.273
Price level of food at limited service eating places	80.11074	18.33823	51.887	115.587
Price level of food at drinking places	81.47362	17.9407	53.085	115.544
Price level of food at other eating places	81.47797	17.94126	53.076	115.562
Price level of non-food	86.43481	14.47330	59.440	109.408
Unemployment Rate	6.04483	1.4882	3.9	9.9
Labor Force Participation Rate of Women	58.52328	1.171722	55.6	60.1
Percent of Population Under 15	0.2437	0.0108	0.2223	0.2593
Percent of Population Age 18-26	0.1730	0.0117	0.1640	0.2045
Affordable Care Act (Dummy)	0.1983	0.4004	0	1

After the expenditure shares have been calculated, I use Stata to run a Seemingly Unrelated Regression technique on the following system of equations:

$$FAH_t = a_1 + \gamma_{11}\ln(FAH\ Price_t) + \gamma_{12}\ln(FAS\ Price_t) + \gamma_{13}\ln(FALS\ Price_t) + \gamma_{14}\ln(FADP\ Price_t) + \gamma_{15}\ln(NF\ Price_t) + \gamma_{16}\ln(FAOEP\ Price_t) + \beta_1\ln(X_t/P_t) + \varphi_1 LFPR_t + \delta_1 UR_t + \tau_1 YOUNG_t + \pi_1 TWENTIES_t + \theta_1 ACA_t$$

$$FAS_t = a_2 + \gamma_{21}\ln(FAH\ Price_t) + \gamma_{22}\ln(FAS\ Price_t) + \gamma_{23}\ln(FALS\ Price_t) + \gamma_{24}\ln(FADP\ Price_t) + \gamma_{25}\ln(NF\ Price_t) + \gamma_{26}\ln(FAOEP\ Price_t) + \beta_2\ln(X_t/P_t) + \varphi_2 LFPR_t + \delta_2 UR_t + \tau_2 YOUNG_t + \pi_2 TWENTIES_t + \theta_2 ACA_t$$

$$FALS_t = a_3 + \gamma_{31}\ln(FAH\ Price_t) + \gamma_{32}\ln(FAS\ Price_t) + \gamma_{33}\ln(FALS\ Price_t) + \gamma_{34}\ln(FADP\ Price_t) + \gamma_{35}\ln(NF\ Price_t) + \gamma_{36}\ln(FAOEP\ Price_t) + \beta_3\ln(X_t/P_t) + \varphi_3 LFPR_t + \delta_3 UR_t + \tau_3 YOUNG_t + \pi_3 TWENTIES_t + \theta_3 ACA_t$$

$$FADP_t = a_4 + \gamma_{41}\ln(FAH\ Price_t) + \gamma_{42}\ln(FAS\ Price_t) + \gamma_{43}\ln(FALS\ Price_t) + \gamma_{44}\ln(FADP\ Price_t) + \gamma_{45}\ln(NF\ Price_t) + \gamma_{46}\ln(FAOEP\ Price_t) + \beta_4\ln(X_t/P_t) + \varphi_4 LFPR_t + \delta_4 UR_t + \tau_4 YOUNG_t + \pi_4 TWENTIES_t + \theta_4 ACA_t$$

$$NF_t = a_5 + \gamma_{51}\ln(FAH\ Price_t) + \gamma_{52}\ln(FAS\ Price_t) + \gamma_{53}\ln(FALS\ Price_t) + \gamma_{54}\ln(FADP\ Price_t) + \gamma_{55}\ln(NF\ Price_t) + \gamma_{56}\ln(FAOEP\ Price_t) + \beta_5\ln(X_t/P_t) + \varphi_5 LFPR_t + \delta_5 UR_t + \tau_5 YOUNG_t + \pi_5 TWENTIES_t + \theta_5 ACA_t$$

$$FAOEP_t = a_6 + \gamma_{61}\ln(FAH\ Price_t) + \gamma_{62}\ln(FAS\ Price_t) + \gamma_{63}\ln(FALS\ Price_t) + \gamma_{64}\ln(FADP\ Price_t) + \gamma_{65}\ln(NF\ Price_t) + \gamma_{66}\ln(FAOEP\ Price_t) + \beta_6\ln(X_t/P_t) + \varphi_6 LFPR_t + \delta_6 UR_t + \tau_6 YOUNG_t + \pi_6 TWENTIES_t + \theta_6 ACA_t$$

Where α is a constant, FAH_t is the expenditure share of food at home in quarter t, FAS_t is the expenditure share of food at schools in quarter t, $FALS_t$ is the expenditure share of food at limited service eating places in quarter t, is the expenditure share of food at drinking places in quarter t, is the expenditure share of non-food in quarter t, $FAOEP_t$ is the expenditure share of food at other places in quarter t, X_t is total expenditures in quarter t, P_t is the price level in quarter t, $LFPR_t$ is the labor force participation rate of women in quarter t, and UR_t is the unemployment rate in quarter t, $YOUNG_t$ is the percentage of the population under 15 in quarter t, is the percentage of the population between 18 and 26 in quarter t, and ACA is a dummy variable for whether or not the Affordable Care Act has been passed at time t.

After the coefficients have been estimated, I calculate each own-price elasticity, cross-price elasticity, and total expenditure elasticity. Own-price elasticities are calculated by:

$$\epsilon_{ii} = \frac{\vartheta_i - \beta_i\left(\omega_i - \beta_i \ln\left(\frac{X}{P}\right)\right)}{\omega_i} - 1$$

Where *i* refers to each outlet with NF=1, FAH=2, FAS=3, FALS=4, FAOEP=5, FADP=6 and ω_i is the expenditure share of each outlet.

Similarly, cross-price elasticities are calculated by:

$$\epsilon_{ij} = \frac{\gamma_{ij} - \beta_i\left(\omega_j - \beta_j \ln\left(\frac{X}{P}\right)\right)}{\omega_i}$$

Where *i, j* refer to each outlet.

Expenditure elasticities are calculated by:

$$\varepsilon_i = \frac{\beta_i}{\omega_i} + 1$$

(SAS).

IV. Results

Results from the estimation of the almost ideal demand system (Table 2) and the estimation of the elasticities (Table 3) were far from ideal. Although nearly all of the coefficients and many of the elasticities are statistically significant, many have the opposite of their expected sign. The own price elasticities are all significant and are negative as expected. However, many cross price elasticities and total expenditure elasticities are different from what was found in past literature. For example, the total expenditure elasticity of food at drinking places has a negative sign. This means that as consumers spend more, they spend a smaller portion on food at drinking places. Although, some theories and research may support this result, it is inconsistent with past literature on the almost ideal demand system. The own price elasticity on food at drinking places is incredibly large. According to my model, a one percent increase in the price of food at drinking places decreases the expenditure share for food at drinking places by almost 109%. The results for the effect of the Affordable Care Act show that the law did not shift demand among the food outlets. Instead, demand shifted from the food outlets to the non-food outlet. On average, since the Affordable Care Act has been passed, my model implies that people are simply spending a smaller fraction on food and a larger fraction on other goods.

Also, since the almost ideal demand system is a dynamic model that estimates the entire system of interrelated equations at once, including insignificant variables jeopardizes the reliability of entire demand model. Major problems with my model suggest that it should be simplified and reinterpreted. To simplify my model, I combined the food away from home outlets into one category and I dropped all of the extra demand variables except for the Affordable Care Act dummy variable and the women's labor force participation rate variable.

TABLE 2–Estimates of the Almost Ideal Demand System
Six Outlet Model

Variable	Non-Food	Food at home	Food at schools	Food at limited service eating places	Food at other eating places	Food at drinking places
Percent of Population Under 15	-0.3564*	0.2224*	0.230*	0.0783*	0.0391*	-0.0064*
Percent of Population Age 18-26	-0.9679*	0.4153*	0.0092*	0.4206*	0.1302*	-0.0074*
Unemployment Rate	0.0055*	-0.0039*	0.00003*	-0.0005*	-0.0012*	-0.00001*
Labor Force Participation Rate of Women	0.0050*	-0.0016*	0.00003	-0.0026*	-0.0008*	0.00002*
Affordable Care Act	0.0430*	-0.0330*	-0.00003	-0.0047*	-0.0051*	-0.0002*
*Significant at less than a 5% level						

TABLE 3–Uncompensated Elasticities Six Outlet Model

	Non-food	Food at Home	Food at schools	Food at limited service eating places	Food at other eating places	Food at drinking places
Price of non-food	-0.9799*	-0.729*	-0.0002*	-0.0036	-0.0152*	-0.0007
Price of food at home	-0.1388*	-0.3152*	0.0094*	0.0266	0.0509	0.0002
Price of food at schools	0.0412*	0.3221*	-1.1169*	-1.9897*	1.9312*	-0.1425*
Price of food at limited service eating places	0.0573	0.0544	-0.1843*	-1.1011*	0.3894*	-0.06879
Price of food at other eating places	-0.3324*	0.1697	0.1930*	0.4213*	-2.9068*	1.7144*
Price of food at drinking places	0.5018*	0.1219	-0.9556*	-4.9569	115.7148*	-108.9867
Total Expenditure	1.0724*	0.3668*	0.9557*	0.8528*	0.7408*	-0.4356*
*Significant at less than a 5% level						

The results from my simplified model turned out much better than the six-outlet model. All of the elasticities have the expected sign and are statistically significant (Table 5). However, the results from the almost ideal demand system (Table 4) and the specific elasticity results are different than expected. The coefficient for women's labor force participation rate had a positive sign for the non-food outlet and a negative sign for both food outlets. In past literature, food away from home and non-food had positive signs while food at home had a negative sign. The result does make sense intuitively. As more women are working, they may choose to spend less money on non-durable goods such as food and instead spend more on durable goods from the non-food outlet. The elasticities for food at home and food away from home are also different from past literature. Past literature has shown food away from home to be more price and income elastic than the food at home, but my results show the opposite.

The Affordable Care Act coefficient had different signs than expected. According to my three-outlet model, since the Affordable Care Act has been passed, consumers have been spending a larger portion of their money on both food outlets and less on non-food. This is still different than the expected result, which was a positive sign on food at home and a negative sign on food away from home. The inconsistencies between both of my models and past literature suggest that I may have misestimated the almost ideal demand system or that my model needs more refining. Since many of the results are different than past literature and vary between my models, the actual effect of the Affordable Care Act is uncertain and my results provide no support that it has been either effective or ineffective.

TABLE 4–Estimates of the Almost Ideal Demand System Simplified Model

Variable	Non-Food	Food at Home	Food away from home
Women's Labor Force Participation Rate	0.00096*	-0.00068*	-0.00028*
Affordable Care Act Dummy	-0.10493*	0.00640*	0.09852*
*Significant at less than a 5% level			

TABLE 5–Uncompensated Elasticities Simplified Model

	Outlet		
	Non-Food	Food at home	Food away from home
Price of non-food	-0.3532*	0.1211*	-0.1983*
Price of food at home	0.1595*	-1.2699*	0.0638*
Price of food away from home	-0.1036*	0.0014*	-0.9672*
Total Expenditure	0.4304*	1.1742*	1.0694*
*Significant at less than a 5% level			

V. Conclusion

Although the results from the model cannot fully prove my prediction that the Affordable Care Act did not successfully encourage healthier eating, it provides some evidence that the Affordable Care Act may not be working as intended. The six-outlet almost ideal demand system suggests that the Affordable Care Act decreased the expenditure share across all food outlets instead of diverting demand from food-away-from-home outlets to food-at-home outlets. The simpler, three-outlet model, suggests the opposite; since the Affordable Care Act was passed, consumers have spent a larger fraction of their money on both the food-at-home outlet and the food-away-from-home outlet; the expenditure share for non-food goods has fallen since the law was passed. Neither of the models showed that the Affordable Care Act has been effective in achieving what it was intended to: increase demand for the relatively healthy food-at-home outlet and decrease the demand for the relatively unhealthy food-away-from-home outlet. Although my model does not conclusively show that the Affordable Care Act is ineffective, it offers little to no evidence that it is working. Introducing a policy that more conclusively encourages healthier eating is important for solving the obesity problem in the United States and would be a big step in the right direction for a healthier America.

The inconsistency of the results across the two models showthat the effects of the Affordable Care Act are not definitive and require further research. Research should be aimed at refining the six-outlet almost ideal demand system model that I created. Developing a six-outlet almost ideal demand system with all significant coefficients and elasticities would provide a detailed description of consumer food demand. Other research may look at disaggregating the food-at-home outlet into other categories such as meat, fruits, vegetables, etc. Once these models are developed, more investigation into the Affordable Care Act can be conducted with more reliable results. Research into other potential policies to improve aggregate consumer eating habits may also be helpful in determining alternate policies to replace the Nutritional Label Provision.

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