Obesity as a Modifier of Price Sensitivity in the United States

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Abstract

This study examines the price responsiveness of individuals by body weight status in the United States by comparing demand estimates across BMI groups. We find differences in eating patterns of households that have an overweight and obese primary shopper with those of normal weight. We test whether body weight status modifies price sensitivity by estimating demand for food by these BMI groups using the almost ideal demand system.

Obesity continues to be a problem in the United States, and even though some reports show a slight decline in childhood obesity (Ogden et al., 2014), more recent evidence shows that obesity across all age groups has continually increased over the past several decades (Skinner et al., 2016). The growth in obesity in the United States is associated with an increase in the prevalence of chronic illnesses, with consequences both for the individuals affected directly and for the broader society. The consequences of obesity for the individual include relatively high risk of morbidity and mortality, resulting in lower work productivity from more sick days from obesity-induced illnesses (Cawley et al., 2007; Goetzel et al. 2010), and greater private expenditures on weight-loss programs and drugs, and on personal health-care costs associated with obesity (Tsai et al. 2011). Evidence from a variety of economic analyses also suggests that some choices made by obese and overweight individuals impose costs on others through the health-care and tax systems. In particular, MacEwan, Alston and Okrent (2014) predicted that a one-unit increase in BMI for every adult in the United States would increase annual public medical expenditures by $6.0 billion. This estimated public cost equates to an average marginal cost of $27 per year, per adult, for a one-unit increase in BMI for each adult in the U.S. population—or $4.35 per pound.

Because of the burden of obesity to both individuals and broader society, many policymakers have called for policies to curb obesity including taxes and subsidies. Much of the literature that has investigated the effects of taxes and subsidies on food consumption and obesity in the United States estimates the average effect of a policy-induced price change on obesity assuming that obese and non-obese respond to policy-induced price changes the same. Such studies generally use elasticities of demand for food to simulate the effect of a tax or subsidy on demand for foods, caloric intake and body weight, and the elasticities of demand used are for the entire U.S. population (e.g., Kuchler, Tegene, and Harris 2005; Smith, Lin and Lee 2010; Okrent and Alston 2012) or sometimes based on income groups (e.g., Zhen et al. 2013). However, it may be the case that the effect of a policy-induced change in price on demand for foods varies with obesity status, and the average effect masks the impact of these policies on those that are meant to be targeted by the policy—the obese.

Evidence of whether food price responsiveness varies with obesity status is mixed. Epstein et al. (2007) found in a lab setting that obese mothers are much more price elastic than non-obese mothers, and that non-obese mothers were more likely to substitute between high and low energy density foods. Also, Temple et al. (2010) found in a sample of 18–50-year-old University at Buffalo students, staff, and community member participants that taxation decreased the purchasing of foods high in fat and sugar in obese, but not non-obese participants. Using a cross section of the 1999-2001 Israeli Health and Nutrition Survey, Gandal and Shabelansky (2010) found a positive correlation between measured obesity rates and price sensitivity; specifically,

women of average height who stated that prices were 'not important' when purchasing food products had a waist circumference that were 4.5 cm less than those women who stated that price was 'very important.' Similarly, Miljkovic, Nganje and de Chastenet (2008) estimated differential impacts of past, current and future prices on body weight status using a rational addiction model. Miljkovic, Nganje and de Chastenet (2008) found that increasing the current price of sugar by 1% decreases the probability of being overweight by 2.32%, and the probability of being obese by 3.07%, and increases the likelihood of being normal weight by 5.39%. They also found differential effects of prices of potatoes and whole milk on the probability of being normal, overweight and obese as well.

In their lab experiment, however, Nederkoorn et al. (2011) found that body weight status has no effect on price responsiveness. Nederkoorn et al. (2011) recruited Dutch-speaking participants on-line, and had them purchase groceries in a web- based supermarket, with an individualized budget based on what they normally spend. Results showed that relative to the no tax condition, the participants in the tax condition bought less calories but BMI and budget did not influence the effectiveness of the tax. Staudigel (2012) found very few differences in expenditure elasticities of demand (i.e., potatoes and milk) between the obese and non-obese in Russian household panel data.

If the obese are found to be more responsive to price changes than the non-obese and such information is not included in measuring the potential effect of a pricing policy aimed at curbing obesity, then social welfare and obesity-related health-care expenditures may be underestimated. Likewise, if the obese are found to be less responsive to price changes, then estimates of social welfare and obesity-related health-care expenditures that do not reflect the differences in price responsiveness by BMI group will be overestimated.

Obese individuals not only eat more than their non-obese counterparts, but also the market basket of foods purchased is different. Several policy initiatives aimed at addressing obesity seek to curb consumption of foods that are deemed fattening by raising the relative price of such foods. For example, in the United States, the city of Berkeley applied a 1-cent per fluid ounce tax on sugar-sweetened beverages in 2014 with part of the tax being partially passed through to consumers (Falbe et al. 2015; Ng et al. 2015). Similar taxes have been implemented in other countries (e.g., Mexico, Denmark). However, some recent evidence shows that the association between consumption of many of the foods that are blamed for obesity and considered for taxation (fast food, soft drinks and candy) are unassociated with BMI once clinically underweight and morbidly obese individuals are excluded from the sample (Just and Wansink 2015). Hence it might be that taxes targeting foods that are blamed for obesity may only work for the morbidly obese and not the rest of the BMI distribution. Our analysis

contributes to this discussion by taking a hard look at purchases across the BMI spectrum and testing whether prices differentially affect demand for purchases.

This study examines the price responsiveness of individuals by body weight status in the United States by comparing demand estimates across BMI groups. In our analysis, we first compare eating patterns of households that have an overweight and obese primary shopper with those of normal weight. We also test whether body weight status modifies price sensitivity by estimating demand for food by these BMI groups using the almost ideal demand system.

Data

We use the 2010–2014 IRI Consumer Network panel data, which is a household scanner data set that contains prices and expenditures on food-at-home purchases made at retail stores for a panel of households in the United States. Households record their purchase information by scanning the UPCs of purchased items using a handheld scanner or mobile app, as well as identifying additional transaction information including the retailer where the item was purchased, quantity, discounts or deals, and coupons. For a majority of the transactions in the household data, IRI imputes prices and expenditures using sales data collected directly from retailers by assigning the average purchase price of the UPC for that particular retailer, market area, and week to the transaction. For retailers where IRI does not have retail sales data, households are asked to report expenditures for those transactions. The Consumer Network data include household purchases of both UPC-labeled and fresh food items (Muth et al. 2016).

A subset of households in the IRI Consumer Panel complete a supplementary survey of household members' medical information, in which they report height and weight for each household member. We define normal-weight, overweight and obesity status of the household by calculated BMI of the household head who is the primary shopper: normal weight (BMI<25), overweight (25≤BMI<30) and obese (BMI≥30).

The purchase data are available as itemized transactions at the UPC level, and we categorize household purchases into food product groups commonly defined in the demand analysis literature (e.g., cereals, bakery products, meat, eggs) as well as food groups that are deemed "unhealthy" (e.g., sugar-sweetened beverages, sweet snacks including candy and salty snacks including potato chips). We aggregate the itemized purchases for households of each BMI status into quarterly expenditures for 58 IRI-defined market areas (analogous to metropolitan statistical areas). We then calculate expenditure shares for 19 food groups. Food group expenditure shares are given by

$$(1)\quad share_{bigq} = \frac{expend_{bigq}}{\sum_{g=1}^{19} expend_{bigq}}$$

where *expend* is expenditures in IRI for households of BMI status *b* (*b* = 1-3) in market *i* (*i* = 1-58) and food group *g* (*g* = 1-19) in quarter *q* (*q* = 2010 Q1 - 2014 Q4). Table 1 shows the composition of the food groups and overall average expenditure shares by food group.

TABLE 1. AVERAGE EXPENDITURE SHARES BY FOOD GROUP, 2010-2014

FOOD GROUP	Share	Type of products
BREAD AND GRAINS	6.1%	Bread, dough, pasta, rice, flour, baking mixes
CEREAL	2.5%	Cold cereal, hot cereal
SNACKS	8.2%	Salty snacks including potato chips, nuts, crackers, snack bars
VEGETABLES	8.3%	Fresh, frozen, and processed vegetables, including beans
FRUIT	6.1%	Fresh, frozen, and processed fruits
JUICE	2.6%	Juice
MILK	4.0%	Milk, cream
CHEESE	4.5%	Cheese
YOGURT	1.6%	Yogurt
MEAT, POULTRY, SEAFOOD	12.1%	Meat, poultry, seafood
PROCESSED MEAT	6.5%	Deli meat, sausage, and other processed meat, poultry, seafood
EGGS	1.0%	Eggs
FATS AND OILS	2.1%	Oil, butter, salad dressing
SAUCES AND CONDIMENTS	2.4%	Sauces, condiments, spreads
MISCELLANEOUS FOOD	2.2%	Spices, baby food, supplements, other uncategorized items
PROCESSED MEALS	10.9%	Frozen, fresh, and shelf-stable prepared meals, soups
SUGAR-SWEETENED BEVERAGES	3.2%	Carbonated beverages, energy drinks, sweetened coffee and tea, fruit drinks
NON-SUGARY BEVERAGES	5.0%	Low-calorie and diet carbonated beverages, coffee, tea, water
SWEETS	10.7%	Candy, desserts, baked goods, ice cream, sugar and sweeteners

SOURCE: AUTHORS' CALCULATIONS USING IRI CONSUMER NETWORK DATA

Summary Statistics

These data on households' food purchases allows us to examine how households choose to allocate food expenditure shares among food groups and how those purchasing decisions may differ among households by BMI status. We use ANOVA techniques to test differences in purchasing patterns among normal weight (BMI<25), overweight (25≤BMI<30) and obese (BMI≥30) households for 19 food groups. Table 2 shows the average expenditure shares by food group for households of each BMI status.

TABLE 2. AVERAGE EXPENDITURE SHARES ON FOOD GROUPS BY BMI STATUS, 2010-2014			
	Percent		
FOOD GROUP	Normal weight	Overweight	Obese
BREAD AND GRAINS	6.0	6.1	6.0
CEREAL	2.7*	2.5*	2.2
SNACKS	8.2*	8.3*	8.0
VEGETABLES	8.8*	8.2*	7.8
FRUIT	6.7*	6.1*	5.5
JUICE	2.8*	2.7*	2.5
MILK	4.2*	4.0*	3.8
CHEESE	4.4*	4.5*	4.6
YOGURT	1.7*	1.6*	1.4
MEAT, POULTRY, SEAFOOD	11.9*	12.2	12.3
PROCESSED MEAT	6.0*	6.5*	7.0
EGGS	1.0	0.9	1.0
FATS AND OILS	2.1	2.1	2.1
SAUCES AND CONDIMENTS	2.4*	2.4*	2.5
MISCELLANEOUS FOOD	2.3	2.2	2.2
PROCESSED MEALS	10.4*	10.7*	11.6
SUGAR-SWEETENED BEVERAGES	3.1*	3.1*	3.3
NON-SUGARY BEVERAGES	4.7*	5.1*	5.3
SWEETS	10.4*	10.7*	11.0
*** DENOTES SIGNIFICANT DIFFERENCE FROM OBESE AT 1% LEVEL**			
SOURCE: AUTHORS' CALCULATIONS USING IRI CONSUMER NETWORK DATA			

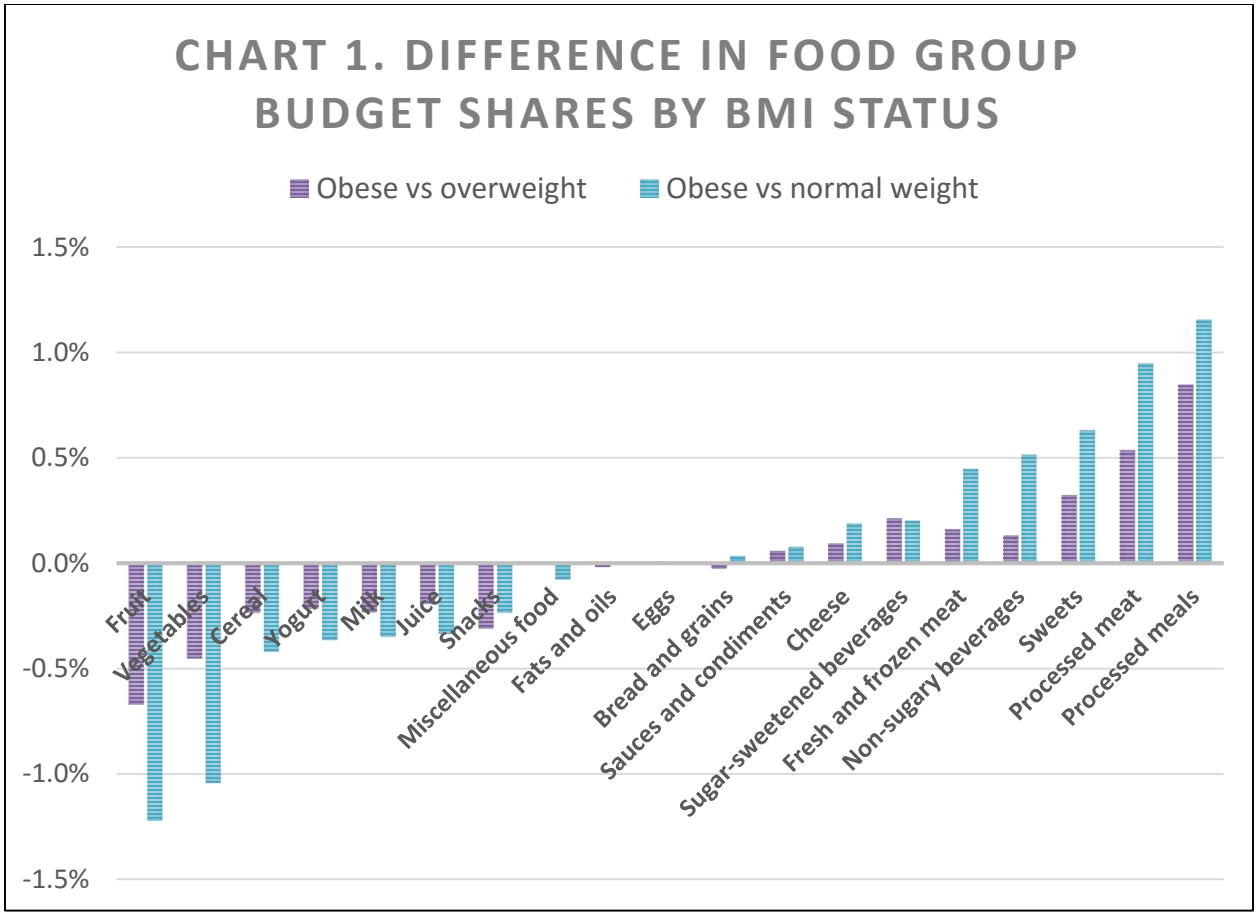
Across all BMI groups, households spent the largest shares of expenditures on meat, poultry, and seafood; processed meals; and sweets and the smallest shares on eggs, fats and oils, and miscellaneous food.

Despite similarities in overall trends, the purchasing patterns of obese households differ for many food groups compared to normal weight and overweight households. Obese households spent a higher share of expenditures on meat, poultry, and seafood; cheese; processed meat;

sauces and condiments; processed meals; sugar-sweetened beverages; non-sugary beverages; and sweets.

Conversely, obese households spent a lower share of expenditures on seven food groups. These include produce and dairy products—fruit, vegetables, juice, milk, and yogurt—as well as cereal and snacks.

Finally, for four food groups, expenditure shares were not significantly different by BMI status. These were bread and grains, eggs, fats and oils, and miscellaneous foods (including spices, baby food, and items not otherwise categorized).



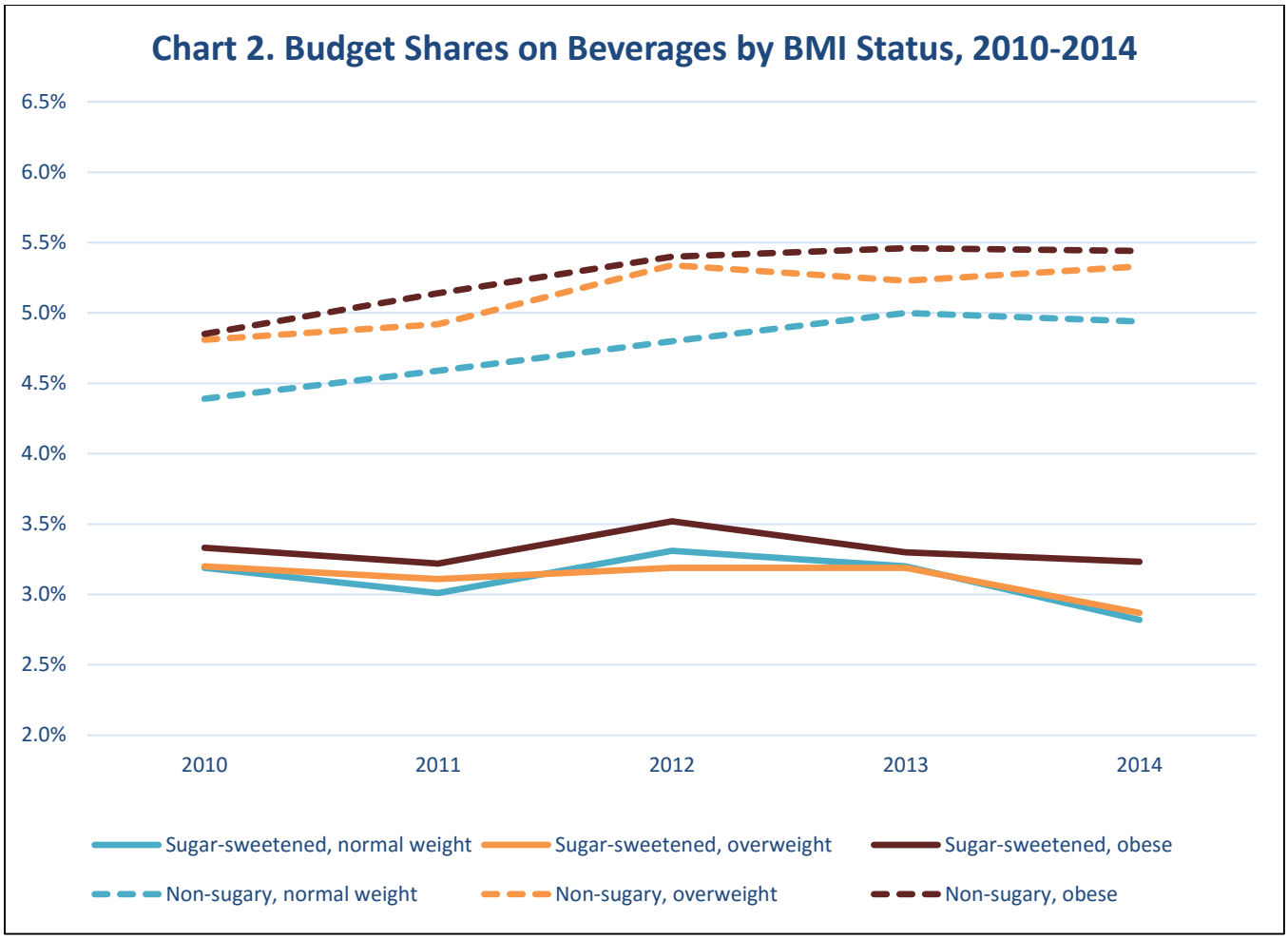
Compared to normal weight and overweight households, obese households devote the largest additional share of food spending to processed meals, processed meat, and sweets. To balance the larger share spent on those products, obese households devote a considerably smaller

share of food spending to fruits and vegetables compared to normal weight and overweight households.

Having five years of data also allows us to examine changes in household food purchasing patterns over time. A number of factors could contribute to changing household preferences over this time period, including updated nutrition guidance, new product offerings and marketing strategies, as well as economic factors surrounding the recession and recovery.

From 2010 to 2014, the purchasing patterns of different BMI groups largely trended in the same direction for each food group; however, the magnitude of change often differed by household BMI status. Compared to 2010, households across all BMIs spent a larger share of their food spending on meat in 2014. However, for obese households, this change was largely due to an increased share of spending on processed meat. This is in contrast to normal weight and overweight households who primarily increased their share of spending on unprocessed meat, poultry, and seafood.

Over this period, normal weight and overweight households also slightly reduced their share of spending on sugar-sweetened beverages; however, the share of spending on these products by obese households remained relatively constant. Households across all BMI groups reduced their share of spending on bread and grains and processed meals, and households increased their share of spending on snacks, non-sugary beverages, cheese, fruit, and sweets. To illustrate the trend over time for beverages, a set of products of particular interest given the ongoing discussion around taxation, chart 2 shows average budget shares over time by household BMI status for sugar-sweetened and non-sugary beverages.



Empirical Approach

To test whether households of different weight status respond differently to prices, we estimate demand for households whose primary shopper is normal weight, overweight and obese using the almost ideal demand system (Deaton and Muellbauer, 1980). Censoring is problematic in the household-level data so we conduct our analysis at the market level. Hence, budget shares and prices used in the almost ideal demand system are for normal weight, overweight and obese households in 58 markets. The almost ideal demand system is

(1) $$w_{I,r,t} = \alpha_I + \sum_{J=1}^{N} \gamma_{I,J} \ln P_{J,r,t} + \beta_I \ln(M_{r,t} / P^*_{r,t}),$$

$w_{I,r,t}$ is the budget share for the Ith food category in market r at time t , P is the price, M is total food-at-home expenditure and $\ln P^*_{r,t}$ is Stone's price index defined by

(2) $\ln P^*_{r,t} = \sum_{J=1}^{N} w_{J,r,t} \ln P_{J,r,t}$.

The following restrictions on the parameters allow the model with translation to conform with demand theory including adding-up, homogeneity and symmetry:

(3) $\sum_I \alpha_I = 1, \sum_I \beta_I = 0, \sum_I \gamma_{I,J} = 0,$

(4) $\sum_J \gamma_{I,J} = 0, \forall j$, and

(5) $\gamma_{I,J} = \gamma_{I,J}, \forall i, j$.

For the model given by equations (1) and (2), the elasticities of demand are

(6) $\eta_{I,M} = 1 + \frac{\beta_I}{w_I}$, (Expenditure elasticity)

(7) $\eta_{I,P_J} = -\delta_{I,J} + \frac{\gamma_{I,J}}{w_I} + w_J$, (Compensated price elasticity)

where and $\delta_{I,J}$ is Kroneker's delta.

For the prices we constructed price indexes for each market, body weight group and quarter. First, we estimated "product" prices for each market, body weight status group, and time period as the average of the UPC-level prices weighted by the projection factors for the market area MedProfiler data. IRI categorizes all UPC items into products such that products are the lowest level of aggregation within the data across all years.[1] For ease of estimation, products that constituted less than 0.5 percent of one of our food categories (table 1) are put into an "all other" product within the food category, and we similarly calculated the average-weighted prices for these all other products. Second, we imputed product prices that are missing in each market, body weight status group and time period using the national average price for the product in a particular time period. We construct Laspeyres prices indexes for each food category using the product prices with the base as national averages for 2010.

We test whether the price and total expenditure coefficients are statistically different across body weight groups by augmenting the almost ideal demand system in (1) and (2) with indicator variables for body weight group that shift the intercept and interaction terms between the indicator variables and price and total expenditure variables that shift the slope:

[1] Brand was available in the data between 2010-2012 but not available between 2013 and 2014.

$$
\begin{aligned}
w_{I,r,t} &= \alpha_I + \theta^1 OVERWEIGHT + \theta^2 OBESE + \sum_{J=1}^{N} \gamma_{I,J} \ln P_{J,r,t} + \beta_I \ln(M_{r,t} / P^*_{r,t}) \\
&+ \sum_{J=1}^{N} \omega^1_{I,J} (\ln P_{J,r,t} \times OVERWEIGHT) + \sum_{J=1}^{N} \omega^2_{I,J} (\ln P_{J,r,t} \times OBESE) + \\
&\lambda^1_I \ln(M_{r,t} / P^*_{r,t}) \times OVERWEIGHT + \lambda^2_I \ln(M_{r,t} / P^*_{r,t}) \times OBESE
\end{aligned}
\qquad (8)
$$

where OVERWEIGHT = 1 if household primary shopper has BMI greater than or equal to 25 but less than 30, and 0 otherwise, and OBESE = 1 if household primary shopper has BMI greater than or equal to 30.

To avoid singularity of the covariance matrix in estimation, we estimate (8) excluding the last food category in estimation (e.g., sweets), and recover these parameters through adding up (equation 3). We use iterative seemingly unrelated regression to estimate (8) with the homogeneity and symmetry restrictions, which is equivalent to maximum likelihood estimation. Maximum likelihood estimation allows for the coefficient estimates to be invariant to the equation dropped (Barten 1969).

Results

For brevity, the parameters estimates for equation (8) are in the appendix. Table 3 shows chi-squared tests of statistical differences in the slope coefficients on the price and total expenditure interaction terms between the body weight status groups. For the own-price price coefficients, we find statistical differences between the body weight status groups for snacks, vegetables, milk, cheese, meat, poultry, seafood, eggs, SSBs and non-SSBs. This means that the primary household shopper responds to own-price changes of these products differently depending on their body weight status. We also see quite a few statistical differences between body weight status groups for complementary and substitute foods as well. For example, for the snack equation (3), 11 out of 18 cross-price coefficients are statistically different across body weight status groups.

We also calculate compensated elasticities of demand for ease of interpretation. All of the own-price elasticities are negative and statistically significant across BMI status (appendix tables). Interestingly, SSBs are net substitutes for non-SSBs across BMI status, and in previous studies these have been found to be complements or no relationship at all (Zhen et al. 2013). Here we mainly discuss the own-price elasticities (table 4). For those foods where we find a statistical difference in the own-price slope coefficients across BMI status, the obese primary household shoppers are less responsive to price changes compared to their overweight counterparts with the exception of milk. For SSBs, a one-percent increase in price will decrease demand for normal weight, overweight and obese primary household shoppers by a little more than 1 percent, 0.90 percent and 0.79 percent, respectively. For vegetables, the own-price elasticities of demand are statistically different across BMI status but the economic difference is small

(e.g., -0.87 for normal, -0.85 for overweight, and -0.78 for obese). Demand for fruits is price elastic across all BMI groups.

Conclusion

This study analyzes food purchasing behaviors by BMI status of primary household shoppers. We find differences in eating patterns of households that have an overweight and obese primary shopper with those of normal weight. In particular, compared to normal weight and overweight households, obese households devote the largest additional share of food spending to processed meals, processed meat, and sweets. To balance the larger share spent on those products, obese households devote a considerably smaller share of food spending to fruits and vegetables compared to normal weight and overweight households. Over the sample period, normal and overweight primary household shoppers decreased spending on SSBs while obese primary shoppers did not.

We also estimated demand for the foods by BMI status to see if the purchasing behavior documented is driven by differences in price responsiveness of primary shoppers. We estimate an almost ideal demand system and test for differences in price and total expenditure responsiveness across BMI groups. We find statistical differences across BMI status for primary shoppers for snacks, vegetables, milk, cheese, meat, poultry, seafood, eggs, SSBs and non-SSBs. We also find statistical differences for complementary and substitute foods across BMI status as well. In particular, obese primary shoppers tend to be much more price inelastic for SSBs, snacks, vegetables and eggs compared with both normal and overweight primary shoppers. Also, obese primary shoppers are more price inelastic for cheese and meat, poultry and seafood compared with their overweight counterparts.

These differences in responsiveness to price changes across BMI status of primary shoppers will affect analyses that investigate the effect of taxes on body weight and calorie consumption. For example, we find obese shoppers to be less responsive to price changes than normal and overweight primary shoppers, so that a simulated tax on SSBs will decrease demand for normal and overweight primary shoppers more than obese shoppers. If the purpose of the tax is to change purchasing behavior of obese consumers as a second-best solution to externalities caused by the obese, then the SSB tax falls short. However, if the purpose of the tax is to collect government revenue for nutrition education, then most of the taxes will be paid by the obese who are less responsive to the tax-induced change in price of SSB. A more rigorous analysis that compares the social welfare across BMI status with varying price responsiveness to such taxes can get at this question more directly. This is left for a future analysis.

This study has several limitations. First, habit persistence is likely to play a role in demand for foods. In future work, we plan to model demand for the foods by BMI status of primary

shopper using a dynamic specification of the almost ideal demand system. Second, we will test whether the prices are endogenous, and if found, correct for the endogeneity.

Table 3. Chi-square tests of statistical differences between slope coefficients of body weight status categories

Parameter		Equation																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Bread	1	0.01	0.63	0.99	0.01	0.34	1.19	7.97*	2.45	0	0.81	0.12	1.15	0.41	0.86	1.2	0.05	1.58	1.06
Cereal	2	10.34*	1.79	1.04	0.2	4.41*	1.08	1.66	2.48	7.64*	3.83*	0	2.47	0.85	0.51	0.5	1.04	1.19	0.11
Snacks	3	0.34	3.41*	4.89*	10.93*	4.31*	0.73	6.98*	0	20.4*	0.12	13.58*	4.56*	13.95*	1.1	0.11	1.24	2.7	9.02*
Vegetables	4	11.27*	1.62	3.03*	4.23*	12.25*	6.5*	6.71*	3.04*	7.21*	1.57	0	1.8	0.03	1.29	1.56	5.08*	0.42	2.68
Fruit	5	0.18	2.52	4.91*	1.44	1.76	3.07*	1.36	34.91*	19.55*	13.39*	8.44*	0.16	0.54	1.55	1.97	0	0.07	0.26
Juice	6	25.29*	11.83*	3.99*	0.03	0.29	0.47	2.58	23.21*	2.12	2.84*	6.79*	4.47*	0.36	2.1	2.37	1.75	0.01	2.68
Milk	7	1.05	0.97	3.78*	0.09	9.81*	5.45*	2.75*	0	11.44*	0.37	4.99*	4.93*	1.12	0.01	6.55*	0.38	0	6.4*
Cheese	8	6.73*	9.83*	6.49*	12.57*	0.3	4.32*	0.46	7.91*	0.55	2.35	0.53	2.81*	3.35*	1.28	0.62	4.7*	0.04	11.33*
Yogurt	9	2.89*	4.72*	0.09	4.33*	0.04	8.74*	5.18*	11.24*	1.09	0.46	1.68	0.88	2.86*	0.37	0.91	0.49	0.96	0.12
meat, Poultry, Seafood	10	0.26	4.69*	14.41*	0.13	1.65	1.04	3.54*	0.02	0.25	3.01*	1.59	0.85	0	8.46*	9.13*	7.43*	10.08*	7.74*
Processed meat	11	0.22	6.78*	8.07*	0.57	0.01	3.17*	0.36	0.12	1.45	0.58	1.45	7.52*	3.93*	0.13	8.18*	0.23	0.57	3.67*
Eggs	12	2.94*	1.14	9.79*	2.83*	7.89*	6.89*	0.02	7.95*	24.47*	29.36*	17.53*	4.68*	0.71	0.06	3.89*	2.32	5.36*	1.26
Fats and oils	13	2.4	0.03	0.56	20.29*	1.51	0.01	2.57	0.96	3.87*	1.48	0.12	2.65	0.05	7.18*	1.16	7.81*	8.78*	18.67*
Sauces and condiments	14	0.03	5.73*	0	2.45	0.02	8.17*	18.12*	0.12	0.51	0.04	0.16	0.42	3.99*	4.64*	5.93*	0.33	1.29	0.29
Miscellaneous food	15	0.37	0.07	0.36	1.91	1.73	1.56	1.6	0.34	0.37	0.11	2.35	0.66	2.04	1.23	2.55	8.15*	20.15*	12.75*
Processed meals	16	18.17*	0.76	3.49*	6.47*	5.79*	3.66*	0	5.11*	7.54*	0	2.03	0.96	0.51	0	0.36	0.65	6.95*	17.26*
Sugar-sweetened beverages	17	0.03	3.11*	0.28	1.13	5.63*	2.11	3.82*	16.95*	0.25	3.67*	0.35	2.93*	7.54*	1.31	0	2.35	13*	42.86*
Non-sugary beverages	18	27.64*	0.4	3.83*	6.39*	4.21*	0.25	20.8*	5.18*	2.58	0.14	2.39	11.37*	1.66	8.61*	3.59*	0.87	6.5*	22.46*
Sweets	--	0.52	5.02*	0.09	0.37	2.4	0.86	7.61*	0.34	0.07	0.23	0.92	1.25	0.76	0.04	2.65	1.72	0	3.52*
Total expenditure	--	0.5	3.43*	0.35	0.42	1.11	2.68	0.07	6.45*	0.36	46.23*	12.6*	0.91	0.62	11.44*	4.17*	2.65	0.03	1.06

*denotes statistical significance at 10 percent

Table 4. Compensated own-price elasticities of demand

	Normal	Overweight	Obese
Bread and grains	-0.9799	-0.9765	-0.9478
Cereal	-0.7540	-0.5214	-0.7219
Snacks	-0.8846	-0.8756	-0.8324
Vegetables	-0.8731	-0.8560	-0.7828
Fruit	-1.1749	-1.0703	-1.2265
Juice	-1.0891	-0.8198	-0.9434
Milk	-1.2590	-0.9025	-1.0446
Cheese	-0.8788	-1.1471	-0.8800
Yogurt	-0.9116	-0.7097	-0.9086
meat, Poultry, Seafood	-0.8182	-0.9570	-0.8614
Processed meat	-0.8382	-0.9252	-1.0010
Eggs	-0.7058	-0.5855	-0.4664
Fats and oils	-0.7375	-0.9318	-1.0511
Sauces and condiments	-0.8593	-0.8178	-0.9119
Miscellaneous food	-0.9590	-1.0514	-0.9446
Processed meals	-0.8516	-0.6151	-0.7344
Sugar-sweetened beverages	-1.0096	-0.9090	-0.7920
Non-sugary beverages	-0.8115	-1.1506	-0.8214
Sweets	-0.8401	-0.8359	-0.8405

Notes: All own-price elasticities of demand are statistically significant at 10 percent and evaluated at the mean of the data.

References

Barten, A.P. 1969. "Maximum Likelihood Estimation of a Complete System of Demand Equations," European Economic Review 1:7-73.

Cawley, J., J.A. Rizzo, and K. Haas. 2007. "Occupation-Specific Absenteeism Costs Associated with Obesity and Morbid Obesity." Journal of Occupational and Environmental Medicine 49(12): 1299-1409.

Deaton, A. and J. Muellbauer. 1980. "An Almost Ideal Demand System." The American Economic Review 70(3): 312-326.

Epstein, L.H., K.K. Dearing, R.A. Paluch, J.N. Roemmich and D. Cho. 2007. "Price and maternal obesity influence purchasing of low- and high-energy-dense foods." American Journal of Clinical Nutrition 86: 914-22.

Falbe, J., N. Rojas, A.H. Grummon, and K.A. Madsen. 2015. "Higher Retail Prices of Sugar-Sweetened beverages 3 Months After Implementation of an Excise Tax in Berkeley, California." American Journal of Public Health 105(11): 2194-2201.

Gandal, N. and A. Shabelansky. 2010. Obesity and Price Sensitivity at the Supermarket. Forum for Health Economics and Policy 13(2): Article 9.

Goetzel RZ, Gibson TB, Short ME, et al. 2010. A multi-worksite analysis of the relationships among body mass index, medical utilization, and worker productivity. Journal of Occupational Environment Medicine 52(suppl 1):S52–S58.

Just, D.R. and B. Wansink. 2015. "Fast food, soft drink and candy intake is unrelated to body mass index for 95% of American adults." Obesity Science and Practice.

Kuchler, F., A. Tegene and J.M. Harris. 2005. "Taxing Snack Foods: Manipulating Diet Quality or Financing Information Programs?" Applied Economic Perspectives and Policy 27(1): 4-20.

MacEwan, J.P., J.M. Alston, A.M. Okrent. 2014. "The Consequences of Obesity for the External Costs of Public Health Insurance in the United States." Applied Economic Perspectives and Policy 36(4): 696-716.

Miljkovic, D., W. Nganje and H. de Chastenet. 2008. "Economic factors affecting the increase in obesity in the United States: Differential response to price." Food Policy 33: 48-60.

Nederkoorn, C, R.C. Havermans, J. Giesen, A. Jansen. "High tax on high energy dense foods and its effects on the purchase of calories in a supermarket. An experiment. Appetite 56: 760-765.

Ng, S.W., L. Silver, S. Ryan-Ibarra, M. Induni, C. Hamma, J. Poti and B. Popkin. 2015. "Berkeley Evaluation of Soda Tax (BEST) Study Preliminary Findings." Presentation at the American Public Health Association, November 3.

Ogden, C.L., Carroll, M.D., Kit, B.K., Flegal, K.M. 2014. "Prevalence of Childhood and Adult Obesity in the United States, 2011–2012." *Journal of the American Medical Association* 311(8): 806–14. Available at http://jama.jamanetwork.com/article.aspx?articleid=1832542#Methods (accessed May 13, 2015).

Okrent, A.M. and J.M. Alston. 2012. "The Effects of Farm Commodity and Retail Food Policies on Obesity and Economic Welfare in the United States." American Journal of Agricultural Economics 94(3): 611-646.

Pollak, R.A. and T.J. Wales. 1981. “Demographic Variables in Demand Analysis.” Econometrica 49(6): 1533–1551.

Staudigel, M. 2012. “How do obese people afford to be obese? Consumption strategies of Russian households.” Agricultural Economics 43: 701-714.

Temple, J.L., K.M. Johnson, K. Archer, A. LaCarte, C. Yi, and L.H. Epstein. 2011. “Influence of simplified nutrition labeling and taxation on laboratory energy intake in adults.” Appetite 57: 184-192.

Tsai, A.G., D.F. Williamson, and H.A. Glick. 2011. “Direct medical cost of overweight and obesity in the United States: a quantitative systematic review.” Obesity Reviews 12(1): 50-61.

Zhen, C., E.A. Finkelstein, J.M. Nonnemaker, S.A. Karns, and J.E. Todd. 2013. “Predicting the Effects of Sugar-Sweetened Beverage Taxes on Food and Beverage Demand in a Large Demand System.” American Journal of Agricultural Economics

Appendix table 1. Compensated elasticities of demand for normal weight primary shoppers

Demand for	With respect to price of																			With respect to total expenditure on food
	Bread and g	Cereal	Snacks	Vegetables	Fruit	Juice	Milk	Cheese	Yogurt	meat, Poult	Processed r	Eggs	Fats and oi	Sauces and	Miscellane	Processed r	Sugar-swee	Non-sugary	Sweets	
Bread and grains	-0.9799	0.0503	0.1680	0.1152	0.1019	-0.0224	0.0589	0.0359	0.0314	-0.0050	0.0116	0.0101	0.0140	0.0682	0.0185	0.1933	0.0613	0.0536	0.0151	0.9995
	0.0167	0.0150	0.0232	0.0157	0.0153	0.0146	0.0161	0.0157	0.0122	0.0140	0.0185	0.0055	0.0088	0.0096	0.0066	0.0277	0.0118	0.0181	0.0180	0.0133
Cereal	0.0986	-0.7540	0.0847	0.0568	-0.0080	-0.0296	0.1997	0.0218	-0.1128	-0.0057	-0.0743	0.0438	0.0499	0.0240	0.0414	0.2716	0.0580	-0.0333	0.0675	1.0081
	0.0294	0.0721	0.0741	0.0422	0.0430	0.0468	0.0499	0.0558	0.0378	0.0433	0.0599	0.0224	0.0312	0.0380	0.0124	0.0811	0.0258	0.0457	0.0370	0.0237
Snacks	0.1102	0.0283	-0.8846	0.0668	-0.0224	0.1106	0.0646	0.1210	-0.0049	0.0195	0.0088	0.0249	-0.0131	0.0201	0.0198	0.0269	0.0675	0.0521	0.1840	0.9906
	0.0152	0.0248	0.0505	0.0214	0.0217	0.0226	0.0246	0.0264	0.0186	0.0216	0.0290	0.0102	0.0147	0.0175	0.0065	0.0408	0.0133	0.0232	0.0189	0.0125
Vegetables	0.1034	0.0260	0.0915	-0.8731	0.0630	0.0111	0.0897	0.0057	-0.0164	0.0332	0.0961	0.0066	0.0410	0.0255	0.0212	0.0878	0.0643	0.0443	0.0792	0.9903
	0.0141	0.0194	0.0294	0.0265	0.0186	0.0184	0.0201	0.0203	0.0152	0.0175	0.0233	0.0072	0.0114	0.0126	0.0070	0.0344	0.0135	0.0213	0.0190	0.0136
Fruit	0.1750	-0.0070	-0.0587	0.1204	-1.1749	0.0872	0.1586	0.2144	-0.1321	-0.0232	0.0411	0.0283	0.0736	-0.0997	0.0491	0.1702	0.0390	0.1395	0.1990	0.9518
	0.0263	0.0377	0.0568	0.0356	0.0499	0.0356	0.0388	0.0399	0.0298	0.0339	0.0451	0.0147	0.0220	0.0253	0.0125	0.0675	0.0246	0.0398	0.0346	0.0242
Juice	-0.0427	-0.0289	0.3221	0.0236	0.0969	-1.0891	0.1400	0.0090	0.0497	-0.1418	0.1618	-0.0164	0.0242	0.1277	0.0415	0.0885	0.0695	0.0451	0.1190	1.1207
	0.0278	0.0456	0.0660	0.0390	0.0395	0.0588	0.0447	0.0487	0.0345	0.0391	0.0536	0.0186	0.0268	0.0320	0.0120	0.0746	0.0244	0.0425	0.0356	0.0228
Milk	0.0774	0.1339	0.1294	0.1311	0.1213	0.0963	-1.2590	0.0172	-0.0603	0.0945	0.0718	0.0171	0.1081	0.0906	0.0172	0.1932	-0.0083	-0.0842	0.1128	0.9326
	0.0211	0.0334	0.0492	0.0294	0.0297	0.0307	0.0467	0.0360	0.0253	0.0290	0.0391	0.0135	0.0195	0.0233	0.0092	0.0559	0.0187	0.0325	0.0268	0.0176
Cheese	0.0514	0.0160	0.2644	0.0091	0.1787	0.0067	0.0187	-0.8788	0.1641	0.0523	0.0227	-0.0573	-0.0455	0.0364	-0.0061	0.1297	-0.0032	-0.0346	0.0752	0.9088
	0.0224	0.0408	0.0576	0.0323	0.0333	0.0365	0.0393	0.0620	0.0296	0.0338	0.0463	0.0181	0.0244	0.0307	0.0093	0.0635	0.0193	0.0347	0.0278	0.0177
Yogurt	0.0955	-0.1750	-0.0225	-0.0554	-0.2337	0.0792	-0.1395	0.3482	-0.9116	-0.0449	0.2148	-0.0068	0.0013	-0.1382	-0.0138	0.1858	0.2061	0.2880	0.3225	1.0208
	0.0371	0.0587	0.0861	0.0513	0.0528	0.0549	0.0585	0.0628	0.0630	0.0513	0.0700	0.0244	0.0349	0.0416	0.0165	0.0991	0.0334	0.0561	0.0479	0.0316
meat, Poultry, Seafood	-0.0113	-0.0066	0.0675	0.0836	-0.0305	-0.1681	0.1630	0.0826	-0.0334	-0.8182	0.1449	0.0548	-0.0016	0.0712	0.0579	-0.0373	0.0426	0.0311	0.3079	1.0525
	0.0318	0.0501	0.0745	0.0442	0.0447	0.0463	0.0499	0.0534	0.0382	0.0615	0.0605	0.0204	0.0295	0.0350	0.0142	0.0835	0.0284	0.0488	0.0408	0.0273
Processed meat	0.0127	-0.0417	0.0147	0.1177	0.0263	0.0932	0.0601	0.0174	0.0778	0.0704	-0.8382	-0.0458	-0.0166	-0.0832	0.0378	0.2247	0.0319	0.0218	0.2190	1.0175
	0.0203	0.0337	0.0487	0.0285	0.0289	0.0309	0.0328	0.0356	0.0253	0.0294	0.0549	0.0138	0.0198	0.0240	0.0088	0.0554	0.0179	0.0310	0.0256	0.0170
Eggs	0.0576	0.1275	0.2166	0.0419	0.0940	-0.0491	0.0744	-0.2285	-0.0128	0.1383	-0.2380	-0.7058	-0.0378	0.1010	0.0034	0.0001	0.0457	0.0703	0.3013	1.0044
	0.0315	0.0654	0.0891	0.0460	0.0487	0.0556	0.0586	0.0724	0.0458	0.0514	0.0719	0.0467	0.0404	0.0548	0.0123	0.0941	0.0265	0.0479	0.0380	0.0237
Fats and oils	0.0366	0.0666	-0.0524	0.1192	0.1121	0.0332	0.2153	-0.0830	0.0011	-0.0019	-0.0395	-0.0173	-0.7375	0.0113	0.0352	0.1221	0.0570	0.0062	0.1156	0.9737
	0.0231	0.0416	0.0586	0.0331	0.0335	0.0368	0.0388	0.0446	0.0301	0.0341	0.0470	0.0185	0.0349	0.0314	0.0095	0.0647	0.0197	0.0348	0.0284	0.0185
Sauces and condiments	0.1519	0.0273	0.0682	0.0632	-0.1293	0.1491	0.1537	0.0567	-0.1013	0.0701	-0.1686	0.0394	0.0096	-0.8593	0.0261	0.2699	0.0656	0.0268	0.0810	1.0075
	0.0215	0.0432	0.0594	0.0314	0.0328	0.0373	0.0395	0.0478	0.0305	0.0344	0.0485	0.0214	0.0267	0.0498	0.0085	0.0649	0.0180	0.0326	0.0261	0.0161
Miscellaneous food	0.0518	0.0593	0.0848	0.0662	0.0803	0.0611	0.0367	-0.0119	-0.0128	0.0719	0.0965	0.0017	0.0378	0.0329	-0.9590	0.1665	0.0812	0.0052	0.0498	1.3003
	0.0184	0.0178	0.0280	0.0218	0.0205	0.0176	0.0197	0.0182	0.0152	0.0176	0.0226	0.0061	0.0103	0.0107	0.0271	0.0361	0.0237	0.0267	0.0326	0.0497
Processed meals	0.1244	0.0892	0.0264	0.0629	0.0638	0.0298	0.0947	0.0583	0.0393	-0.0106	0.1314	0.0000	0.0301	0.0779	0.0381	-0.8516	-0.0226	0.0570	-0.0384	0.9963
	0.0178	0.0266	0.0400	0.0247	0.0253	0.0252	0.0274	0.0285	0.0210	0.0237	0.0324	0.0106	0.0159	0.0187	0.0083	0.0647	0.0164	0.0280	0.0233	0.0162
Sugar-sweetened beverages	0.1050	0.0507	0.1763	0.1226	0.0389	0.0624	-0.0108	-0.0038	0.1162	0.0323	0.0496	0.0137	0.0373	0.0504	0.0495	-0.0602	-1.0096	0.1100	0.0696	1.0302
	0.0203	0.0225	0.0346	0.0257	0.0245	0.0219	0.0244	0.0231	0.0188	0.0215	0.0279	0.0079	0.0129	0.0138	0.0145	0.0437	0.0322	0.0301	0.0313	0.0300
Non-sugary beverages	0.0623	-0.0198	0.0924	0.0572	0.0943	0.0275	-0.0744	-0.0281	0.1100	0.0159	0.0230	0.0143	0.0028	0.0139	0.0021	0.1028	0.0746	-0.8115	0.2406	0.9498
	0.0210	0.0271	0.0411	0.0276	0.0269	0.0259	0.0288	0.0282	0.0214	0.0250	0.0327	0.0097	0.0155	0.0170	0.0110	0.0505	0.0204	0.0451	0.0286	0.0213
Sweets	0.0084	0.0191	0.1556	0.0489	0.0642	0.0345	0.0476	0.0291	0.0588	0.0754	0.1104	0.0293	0.0245	0.0201	0.0098	-0.0331	0.0225	0.1149	-0.8401	0.9919
	0.0100	0.0105	0.0160	0.0117	0.0112	0.0103	0.0113	0.0108	0.0087	0.0100	0.0129	0.0037	0.0060	0.0065	0.0064	0.0200	0.0101	0.0136	0.0195	0.0140

Appendix table 3. Compensated elasticities of demand for obese primary shoppers

Demand for	With respect to price of																			With respect to total expenditure on food
	Bread and g	Cereal	Snacks	Vegetables	Fruit	Juice	Milk	Cheese	Yogurt	meat, Poult	Processed r	Eggs	Fats and oi	Sauces and	Miscellane	Processed r	Sugar-swee	Non-sugary	Sweets	
Bread and grains	-0.9478	-0.0310	0.1460	0.1219	0.1119	0.0319	-0.0407	-0.0053	0.0284	0.0906	0.0567	0.0107	0.0129	0.0734	0.0014	0.0309	0.0469	0.1795	0.0818	1.0008
	0.0170	0.0129	0.0241	0.0166	0.0138	0.0144	0.0169	0.0177	0.0117	0.0169	0.0197	0.0058	0.0093	0.0092	0.0098	0.0315	0.0131	0.0175	0.0148	0.0127
Cereal	-0.0700	-0.7219	0.0268	0.0851	-0.0389	0.1583	-0.1115	-0.0337	0.1887	-0.1246	0.0277	-0.1172	-0.0592	0.1412	0.0439	0.3498	-0.0129	0.1689	0.0997	1.0402
	0.0292	0.0655	0.0789	0.0459	0.0401	0.0463	0.0527	0.0627	0.0373	0.0473	0.0569	0.0233	0.0349	0.0365	0.0179	0.0865	0.0265	0.0375	0.0273	0.0202
Snacks	0.0956	0.0078	-0.8324	0.0161	0.0492	0.0535	-0.0405	0.1363	0.0120	-0.0616	0.2178	0.0437	0.0882	0.0365	0.0227	-0.0083	0.0345	-0.0153	0.1441	0.9140
	0.0158	0.0229	0.0545	0.0241	0.0205	0.0237	0.0266	0.0302	0.0185	0.0244	0.0290	0.0110	0.0167	0.0173	0.0098	0.0445	0.0145	0.0201	0.0147	0.0112
Vegetables	0.1155	0.0357	0.0233	-0.7828	0.0262	0.0754	0.1097	0.0527	0.0109	0.0783	0.0094	0.0236	-0.0027	0.0497	0.0442	-0.0866	0.0451	0.0746	0.0976	0.9846
	0.0157	0.0193	0.0348	0.0316	0.0190	0.0208	0.0239	0.0257	0.0165	0.0229	0.0270	0.0088	0.0138	0.0139	0.0110	0.0431	0.0158	0.0213	0.0162	0.0128
Fruit	0.2326	-0.0358	0.1561	0.0576	-1.2265	-0.0297	0.2970	0.2304	-0.0651	-0.0261	-0.2186	0.0365	0.0767	-0.1040	0.0654	0.5811	-0.0599	-0.0617	0.0939	0.9292
	0.0287	0.0369	0.0650	0.0417	0.0500	0.0393	0.0457	0.0494	0.0318	0.0427	0.0505	0.0173	0.0267	0.0277	0.0194	0.0803	0.0279	0.0384	0.0289	0.0226
Juice	0.0670	0.1473	0.1717	0.1675	-0.0300	-0.9434	0.1563	-0.0776	0.0097	-0.0329	0.0603	-0.0947	0.0249	-0.0446	0.0708	0.1862	-0.0195	0.0813	0.0997	1.2458
	0.0304	0.0431	0.0760	0.0462	0.0397	0.0637	0.0515	0.0588	0.0355	0.0476	0.0565	0.0204	0.0313	0.0323	0.0191	0.0875	0.0283	0.0397	0.0289	0.0217
Milk	-0.0566	-0.0687	-0.0859	0.1611	0.1988	0.1034	-1.0446	0.0891	0.0210	0.0506	0.0812	-0.0634	0.0239	0.0664	0.0811	0.2431	0.0768	-0.0575	0.1802	0.9924
	0.0235	0.0325	0.0565	0.0352	0.0306	0.0341	0.0551	0.0439	0.0272	0.0366	0.0433	0.0156	0.0237	0.0245	0.0153	0.0666	0.0225	0.0312	0.0227	0.0175
Cheese	-0.0070	-0.0196	0.2731	0.0730	0.1455	-0.0484	0.0841	-0.8800	-0.0512	0.0791	0.2001	-0.0124	0.0425	0.0453	0.0448	-0.0393	-0.0408	-0.0630	0.1741	0.8778
	0.0233	0.0364	0.0604	0.0356	0.0312	0.0367	0.0414	0.0679	0.0293	0.0369	0.0442	0.0183	0.0277	0.0285	0.0145	0.0665	0.0216	0.0301	0.0218	0.0166
Yogurt	0.1055	0.3101	0.0681	0.0427	-0.1163	0.0172	0.0560	-0.1448	-0.9086	0.1978	0.0471	0.0382	0.1460	0.1492	0.0505	-0.1292	0.1245	-0.1837	0.1297	0.9736
	0.0434	0.0613	0.1048	0.0647	0.0568	0.0627	0.0726	0.0828	0.0708	0.0681	0.0804	0.0298	0.0452	0.0468	0.0285	0.1216	0.0413	0.0571	0.0426	0.0328
meat, Poultry, Seafood	0.1934	-0.1178	-0.2009	0.1764	-0.0268	-0.0335	0.0777	0.1288	0.1137	-0.8614	0.0225	0.1283	0.0788	0.0031	0.0163	-0.1471	0.0050	0.2263	0.2172	1.3465
	0.0360	0.0447	0.0797	0.0517	0.0439	0.0484	0.0561	0.0601	0.0392	0.0747	0.0641	0.0205	0.0321	0.0328	0.0253	0.0973	0.0361	0.0500	0.0371	0.0298
Processed meat	0.0520	0.0112	0.3046	0.0091	-0.0963	0.0263	0.0535	0.1396	0.0116	0.0097	-1.0010	0.0585	0.0568	-0.0209	-0.0056	0.0847	-0.0239	0.1203	0.2098	1.1129
	0.0181	0.0231	0.0405	0.0262	0.0223	0.0246	0.0285	0.0309	0.0198	0.0275	0.0448	0.0105	0.0164	0.0168	0.0126	0.0498	0.0178	0.0246	0.0187	0.0151
Eggs	0.0597	-0.2886	0.3711	0.1387	0.0977	-0.2505	-0.2535	-0.0524	0.0572	0.3340	0.3553	-0.4664	-0.1420	-0.0074	0.0451	-0.0929	0.0976	-0.1496	0.1470	1.1172
	0.0321	0.0574	0.0938	0.0514	0.0462	0.0539	0.0622	0.0777	0.0446	0.0534	0.0640	0.0450	0.0468	0.0483	0.0187	0.0966	0.0284	0.0397	0.0289	0.0212
Fats and oils	0.0326	-0.0664	0.3411	-0.0072	0.0935	0.0300	0.0435	0.0821	0.0996	0.0934	0.1572	-0.0647	-1.0511	0.0534	-0.0233	0.1143	-0.0573	0.0269	0.1022	0.9146
	0.0237	0.0392	0.0646	0.0369	0.0325	0.0377	0.0431	0.0534	0.0309	0.0380	0.0454	0.0213	0.0434	0.0324	0.0144	0.0702	0.0214	0.0296	0.0220	0.0170
Sauces and condiments	0.1537	0.1310	0.1169	0.1101	-0.1049	-0.0444	0.1000	0.0724	0.0842	0.0030	-0.0479	-0.0028	0.0442	-0.9119	0.0013	0.0525	0.0352	0.1217	0.0857	1.0145
	0.0193	0.0339	0.0552	0.0308	0.0279	0.0322	0.0369	0.0455	0.0264	0.0322	0.0385	0.0182	0.0268	0.0396	0.0113	0.0590	0.0169	0.0239	0.0175	0.0128
Miscellaneous food	0.0039	0.0547	0.0977	0.1314	0.0886	0.0949	0.1641	0.0960	0.0383	0.0215	-0.0173	0.0228	-0.0258	0.0017	-0.9446	0.3061	-0.1149	-0.0036	-0.0154	1.2593
	0.0275	0.0223	0.0422	0.0327	0.0262	0.0256	0.0309	0.0312	0.0216	0.0334	0.0387	0.0095	0.0161	0.0152	0.0469	0.0628	0.0371	0.0430	0.0438	0.0519
Processed meals	0.0183	0.0919	-0.0076	-0.0543	0.1659	0.0526	0.1037	-0.0178	-0.0207	-0.0409	0.0549	-0.0099	0.0268	0.0149	0.0645	-0.7344	0.1300	0.0556	0.1064	1.0129
	0.0187	0.0227	0.0404	0.0270	0.0229	0.0247	0.0284	0.0301	0.0194	0.0270	0.0323	0.0103	0.0164	0.0167	0.0132	0.0701	0.0189	0.0262	0.0192	0.0158
Sugar-sweetened beverages	0.0733	-0.0089	0.0822	0.0743	-0.0450	-0.0145	0.0862	-0.0486	0.0524	0.0037	-0.0408	0.0274	-0.0353	0.0262	-0.0637	0.3421	-0.7920	0.1843	0.0967	1.0201
	0.0205	0.0183	0.0346	0.0261	0.0210	0.0211	0.0253	0.0257	0.0174	0.0264	0.0304	0.0080	0.0132	0.0126	0.0206	0.0497	0.0356	0.0314	0.0275	0.0273
Non-sugary beverages	0.1821	0.0758	-0.0237	0.0799	-0.0301	0.0392	-0.0419	-0.0487	-0.0502	0.1075	0.1332	-0.0273	0.0108	0.0589	-0.0013	0.0951	0.1196	-0.8214	0.1424	0.8867
	0.0177	0.0168	0.0312	0.0228	0.0187	0.0192	0.0227	0.0233	0.0156	0.0238	0.0272	0.0072	0.0118	0.0116	0.0155	0.0448	0.0204	0.0375	0.0211	0.0190
Sweets	0.0416	0.0224	0.1118	0.0524	0.0230	0.0241	0.0659	0.0675	0.0178	0.0517	0.1165	0.0134	0.0205	0.0208	-0.0028	0.0912	0.0315	0.0714	-0.8405	0.9274
	0.0075	0.0061	0.0114	0.0087	0.0071	0.0070	0.0083	0.0084	0.0058	0.0088	0.0104	0.0026	0.0044	0.0043	0.0079	0.0164	0.0089	0.0106	0.0148	0.0131

Appendix table 2. Compensated elasticities of demand for overweight primary shoppers

Demand for	With respect to price of																		With respect to total expenditure on food
	Bread and g	Cereal	Snacks	Vegetables	Fruit	Juice	Milk	Cheese	Yogurt	meat, Poult	Processed r	Eggs	Fats and oi	Sauces and	Miscellane	Processed r	Sugar-swee	Non-sugary	Sweets	
Bread and grains	-0.9765	0.0288	0.2045	0.0653	0.1266	-0.0250	0.0455	0.0472	0.0417	0.0039	0.0369	0.0155	0.0052	0.0568	0.0160	0.1591	0.0291	0.0424	0.0772	0.9851
	0.0165	0.0136	0.0232	0.0153	0.0149	0.0150	0.0169	0.0157	0.0119	0.0148	0.0193	0.0053	0.0089	0.0088	0.0099	0.0302	0.0111	0.0180	0.0159	0.0134
Cereal	0.0601	-0.5214	0.1073	0.1499	-0.1345	-0.0710	-0.0724	-0.0303	-0.0810	-0.0195	0.2416	-0.1433	-0.0500	0.0967	0.0070	0.1491	0.0338	0.2546	0.0232	1.0017
	0.0285	0.0638	0.0756	0.0429	0.0423	0.0465	0.0533	0.0570	0.0373	0.0433	0.0576	0.0204	0.0320	0.0333	0.0184	0.0824	0.0223	0.0462	0.0304	0.0224
Snacks	0.1318	0.0331	-0.8756	-0.0136	0.0797	0.0118	0.1133	0.0356	0.0851	0.0768	0.0480	0.0254	0.0061	0.0823	0.0100	-0.0271	0.0266	0.0306	0.1200	0.9239
	0.0149	0.0233	0.0519	0.0222	0.0216	0.0235	0.0273	0.0282	0.0188	0.0219	0.0290	0.0099	0.0158	0.0163	0.0098	0.0428	0.0119	0.0239	0.0161	0.0120
Vegetables	0.0604	0.0665	-0.0195	-0.8560	0.1139	-0.0168	0.0858	0.1537	0.0770	0.0389	0.0355	0.0082	0.0216	0.0220	0.0342	0.1076	0.0452	-0.0618	0.0837	0.9764
	0.0142	0.0190	0.0319	0.0279	0.0192	0.0203	0.0231	0.0227	0.0161	0.0194	0.0257	0.0076	0.0126	0.0127	0.0102	0.0387	0.0122	0.0223	0.0165	0.0128
Fruit	0.2325	-0.1183	0.2270	0.2259	-1.0703	-0.0157	0.1127	-0.0551	-0.0490	0.0886	-0.0406	0.0169	0.0912	-0.0822	0.0294	0.2896	0.0226	0.0287	0.0662	0.8921
	0.0274	0.0372	0.0616	0.0381	0.0521	0.0393	0.0446	0.0446	0.0317	0.0373	0.0501	0.0152	0.0246	0.0253	0.0195	0.0751	0.0232	0.0427	0.0312	0.0243
Juice	-0.0499	-0.0679	0.0365	-0.0363	-0.0171	-0.8198	-0.0620	0.3544	-0.0984	-0.1251	0.0149	0.0160	0.0927	0.0299	0.0150	0.4497	-0.0112	0.1350	0.1436	1.1823
	0.0299	0.0444	0.0727	0.0437	0.0427	0.0649	0.0523	0.0546	0.0370	0.0435	0.0579	0.0185	0.0297	0.0309	0.0197	0.0844	0.0240	0.0479	0.0328	0.0241
Milk	0.0608	-0.0463	0.2348	0.1239	0.0820	-0.0415	-0.9025	0.1207	0.0188	0.0230	0.0987	-0.0387	0.0044	-0.0026	0.0296	-0.0148	-0.0096	0.1684	0.0907	0.9948
	0.0226	0.0341	0.0566	0.0334	0.0324	0.0350	0.0564	0.0420	0.0280	0.0331	0.0444	0.0149	0.0232	0.0241	0.0150	0.0640	0.0179	0.0362	0.0244	0.0184
Cheese	0.0647	-0.0199	0.0758	0.2279	-0.0412	0.2438	0.1240	-1.1471	0.0500	0.0618	0.2107	0.0471	0.0883	0.0456	0.0263	-0.3485	0.0670	0.0918	0.1320	0.9160
	0.0215	0.0375	0.0600	0.0336	0.0333	0.0375	0.0431	0.0709	0.0306	0.0345	0.0453	0.0193	0.0287	0.0304	0.0132	0.0658	0.0161	0.0346	0.0220	0.0158
Yogurt	0.1365	-0.1270	0.4320	0.2721	-0.0873	-0.1613	0.0460	0.1192	-0.7097	-0.0094	0.2622	0.0742	0.2499	0.1273	0.0096	-0.7755	0.0823	-0.0258	0.0847	1.0254
	0.0390	0.0585	0.0957	0.0567	0.0564	0.0607	0.0686	0.0730	0.0684	0.0575	0.0768	0.0258	0.0407	0.0423	0.0261	0.1101	0.0314	0.0614	0.0434	0.0325
meat, Poultry, Seafood	0.0087	-0.0207	0.2645	0.0933	0.1071	-0.1391	0.0383	0.0999	-0.0064	-0.9570	0.1082	0.0503	-0.0511	-0.1230	0.0054	-0.0449	0.0333	0.2293	0.3040	1.0936
	0.0328	0.0460	0.0754	0.0464	0.0451	0.0484	0.0549	0.0558	0.0390	0.0647	0.0613	0.0189	0.0307	0.0314	0.0225	0.0897	0.0266	0.0518	0.0366	0.0281
Processed meat	0.0372	0.1169	0.0753	0.0388	-0.0223	0.0075	0.0747	0.1551	0.0810	0.0493	-0.9252	0.0258	0.0187	0.0011	0.0308	0.0501	0.0261	-0.0139	0.1730	1.0531
	0.0195	0.0279	0.0455	0.0281	0.0276	0.0293	0.0336	0.0334	0.0237	0.0279	0.0521	0.0113	0.0184	0.0190	0.0134	0.0555	0.0161	0.0311	0.0218	0.0168
Eggs	0.0878	-0.3897	0.2236	0.0504	0.0522	0.0456	-0.1643	0.1949	0.1287	0.1288	0.1452	-0.5855	0.0182	0.0124	0.0302	-0.2001	-0.0048	0.0593	0.1671	1.0629
	0.0298	0.0554	0.0874	0.0468	0.0471	0.0526	0.0632	0.0798	0.0447	0.0483	0.0635	0.0490	0.0467	0.0508	0.0176	0.0922	0.0216	0.0470	0.0299	0.0215
Fats and oils	0.0133	-0.0613	0.0244	0.0598	0.1272	0.1190	0.0085	0.1647	0.1955	-0.0590	0.0473	0.0082	-0.9318	0.0269	0.0270	0.1452	-0.0001	-0.0112	0.0965	0.9255
	0.0227	0.0392	0.0627	0.0347	0.0343	0.0381	0.0444	0.0535	0.0319	0.0354	0.0467	0.0211	0.0430	0.0327	0.0139	0.0678	0.0169	0.0353	0.0233	0.0176
Sauces and condiments	0.1245	0.1016	0.2802	0.0522	-0.0982	0.0329	-0.0042	0.0729	0.0854	-0.1217	0.0024	0.0048	0.0231	-0.8178	0.0223	0.1376	0.0654	-0.0357	0.0724	0.9436
	0.0192	0.0350	0.0556	0.0302	0.0302	0.0340	0.0395	0.0485	0.0284	0.0310	0.0411	0.0196	0.0280	0.0425	0.0115	0.0597	0.0141	0.0305	0.0197	0.0140
Miscellaneous food	0.0458	0.0096	0.0444	0.1058	0.0460	0.0215	0.0635	0.0550	0.0084	0.0070	0.0873	0.0153	0.0302	0.0292	-1.0514	0.0219	0.1160	0.2576	0.0870	1.3930
	0.0283	0.0252	0.0437	0.0316	0.0304	0.0283	0.0321	0.0275	0.0229	0.0290	0.0380	0.0089	0.0156	0.0150	0.0471	0.0625	0.0320	0.0391	0.0448	0.0550
Processed meals	0.1008	0.0452	-0.0267	0.0736	0.0999	0.1428	-0.0070	-0.1609	-0.1501	-0.0128	0.0314	-0.0223	0.0359	0.0397	0.0048	-0.6151	0.0931	0.1889	0.1387	1.0546
	0.0191	0.0250	0.0421	0.0265	0.0259	0.0268	0.0303	0.0304	0.0213	0.0256	0.0348	0.0103	0.0168	0.0172	0.0138	0.0716	0.0162	0.0303	0.0220	0.0176
Sugar-sweetened beverages	0.0495	0.0275	0.0703	0.0831	0.0209	-0.0095	-0.0122	0.0830	0.0428	0.0256	0.0439	-0.0014	-0.0001	0.0507	0.0689	0.2500	-0.9090	0.0183	0.0978	1.0250
	0.0188	0.0181	0.0315	0.0223	0.0215	0.0204	0.0228	0.0199	0.0163	0.0204	0.0272	0.0065	0.0112	0.0109	0.0190	0.0435	0.0277	0.0269	0.0266	0.0270
Non-sugary beverages	0.0450	0.1296	0.0505	-0.0709	0.0166	0.0719	0.1339	0.0710	-0.0084	0.1098	-0.0146	0.0111	-0.0047	-0.0173	0.0955	0.3168	0.0114	-1.1506	0.2036	0.9461
	0.0191	0.0235	0.0393	0.0256	0.0247	0.0255	0.0287	0.0268	0.0199	0.0248	0.0327	0.0088	0.0147	0.0148	0.0145	0.0509	0.0168	0.0422	0.0225	0.0179
Sweets	0.0411	0.0059	0.0992	0.0482	0.0192	0.0383	0.0361	0.0512	0.0138	0.0730	0.0912	0.0157	0.0201	0.0176	0.0162	0.1166	0.0306	0.1021	-0.8359	0.9702
	0.0084	0.0078	0.0133	0.0095	0.0091	0.0087	0.0097	0.0085	0.0071	0.0088	0.0115	0.0028	0.0048	0.0048	0.0083	0.0185	0.0083	0.0113	0.0162	0.0132

Notes: Standard errors below elasticities of demand