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Abstract

I estimate habit formation to dietary fat in two categories of common food products: ground meat and fluid milk. Products in each category display salient fat content information on the packaging and are identical in nearly all aspects other than fat content. This allows habit formation to be based on levels of fat content and eliminates bias arising from unobservable product attributes. I construct a dynamic AIDS model using scanner-generated household purchases of five ground meat products and four fluid milk products during the period 2004 to 2014. Results show strong habit formation to all products in the two categories. In addition, there is modest evidence of a positive association between habit formation and dietary fat for products in both categories. With the exception of fat-free milk, all high fat products exhibit stronger habit formation than low fat products in the ground meat and fluid milk category.

I. Introduction

Obesity has reached epidemic proportions in the US. Statistics from the National Health and Nutrition Examination Survey (NHANES) show that between 2009 and 2010, more than 1 in 3 adults were considered obese. The prevalence of childhood obesity is especially alarming as more than 1 in 6 children and adolescents aged 6 to 19 were considered obese (National Institute of Health, 2012). A wide range of detrimental health outcomes is associated with obesity including diabetes, cardiovascular disease, and cancer. In addition, children are considered especially vulnerable to health issues arising from obesity because it not only leads to abnormalities such as earlier puberty, type 2 diabetes, and metabolic syndrome (Biro and Wien, 2010) but also leads to greater likelihood of obesity as an adult (Serdula *et al.*, 1993).

While numerous explanations and policy recommendations have been offered for such a high rate of obesity in the country, there are only few factors that have consensus among researchers. Traditionally, obesity has been attributed to lack of access to healthy food, cognitive disposition, food acquisition cycles, etc. However, in recent years economists have started to consider the time-dependence of energy-dense nutrients, such as sugar and saturated fat, as a possible explanation. Excess consumption of these harmful nutrients may cause households to form habits due to which greater consumption will be required to attain the same level of utility in subsequent periods.

While dietary fat is an important nutrient, there is considerable evidence to show that excess consumption is a significant contributor to obesity (Bray and Popkin, 1998; Golay and Bobbioni, 1997; Astrup, 2005, Bray *et al*., 2004). This is not surprising because fat is the most energy-dense nutrient found in food (9 calories per gram compared to 4 calories per gram in

3

carbohydrates and protein). As a result, in an effort to combat obesity, policymakers have begun to explore ways to curb fat consumption. A policy that has gained traction in recent years is the imposition of a Pigouvian tax on fatty foods akin to a tax on tobacco, alcohol, and sugar. In October 2011, Denmark became the first country in the world to pass a "fat tax", which was levied on food items exceeding 2.3% saturated fat content. Although the tax was rescinded shortly afterwards, it galvanized substantial interest into whether it can be a valid policy intervention in the US. Although there is no history of a fat tax in the US, other Pigouvian taxes like a tobacco tax have been remarkably effective (Chaloupka *et al.,* 2010).

The purpose of this study is to determine whether dietary fat is a habit forming nutrient. I consider two categories of grocery products that are widely used in American households; fresh ground meat and fluid milk. Products in both categories are differentiated by level of fat content specified directly on the package and therefore households are aware of the nutritional properties of their purchase. For example, ground beef may be labeled as "80% lean, 20% fat" while milk products may contain one percent or two percent fat. Apart from fat content information and other minor aspects such as color of packaging, products are generally identical. This study empirically tests the hypothesis that dietary fat is a habit forming nutrient such that current purchases of high fat products exert a positive influence on future household consumption. I estimate a dynamic Almost Ideal Demand System (AIDS) to show that all products in the two categories display strong habit formation. In addition, results show modest evidence of a positive link between habit formation parameters and fat content in the ground meat and fluid milk category.

Although habit formation to sugar has been well documented in literature (Gearhardt *et al.*, 2009; Avena *et al.*, 2008; Zhen *et al*., 2010), there is only sparse evidence on the habit

forming properties of dietary fat, especially in human beings. Among a handful of studies, Bruijn *et al.* (2008) and Richards *et al.* (2007) show that saturated fat is a habit forming nutrient. This paper tries to overcome the limitations of these two studies by utilizing both time and cross-sectional variation in household purchases and employing a large scanner-generated dataset. I also provide finer estimates for habit formation by comparing products that are differentiated only by levels of fat content. As a result, this research design largely eliminates bias arising from unobservable product characteristics.

The rest of this paper is organized as follows. Section II provides a review of literature in this area. Section III develops the conceptual dynamic AIDS model used to test the above hypothesis. Section IV outlines the empirical framework. Section V describes the dataset used and provides summary statistics. Section VI reports results from empirical estimation. Section VII discusses policy relevance and possible areas of improvement for future research. Section VIII concludes and is followed by an appendix of tables.

II. Literature Review

Habit formation has been extensively studied on multiple categories of goods, including food (Carrasco *et al.*, 2005; Heien and Durham, 1991; Dynan, 2000; Khare and Inman, 2006), transportation (Carrasco *et al.*, 2005; Heien and Durham, 1991), services (Carrasco *et al.*, 2005), alcohol, tobacco, and clothing (Heien and Durham, 1991). The most common method of estimating habit formation is to exploit time-series variation to observe the dependence of current consumption on consumption in previous periods. However, a few researchers such as Bruijn *et al.* (2008) and Heien and Durham (1991) have utilized cross-sectional datasets to estimate the magnitude of habit formation as well. Heien and Durham (1991) find that cross-

5

sectional estimates tend to be much smaller, albeit highly significant, relative to time-series estimates.

Habit formation to food products has been the focus of many previous studies but only a handful are directed at meat and fluid milk. Among literature that looks into habit forming properties of milk, Briz et al. (1998) employ the Prais-Houthakker demand model to show that milk consumption in Spain is heavily influenced by habit persistence. Zhen et al. (2011) use a dynamic AIDS model on a group of beverages such as milk, Sugar-Sweetened Beverages (SSBs), bottled water, and coffee to find that low-fat milk is the most habit-forming beverage. Whole milk also exhibits a high degree of habit formation in their analysis and ranks among the top three most habitual beverages. Similar studies can be found on the habit-formation properties of meat. For example, Capps (1989) use data from a Houston retail food firm to show that habits are evident in the consumption of steak, chicken, pork chops, ham, and pork loin.

Supplementing this strand of literature is a small collection of studies that examine the addictive properties of dietary fat. A recent study by Bruijn *et al.* (2008) applies the Theory of Planned Behavior (Azjen, 1991) on a sample of Dutch adults in an intervention trial and depicts that saturated fat is associated with habit formation. The main shortcoming of this paper, however, is that it relies on cross-sectional data and therefore largely ignores the possible confounding influence of household consumption over time. In addition, the experiment is conducted on a small sample of 764 participants, the research design does not support external validity of results, and the authors use a self-reported measure of fat content in food consumed. Richards *et al.* (2007) consider the consumption of snack foods to determine rational addiction to macronutrients and show strong habit formation to fat. A related study by Arnade and Gopinath (2006) uses a dynamic approach to analyze adjustments to cumulative fat consumption from

meat, fish, and dairy products. The authors show that although not instantaneously, consumers consciously adjust their cumulative fat level with the rate of adjustment being higher for educated households. In particular, when cumulative fat level increases from the optimum, consumers shift consumption away from red meat products to healthier alternatives such as white meat and dairy.

The results of this study shed some light on the potential success of a fat tax. Some research has been devoted to the efficacy of a tax on saturated fat but it is largely constricted by lack of data due to sparse adoption of the policy. Smed et al. (2007) analyze the potential of targeted price change and show that it is effective in reducing demand for saturated fat among individuals in "lower social classes" (p. 627) and among young individuals in Denmark. Chouinard et al. (2007) simulate the effects of a fat tax on demand for dairy products and find that the short run effect of a 10% fat tax would be to reduce fat consumption by less than 1%. This area of literature is largely inconclusive in determining the magnitude of a tax on fat consumption. Neither of the two studies mentioned take habit formation into account.

To the best of my knowledge, this study is the first to measure habit formation to dietary fat in fresh meat and fluid milk products using household-level panel data. It will add to existing literature by enhancing our understanding of the addictive properties of dietary fat. While other studies have provided elasticity estimates for products analyzed in this paper, their estimates largely ignore the influence of habit formation. Moreover, I estimate demand over an 11 year period while other studies generally consider shorter periods of time. Hence, I provide a more complete picture of the link between habit formation and dietary fat. Finally, this study provides more granular estimates because it analyzes the fat content of more specific products relative to other studies (for example, ground meat versus all meat products).

III. Conceptual Model

I closely follow the conceptual framework of the dynamic AIDS model laid out in Zhen et al. (2011) and apply it to fresh ground meat and fluid milk products purchased in grocery stores. For the sake of simplicity, I depart from Zhen et al.'s (2011) approach by excluding the durability parameter. Durability refers to the idea that purchases in current period have a positive influence on future utility. Even though perishable items such as fresh ground meat and milk are generally not considered durable, the authors argue that they could still depict durability by reflecting both the physical trait as well as consumer preference for the product (2011, p. 178). In other words, despite physical depletion the perishable item may exert an influence on future consumption by altering current household preference. However, I defer to the argument put forth by Muellbauer and Pashardes (1992) that the habit formation parameter is capable of capturing both habit formation and durability. Foregoing the inclusion of durability lends substantial computational simplicity to the dynamic AIDS and allows for a more straightforward interpretation of the habit formation parameters.

A two-stage process is modeled for the representative consumer who allots total income between a product category (ground meat or milk) and the numeraire good (all other goods) in the first stage, and chooses among different products in each category in the second stage. Assuming a myopic consumer (one who ignores the effects of current purchases on future utility), the dynamic AIDS is given by:

(1) $q_{it} = \{a_i + \sum_{j=1}^{J} \gamma_{ij} \ln p_{jt} + \beta_i [ln\bar{x} - \ln a(p_t)]\} \left(\frac{\bar{x}_t}{p_{it}}\right) + \varphi_i q_{it-1}$

(2) $ln\bar{x}_t = a_m + \beta_m \ln(hhinc_t) + \gamma_m ln a(p_t)$

(3) $ln a(p_t) = a_0 + \sum_{i=1}^{n} a_i ln p_{it} + 0.5 \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} ln p_{it} ln p_{jt}$

(4) $a_i = a_{i0} + X_{it} + R_{mt} + Q_t$

where q_{it} represents expenditure on product i at time t, p_{jt} is a vector of all prices in the product category, category expenditure is given by $\bar{x} = \sum_{i=1}^{n} p_{it} Z_{it}$, Z_{it} is the service provided by the stock of good in period t, and $\ln a(p_t)$ is the price index of the product groups shown in equation (3). In equation (4) the parameter a_i is augmented into household-level demographic variables X_{it}, binary variables for nine Nielsen geographic regions R_{mt}, and quarters Q_t in the year. X_{it} contains variables for household size, race, and gender of household head. The coefficient φ_i captures the effect of habit formation. Equation (2) represents the first-stage decision of the household to allocate expenditure to the product category relative to the numeraire good. The first-stage budget allocation is a function of $hhinc_t$, which represents household income, and the price index of all products in the group, $lna(p_t)$. Theoretical restrictions are imposed on demand, including the adding up restriction $\sum_{i=1}^{n} \alpha_i = 1$ and $\sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \gamma_{ij} = 0$ for all j, where $n = 5$ for the ground meat category and $n = 4$ for fluid milk category. Similarly, the homogeneity restriction $\sum_{j=1}^{n} \gamma_{ij} = 0$ for all i and the symmetry restriction $\gamma_{ij} = \gamma_{ji}$ for all i and j, are imposed. For a full discussion and derivation of the dynamic AIDS model refer to Zhen et al. (2011).

IV. Empirical Specification

Each major product within the ground meat and fluid milk category is included in the AIDS model. Product types in the ground meat category include beef, turkey, and chicken. Beef and turkey products are classified by fat content using a threshold of 20% fat. For example, beef is characterized as high fat if the product is specified as having 25% fat or being 75% lean. Chicken is not classified by high or low fat since the product does not exhibit sufficient variation in fat

content. Most chicken products available in the data contain less than 20% fat, making chicken the leanest product in the ground meat category. The fluid milk category includes fat-free or skim milk (0% fat), low fat milk (1% fat), reduced fat milk (2% fat), and whole milk (3.25% fat) products. These classifications result in five product types in the ground meat category and four product types in the milk category. The dynamic AIDS model is estimated separately for each of the two categories.

A major challenge in estimating dynamic AIDS is addressing the issue of zero purchases. That is, within a market, year, and month, the total expenditure for a product may be zero. This is especially relevant for ground meat products as they are classified in a narrower category and are less frequently consumed by the average household relative to fluid milk. I follow Zhen et al.'s (2011) synthetic household approach by aggregating monthly purchases within each market and year for the ground meat sample and by aggregating monthly purchases within each market, year, and poverty status for the fluid milk sample. Poverty status is not used for the creation of synthetic households in the ground meat sample because a higher level of aggregation is required to eliminate zero purchases. The resulting data includes 836 synthetic households in the ground meat sample and 1,672 synthetic households in the fluid milk sample.

Prices are determined using the Fisher Price Index for products in each category. Prices and quantities are averaged over market, brand, poverty status, and month. In other words, brand-level monthly prices faced by a synthetic household and quantities purchased by a synthetic household of a certain poverty status are averaged to create the Fisher price index. Poverty status is included to reflect the possibility that low-income households typically shop in different market sub-sections relative to high-income households. The Fisher price index is a transformation of the Laspeyres price index and the Paasche price index and is calculated by

comparing average market-brand-month-poverty status prices with national averages. Missing prices are inferred by prediction using coefficients estimated from a simple OLS regression of product price on year, month, market, and brand.

To simplify estimation, I reduce brand parameters by condensing brands with small market shares into a category-specific composite brand. The composite brand includes all brands with less than 1% market share in their respective category. All major brands are included separately. Demographics include dummy variables for nine household geographic regions (for example, New England, Middle Atlantic, Pacific, and Mountain), household size, race, income, gender of household head, and quarter of the year in which the household is observed. These variables are averaged over all households within a synthetic household to assign continuous measures for each demographic.

V. Data

Two samples are generated from Nielsen's Consumer Panel survey. Nielsen provides a large national scanner dataset of household level purchases for 40,000 to 60,000 households per year dispersed across the country. A tremendous amount of detail is available for each purchase including the date of the shopping trip, store location, average weekly prices, quantities purchased, etc. Nielsen samples households across 52 major markets that cover most of the country. The dataset includes a range of different food and non-food products, each characterized by a unique Universal Product Code (UPC). Product attributes include brand, size of package, promotional status, and additional characteristics for some products such as flavor and nutritional value.

Products in the ground meat and fluid milk category are chosen based on availability of fat content information for the UPC, either as a product attribute or in the UPC description. I use all purchases available in the Nielsen Consumer Panel for the years 2004 to 2014. Virtually all ground meat and fluid milk products provide fat content information. The small number of UPCs for which fat content is unavailable are excluded from the sample. For years 2004 to 2013, the number of ground meat purchases that do not disclose fat content average less than 0.3% of the total number of purchases each year. In contrast, in 2014 about 8% of total ground meat purchases are excluded due to lack of fat content information. About 98% of these excluded 2014 purchases are attributed to one brand of ground beef that does not disclose fat content information for the product. In addition, the ground meat category includes a small number of specialty products such as bison and veal. Nielsen Consumer Panel does not include sufficient purchases for these products over the time period considered and they are also excluded from the sample. Among fluid milk UPCs, the number of excluded purchases average about 0.2% for the years 2004 through 2014. Note that two additional milk products, 0.5% fat milk and 1.5% fat milk, represent a negligible share of total milk expenditure and are combined with low fat milk. This results in a sample of 10,024 monthly purchases in the ground meat category and a sample of 19,972 monthly purchases in the fluid milk category at the synthetic household level.

Table 1 shows the average fat content for each product in the two categories. In the ground meat category, the fat content provided in the table is the average of all products included in the sample. For products in the fluid milk category, fat content is more standardized. For example, high fat beef includes all beef products that have fat content greater than 20% and ranges up to 50%. On the other hand, reduced fat milk is a federally regulated label that must contain 25% less fat than the full-fat product (whole milk) (Food for Human Consumption,

2016). As a result, there is little, if any, variation in within-product fat content in the fluid milk category. In terms of fat content, the highest fat product in the ground meat category is high-fat turkey. If dietary fat is habit forming as hypothesized, then not only can we expect high fat turkey to have a greater habit formation parameter than low fat turkey but also relative to all other products in this category. Chicken is the lowest fat ground meat product with an average fat content of only 3.46%. By the same argument, we expect ground chicken to exhibit the smallest habit formation parameters in this category. In the fluid milk category, fat content ranges from 0% (fat-free or skim milk) to 3.25% (whole milk). For dietary fat to exhibit habit formation in this category, fat-free milk is expected to have the lowest habit formation parameter and whole milk is expected to have the largest.

Table 2 juxtaposes average monthly quantity and expenditure of ground meat and fluid milk purchases of individual households with synthetic households. Values for synthetic households are monthly aggregations of all individual household purchases within the synthetic household. While high fat turkey and chicken have a small number of monthly purchases, the synthetic household approach eliminates most zero purchases from the sample. Synthetic households in the fluid milk category represent greater number of individual households because more households purchase fluid milk products in an average month than ground meat products. In the ground meat sample, the most popular products seem to be both, high fat and low fat ground beef. The least popular product is ground chicken which is also the leanest product in the category. For fluid milk products, Reduced-Fat (2%) milk is the most purchased product while whole milk is least popular. Note that price variation is considerably higher for the ground meat sample than the fluid milk sample. In general, high fat ground meat products are cheaper than

13

low fat products, whereas price does not vary with fat content of fluid milk products. As a result, high quantity purchases may not always represent high expenditure on ground meat products.

Tables 3(a) and 3(b) show summary statistics by synthetic household for variables in each sample. The first panel of each table represents each product's share of monthly expenditure on the category and the second panel provides statistics on total expenditure and demographic variables. In the ground meat sample shown in Table 3(a), synthetic households spend a monthly average of $586 on the five ground meat categories included in this model. Average household size is 2.57 individuals, about 10% of households in the sample are black, mean annual income per synthetic household is just under $58,000, and about 78% of households have male heads. Table 3(b) shows summary statistics for variables in the fluid milk category. Monthly expenditure per synthetic household on the fluid milk category is considerably higher than that of the ground meat category. Annual household income for the milk sample is approximately $43,000 per annum which is significantly lower than the ground meat sample. This is not surprising given that milk is a more common household food and the category is more broadly defined (including almost all milk products) relative to ground meat which may have cheaper alternatives. In addition, milk is generally available to households of all income strata and is a more affordable source of nutrition relative to ground meat. The average household size for the fluid milk sample is 2.48, about 9% of all households are black, and 71% of all households have a male household head.

VI. Results

Habit formation parameters for each product category estimated using dynamic AIDS model are shown in Table 4. Standard errors for all estimates are clustered by Nielsen scantrack market. The first panel shows results for the five ground meat products and the second panel shows

results for the four fluid milk products. All products exhibit strong habit formation as given by the significance level of the estimates.

The results show there is a clear positive association between dietary fat content and strength of habit formation, although the effect is invariably small. In the ground meat category, as expected, high fat beef has a larger habit formation parameter relative to low fat beef and high fat turkey has a larger habit formation parameter relative to low fat turkey. The leanest product in the category, chicken, exhibits the weakest level of habit formation. Similarly, the highest fat product in this category, high fat turkey, shows the strongest level of habit formation. Consistent with expectations, the habit formation parameters in this category are all positively correlated with fat content. However, habit formation parameters for high fat products are only slightly greater than habit formation parameters for low fat products.

With the exception of fat-free milk, fluid milk products generally exhibit a positive relationship between fat content and level of habit formation as well. Whole milk depicts a higher degree of habit formation relative to all other products in this category and reduced fat milk shows a higher degree of habit formation relative to low fat milk. Counterintuitively, the lowest fat content product, fat-free milk, has a larger habit formation parameter relative to low fat and reduced fat milk. Some possibilities for this unexpected result are discussed below. The parameters for all other milk products provide strong evidence for the habit forming properties of dietary fat. Similar to the ground meat category, there are only small differences in habit formation parameters among fluid milk products, indicating that habit formation properties of dietary fat are modest.

Table 5 shows long run unconditional own-price and cross-price elasticities. For ground meat products, all own-price elasticities are negative and statistically significant. Demand for

high-fat turkey is most own-price sensitive and demand for low-fat beef is least own-price sensitive. The magnitude of all ground meat elasticities is consistent with the results of Capps (1989) who estimated elasticities for several beef, chicken, and pork products (including ground meat) in the range of -0.6557 and -1.2737. Furthermore, low-fat beef and high-fat turkey largely show negative cross-price elasticities with other products in the category, which indicates complementarity. On the other hand, while chicken is complementary to high-fat and low-fat beef, it is considered a substitute for high-fat turkey. In the same vein, all own-price elasticities of fluid milk products are negative and statistically significant. The estimates for these products are much lower than the -1.59 estimate for whole milk and the -2.17 estimate for low fat milk obtained by Zhen et al. (2011). Among cross-price elasticities, almost all that are statistically significant are negative. This is, again, an indication that fluid milk products within the category are generally complementary to each other.

VII. Discussion

The results show that, in general, high fat products are more habitual than low fat products. However, the difference in habit formation parameters is small, indicating that dietary fat is only modestly habit forming. Moreover, in the fluid milk category, the coefficient on fat-free milk is inconsistent with expectations. A possible explanation for this result is that fat-free milk might be considered a specialty product that may appeal to consumers with unobservable traits. If these traits influence demand for fat-free milk differently relative to other fluid milk products, the habit formation parameter may not reflect the effect of dietary fat only.

These results have important policy implications. First, households form stronger habits to ground meat products relative to fluid milk products. Ground meat products have substantially higher fat content than fluid milk. Second, within each category households form stronger habits

16

to products with higher fat content. This indicates that diverting household consumption away from high fat products to low fat products can be challenging because habit formation may inhibit a policy intervention from yielding tangible results. To complicate the situation further, most high fat products exhibit complementarity with low fat products. As a result, a simple policy intervention that attempts to encourage substitution between high fat and low fat products may prove to be ineffective and may even be detrimental. For example, a targeted tax on saturated fat may not be successful in changing household behavior but may also be regressive. Fluid milk is a staple food for most households, especially those with children. Not surprisingly, milk products are inelastic with respect to own prices and the elasticity estimate for whole milk is lowest among all fluid milk products in the sample. Therefore, taxing high fat milk products may not result in significant changes in quantity demanded and may increase the tax burden of low income households due to its regressive nature. In addition, instead of inducing households to switch to lower fat products, a saturated fat tax may discourage consumption of milk altogether because milk products are generally complementary. On the other hand, a fat tax on ground meat products may be more justified. Unlike fluid milk, ground meat products are not essential household foods and are consumed by higher income households on average as shown in Tables 3(a) and 3(b). As a result, a fat tax on ground meat may be less regressive relative to a fat tax on fluid milk. It may also be more effective since ground meat products have higher own-price elasticities. While more work is needed to determine the extent of these substitutions, the results of this study show that a broad-stroke tax policy may not be a viable option to reduce consumption of saturated fat.

Some shortcomings of the analysis are worth mentioning. First, to circumvent the problem of zero purchases I use a synthetic household approach. This led to the aggregation of

17

purchases for each market-year (and poverty status in the fluid milk sample) and this censoring might have led to some loss of information. Second, for the sake of computational simplicity I chose not to model durability in the dynamic AIDS model. Literature provides sufficient support for this decision. However, it can be argued that durability might exist for food products. Therefore, future studies may provide more insight by estimating the durability parameter in a demand system.

VIII. Conclusion

I estimate a dynamic AIDS model to estimate habit formation to dietary fat. I consider two categories of products, ground meat and fluid milk, that saliently show fat content information on the label and are identical in almost all other aspects. The ground meat category includes high fat beef, low fat beef, high fat turkey, low fat turkey, and chicken. Products are characterized high fat if they contain at least 20% fat and fat content ranges from 1% (99% lean) to 50% (50% lean). The fluid milk category includes fat-free milk (or skim milk), low fat milk (1% fat), reduced fat milk (2% fat), and whole milk. The dynamic AIDS model is estimated separately for the two categories. Results show strong habit formation to each product in the two categories. In addition, there is a clear positive association between fat content and strength of habit formation. However, evidence of habit formation to dietary fat is modest as indicated by the magnitude of habit formation parameters. Nonetheless, habit formation may prevent small policy interventions such as a tax on saturated fat from achieving tangible reductions in consumer demand for high fat products. Elasticity measures for most high fat products in the two categories depict complementarity with low fat products which indicates that a fat tax may fail to induce households to substitute high fat products for low fat counterparts. Therefore, any intervention to

18

discourage consumption of dietary fat must be considered on a case-by-case basis instead of

imposing an across-the-board tax on saturated fat.

IX. Appendix

| Table 1. Average Fat Content by Product ||
Category	Fat Content
Ground Meat:	
Beef: High Fat (>20% fat)	22.95%
Beef: Low Fat (≤20% fat)	8.76%
Turkey: High Fat (>20% fat)	49.99%
Turkey: Low Fat (≤20% fat)	8.95%
Chicken (all fat levels)	3.46%
Milk:	
Fat-free	0%
Low fat	1%
Reduced Fat	2%
Whole	3.25%

Note: Fat content for ground meat categories is based on sample averages while fat content for milk products is obtained from US FDA regulations

	Table 2: Average Monthly Expenditure and Quantity			
	Individual Households		**Synthetic Households**	
	Quantity	**Expenditure**	**Quantity**	**Expenditure**
Ground Meat:				
Beef: High Fat	0.64	$3.24	69	$345
Beef: Low Fat	0.61	$3.07	70	$359
Turkey: High Fat	0.06	$0.15	8	$19
Turkey: Low Fat	0.60	$2.27	64	$244
Chicken	0.01	$0.03	2	$6
Milk:				
Fat Free	8	$22	517	$1,367
Low Fat (1%)	6	$15	353	$944
Reduced Fat (2%)	12	$32	634	$1,713
Whole Milk	6	$16	322	$874

Table 3(a). Summary Statistics by Synthetic Household: Ground Meat Category

	Mean	Std. Dev.
Budget Shares		
Beef: High Fat	0.351	0.17
Beef: Low Fat	0.343	0.16
Turkey: High Fat	0.015	0.03
Turkey: Low Fat	0.286	0.20
Chicken	0.004	0.02
Monthly Expenditure on Category	$586	$501
Household size	2.57	0.16
Percentage of population that is black	10%	8.01
Annual Income	$57,857	$8,193
Percentage of Male HH heads	78%	0.04

Table 3(b). Summary Statistics by Synthetic Household: Milk Category

	Mean	Std. Dev.
Budget Shares		
Fat-free	0.22	0.15
Low Fat (1%)	0.16	0.13
Reduced Fat (2%)	0.39	0.17
Whole	0.22	0.16
Monthly Expenditure on Category	$2,454	$2,316
Household size	2.48	0.24
Percentage of population that is black	9%	7.72
Annual Income	$42,959	$22,978
Percentage of Male HH heads	71%	0.10

Table 4. Habit Formation Parameter Estimates using Dynamic AIDS

	φ_i	Standard Errors
Ground Meat		
Beef: High Fat	0.484***	(0.0263)
Beef: Low Fat	0.465***	(0.0258)
Turkey: High Fat	0.552***	(0.0564)
Turkey: Low Fat	0.466***	(0.0261)
Chicken	0.400***	(0.0731)
Milk		
Fat-free	0.057***	(0.0062)
Low-fat (1%)	0.042***	(0.0065)
Reduced-Fat (2%)	0.053***	(0.0059)
Whole	0.059***	(0.0059)

*** $p<0.01$, **$p<0.05$, *$p<0.1$

Table 5. Long Run Unconditional Own and Cross-Price Elasticities

Ground Meat	Beef: High Fat	Beef: Low Fat	Turkey: High Fat	Turkey: Low Fat	Chicken
Beef: High Fat	-0.849***	-0.010	-0.005	0.001	0.029
Beef: Low Fat	-0.049**	-0.696***	-0.009***	-0.005**	-0.221***
Turkey: High Fat	-0.121**	-0.149**	-0.964***	0.014	-0.311***
Turkey: Low Fat	-0.190	-0.235	0.024	-0.962***	-0.506
Chicken	-0.083***	-0.252***	0.004***	0.004	-0.763***

Milk	Fat-free	Low-Fat (1%)	Reduced-Fat (2%)	Whole
Fat-free	-0.575***	0.0004	-0.412***	-0.454***
Low Fat (1%)	0.002	-0.713***	-0.195***	-0.271***
Reduced Fat (2%)	-0.103***	-0.073***	-0.463***	-0.151***
Whole	-0.104***	-0.193***	0.040	-0.158***

*** p<0.01, **p<0.05, *p<0.1