The Size vs. Health Trade-off in Lower-Income Households' Food Choices: The Case of Fluid Milk.

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Abstract:

The debate around the healthfulness of food choices for low-income households is still a relevant point of contention for policymakers as they aim to provide tools to incentivize consumption of healthier foods in different ways. Using fluid milk as a case study, and one year of household-level weekly milk purchases data in the Northeastern U.S., we assess the demand for milk of households with income levels above and below poverty, across fat content and packaging size. We find estimated own-price elasticities differing little across samples of households: even in cases where differences emerge, the estimated values, along with price differences experienced by purchasing households do not seem to justify the different purchasing patterns of the two household groups. Household characteristics however show differences in impacting the demand of milk across households with different income levels.

The notion that households with lower income levels make poorer choices when it comes to the healthfulness and quality of the food they choose is widespread. Policymakers have been aware of differences in overall dietary quality, by income, for decades and many corrective and educational efforts have been targeted at this problem. Recall, for example, the breadth of coverage in the popular press on calorie counts in fast food restaurants or the size of fountain drinks in convenience stores and eateries. As researchers across a range of disciplines, including economists, are increasingly observing that these important differences in choices pertain to grocery shopping and food at home, the focus is shifting toward the supermarket.

The reasons why lower-income households, on average, make grocery purchases that are less in accordance with the Dietary Guidelines for Americans (DGA) than those made by higher-income households are not clear. Several hypotheses have been proposed and investigated to various extents. One concept that is central to this line of inquiry is that price sensitivity and income share an inverse relationship, leading low-income households to make purchases subject to budget constraints rather than nutritional or health considerations. To the extent that healthy foods are more expensive than unhealthy foods, this relationship appears appealing. However the average supermarket carries many thousands of products and questions abound as to how to properly measure healthfulness vis-à-vis as well as food cost in this setting: foods heavy in sugars or fats are cheaper than fruits and vegetables when price is measured by the calorie (Monsivais and Drewnowski, 2007). The converse is true when price is measured according to serving size (Carlson and Frazao, 2012).

We investigate the purchase habits and price sensitivity of U.S. households with below and above poverty income levels, for fluid milk. Milk is a rich product category for empirical work given that it is a homogenous, frequently purchased staple for many households. Within the

milk product category, healthfulness differs only according to fat content, leading to less potential confusion in classifying purchases according to implications for dietary quality. To further account for consumers' efforts at economization, we study fluid milk purchases across a range of package sizes. A rich marketing literature has examined the propensity for retailers to engage in nonlinear pricing according to package size within brands and product categories, and economists have explored the extent to which households can reduce food costs by purchasing package sizes that are cheaper on a per-unit basis (e.g. Leibtag and Kaufman, 2003). The perishability of fluid milk precludes the potential for consumer stockpiling, a practice that is usually more feasible for high-income households, to obfuscate the story.

By subjecting fluid milk purchases to a demand analysis, we are able to describe household preferences for healthful foods, given a wide menu of options offering economization opportunities for lower-income households, in terms of price sensitivity. We inform the ongoing discussion in both applied research and the popular press regarding the propensity of lower-income households to purchase less healthful foods and its determinants.

Food Prices, Healthy Choices, and Household Income

Much of the research on income levels (or wealth) and food choices can be traced back to the consistent finding throughout the fields of health and epidemiology that low-income households are disproportionately represented among the overweight and obese in the U.S. Rimm and Rimm (1974) and Garn et al. (1977) are examples of early and influential studies that demonstrated an inverse relationship between excessive bodyweight and income. Chang and Lauderdale (2005) found that body mass index (BMI), a commonly-used metric of bodyweight today, was significantly higher among lower income groupings for the period of 1971 to 2002.

Researchers in the social sciences and beyond have often framed the income-based disparity in obesity, overweight, and related health problems an issue of food access. A number of studies have argued that in rural areas or dense inner cities, where low-income households tend to be concentrated, healthful food options are difficult to find and expensive in comparison to regions in which large supermarkets operate (Liese, et al., 2007, Zenk, et al., 2005). Powell and Bao (2009) measured an inverse relationship between BMI and supermarket availability across metropolitan areas in the U.S., and Rose and Richards (2004) concluded that access to large supermarkets was directly correlated with the consumption of fruits and vegetables among Food Stamp recipients.

Limited food access, as defined by lack of proximity to supermarkets (in conjunction with vehicle ownership), however, only affects between five and six percent of American households (Ver Ploeg, et al., 2009).[1] Therefore the vast majority of American households, across all income levels, do not suffer from lack of food access. Yet important differences persist across income levels in terms of obesity and other health outcomes related to food choices, suggesting that other factors are at play. This line of reasoning has led researchers to focus on the choices consumers make when shopping for food at home in supermarkets and other grocery stores, often with the intention of drawing linkages to income. Agricultural economists in particular have studied actively the relationships between market structure, store format, and prices in food retail to consumers' purchasing decisions (Unnevehr, et al., 2010).

Recent decades have produced a wealth of studies on the income-based differences in food choices at the supermarket and their determinants. Across a wide range of data resources and methodological approaches, researchers have demonstrated that lower-income households

[1] According to Ver Ploeg et al. (2009), 2.2 percent of American households live more than one mile away from the nearest supermarket and do not have a car. Another 3.2 percent of households live between one half of a mile to one mile from a supermarket and do not have a car.

make less nutritious choices. Adelaja et al. (1997) found significant differences in the intake of important nutrients, across income levels, with higher-income individuals consuming more of the most beneficial nutrients such as calcium, vitamin A, and vitamin C. Their data included both food at home and food away from home. Leibtag and Kaufman (2003) showed that low-income households adopt a number of economizing strategies to reduce grocery costs, some of which have implications for dietary quality. These include purchasing lower-quality meat products and fewer fruits and vegetables than high-income households. Stewart et al. (2003) and Blisard et al. (2004) both found that purchases of fruits and vegetables, a cornerstone of healthy eating, increase with income. Volpe and Okrent (2012) measured the extent to which household's total shopping baskets conformed to the DGA and found that households in this highest income group scored about 18 percent higher than those in the lowest.[2]

Two studies stand out in the literature due to their implications for our own. Chen et al. (2012) examined consumption within the fluid milk and soda categories as it differs by income. The authors found that low-income consumers were more likely to purchase the more caloric options within these categories (e.g. whole milk and regular soda) despite typically equal prices among substitutes. Dong and Stewart (2013) modeled milk choices among fat contents and package sizes and found that increases in income lead to small but significant increases in the demand for low-fat milk, concomitant with decreases in the demand for whole milk. Package size demand was found to be highly unresponsive to income or prices.

Many of these studies touch upon, if not explicitly model, the budget constraints faced by lower-income shoppers. However budget constraints are only a valid casual mechanism of systematic differences in food choices and dietary quality across income groups if healthy foods

[2] Leibtag and Kaufman (2003), Stewart et al. (2003), Blisard et al. (2004), and Volpe and Okrent (2012) all used the Nielsen Homescan data. This is the same dataset utilized in this study, and it pertains solely to food at home.

are more expensive than unhealthy foods. Wiig and Smith (2009) is just one example of many studies that have explored how low-income and fixed-income shoppers, including those benefiting from food assistance programs, prioritize and economize their grocery shopping decisions. The authors discuss how price is the most important factor in shaping choices in the supermarket, which underscores the price sensitivity of low-income households, but also demands that healthy foods be more expensive than less healthy options if this is the driving factor behind the inverse relationship between income and dietary quality.

Are Healthier Foods More Expensive?

Given that the focus of our study is not on food access and that the majority of shopping trips observed in our data take place at large, conventional supermarkets, we are most interested in the question of healthy vs. unhealthy foods' prices within markets or even within stores. Several of the studies referenced above pertaining to rural or inner-city locations compare the prices and product menus of small vendors, in some cases convenience stores, to those of larger supermarkets serving geographically distinct customers. A different question is whether considering options within conventional supermarkets or comparably large retailers such as supercenters or club stores, one can say something about the costs of a healthy diet.

There is no shortage of work suggesting that healthier foods are more expensive. Drewnowsky and Darmon (2005) and Jetter and Cassady (2006) both argued that healthier foods and, more generally, healthier diets, are more expensive and less likely to be affordable for lower-income households. Monsivais and Drewnowski (2007) go one step further and show that healthier foods are growing relatively more expensive over time, as food prices in the 21st century respond to commodity price volatility and other factors. However each of these studies,

and many more, measure food prices on a per-calorie basis. Foods that are generally considered to be unhealthy, including but not limited to many processed foods heavy in fats, sodium, and added sugars, are also calorically dense. This is especially true when compared to many foods that are recommended for increased consumption according to the DGA, including fruits, vegetables, and lean meats. Carlson and Frazao (2012) show that when you measure food prices on a per-serving basis, in many cases healthier options are actually cheaper.

As an additional source of confusion, it is not always clear how to classify foods or meals as being "healthy" or "unhealthy." The 2010 executive summary of the DGA categorizes foods as recommended for "increased" or "limited" consumption, stressing variety and moderation above all else. This leads to a lot of relative comparisons among foods without clear distinctions between healthy and unhealthy. For example, most nutritionists would agree that lean meats are preferable to red meats as the basis for a meal, but red meats are in turn preferable to processed meat snacks. This leaves the overall classification of red meat unclear and it is straightforward to see how this can lead to controversy and lack of consensus among studies of food choices and dietary quality. As another example, organic food is increasingly a part of the debate around healthy eating and food prices. As a part of a longstanding pledge to offer more healthy options, Wal-Mart is in the midst of increasing its organic offerings (Warner, 2006). Simultaneously, a great deal of research has demonstrated both price premia and increased willingness to pay on the part of consumers for organic options within product categories (e.g. Bernard and Bernard, 2009). This has understandably strengthened the argument that healthy foods are more expensive.[3]

[3] While it is far beyond the scope of this study to weigh in on the relative nutritional qualities of organics, we are interested in studying dietary quality with respect to general adherence to the DGA, which makes no reference to organic versus conventional foods.

Taking everything into account, the price differential between healthy and unhealthy foods is somewhat unclear, and more work on this topic is warranted. However, this uncertaintysuggests that there may be more factors driving healthfulness differences by income. This is especially true given the empirical findings of Chen et al. (2012), as well as Stewart et al. (2003), who showed that while low-income households purchased fewer fruits and vegetables, expenditures on these foods were not responsive to changes in income. Behrman (1989) raised one possibility by observing that the demand for variety in food increases with income. Variety in intake is central to MyPlate, the current nutritional guide of the USDA and to its predecessors, including MyPyramid. Drichoutis et al. (2005) found that higher-income consumers, on average, have more nutritional knowledge than lower-income consumers and are more responsive to nutritional information on labels. This final point serves to suggest that uncertainty and lack of information, which plays a large role in shaping food choices (Downs, et al., 2009), may be systematically different according to income.[4]

The Role of Package Size

Many studies of food prices or consumer choices holding package size constant, usually at the top-selling option within categories, in order to facilitate direct comparisons or increase tractability. However both Kaufman et al. (1997) and Chung and Myers (1999) found that low-income households may pay slightly more for food, especially in urban areas. One of the explanations for this counterintuitive finding is that low-income households are more likely to shop at smaller stores, which do not carry large package sizes, which in turn tend to be more

[4] The introduction and use of new data gathering techniques such as eye-tracking software have helped to quantify the influence of shelf labels, product positioning, and promotions on consumers' food shopping decisions. There is reason to believe that these marketing factors can bias decisions and even make suboptimal choices (Reutskaja et al., 2011). But more work is needed to understand if this has direct impacts on dietary quality or qualitatively different effects across socioeconomic groups.

expensive by the unit (volume). Relatedly, Leibtag and Kaufman (2003) showed that one common economization strategy of low-income shoppers when faced with rising food prices is to purchase larger package sizes. All of this suggests the possibility of substitutions across package sizes, potentially at the expense of health considerations, within product categories.

The idea that unit prices and demand can differ according to package size is not new. Frank et al. (1967) noted that household income was correlated with the demand for larger package sizes within categories while Isakson and Maurizi (1973) discussed the means by which the posting of unit prices in supermarkets would shape consumer search dynamics. More recently, research has established that package size is an important determinate of consumer food choices (Silayoi and Speece, 2004, Wansink, 2004) and even price elasticity of demand (Kumar and Divakar, 1999). Gu and Yang (2010) supported earlier work on economization by package size by estimating the welfare impacts of package sizes within supermarkets. The authors calculated that nonlinear pricing, or differences in unit prices, across package sizes benefit consumers more than producers in most cases.[5]

While studies focusing on package sizes have unambiguously uncovered evidence of nonlinear pricing, it is not always the case that unit prices decrease with package size. Agrawal et al. (1993) and Binkley and Bejnarowicz (2003) both found common examples of quantity surcharges in food prices, that is, product categories in which unit prices increased with package size. The latter study hypothesizes that consumers who pay quantity surcharges typically have failed to completely and accurately gather price information. The existence and persistence of quantity surcharges leads to two key considerations for our study: first that it is not entirely clear what to expect in terms of prices or demand elasticity according to package size, and second, that uncertainty is likely to be a significant driver of food choices, in practice.

[5] Cohen (2008) derived a similar result with respect to the paper towel market.

The Model

The demand for milk in the Northeastern USA is modeled following the LA/AIDS developed by Deaton and Muellbauer (1980). Consider household *i* (*i*=*i*…*I*) weekly budget for milk to be allocated among *J* milk types (indexed by *j*=1,…., *J*), where each type is a combination of fat content and package size Let q_{ij} be the retail-level quantity demanded for milk-type *j* in a given week and p_j be its price; as household *i*'s expenditure for milk j is $p_j q_{ij}$, its expenditure share is $w_{ij} = p_j q_{ij} / M_i$ where $M_i = \sum_{k=1}^{J} p_k q_{ik}$ is the total weekly milk expenditure. According to the LA/ADIS one has:

$$w_{ij} = \alpha_{ij} + \sum_{j=1}^{J} \gamma_{jk} \log p_k + \beta_j \log \frac{M_i}{P^*} \quad (1)$$

where logP^* = $\sum_{j=1}^{J} w_{ik} \log p_k$ is the Stone Index used in the LA/AIDS as a proxy for the trans-log price index, and $\alpha_{ij} = \alpha_{0j} + \sum_{l=1}^{L} \alpha_{lj} Z_l$ where Z_l are household characteristic.

Denoting the vector of demand parameters as $\boldsymbol{\theta}$, that of household characteristics as *Z*, log prices as $\boldsymbol{p}$, and introducing stochasticity in the system of equations (since equation 1 exemplifies a system of *J* equations) by appending error terms to each equation (which represents the deterministic – observed – shares in 1), consistently with McElroy (1987), one has:

$$w_{ij}^* = s_{ij}(\boldsymbol{Z}, \boldsymbol{p}, M; \boldsymbol{\theta}) + \nu_{ij} \quad (2)$$

For this system of *J* equations to be well behaved, one must ensure all the restrictions dictated by theory to hold; i.e. homogeneity ($\sum_{j=1}^{J} \gamma_{jk} = 0 \; \forall k$; $\sum_{k=1}^{J} \gamma_{jk} = 0 \; \forall j$ and $\sum_{k=1}^{J} \beta_j = 0$), symmetry ($\gamma_{jk} = \gamma_{kj} \;\; \forall j, k$) and adding up ($\sum_{j=1}^{J} \alpha_{0j} = -1$ and $\sum_{j=1}^{J} \alpha_{lj} = 0 \; \forall l$). In order to impose all these parametric restrictions one can treat the *J*-th product as the residual category,

estimate *J*-1equations and recover the parameters of the *J*-th equation using the theoretical restrictions.

However, a common problem arising when estimating the system (2) using household-level data is that, in a given time period (in our case a week), a household may consume only a limited number of products in in the set. In other words, as consumers' choice is subject to non-negativity constraints, the relationship between the observed shares w_{ij} and the latent shares w_{ij}^* can be represented as:

$$w_{ij} = \max\{w_{ij}^*, 0\}, \quad j = 1, \dots, J \tag{3}$$

Different approaches and methods have been developed to obviate the empirical hurdles of estimating a system of truncated regressions (e.g. Heien and Wesseils, 1990, Kasteridis, et al., 2011, Shonkwiler and Yen, 1999, Yen and Lin, 2006, Yen, et al., 2003). For our analysis we follow Shonkwiler and Yen (1999) approach, which is illustrated as follows:

Consider the following the following system of *J* equaitons

$$d_{ij}^* = X'\pi_j + \varepsilon_{ij}; \text{ where } d_{ij} = \begin{cases} 1 \; if \; d_{ij}^* > 0 \\ 0 \; if \; d_{ij}^* \leq 0 \end{cases} \quad j = 1,2, \dots, J \tag{4}$$

where the *X*s are exogenous variables, the πs are paramters and ε_{ij} is an error term. One car rewrite equation (3) as

$$w_{ij} = d_{ij} w_{ji}^* . \tag{5}$$

If the error terms ε_{ij} are normally distributed, one can estimate *J* equations via maximum likelihood probit and recover *J* vectors of estimates of the π parameters. If the errors of each of the *J* equations in (2) and (4) are distributed as a bivariate normal and if $\text{cov}(v_{ij}\, \varepsilon_{ij}) = \delta_j$, the conditional mean of w_{ij} is

$$E\left(w_{ij}^* \mid \boldsymbol{Z}, \boldsymbol{p}, M, \boldsymbol{X}; \varepsilon_{ij} > -X'\pi_j\right) = s_{ij}(.) + \delta_j \frac{\phi\left(X'\pi_j\right)}{\Phi\left(X'\pi_j\right)} \tag{6}$$

where Φ (.) and φ(.) represent, respectively, the normal CDF and pdf distributions. Using Wales and Woodland (1980) formula for the conditional mean of w_{ij} and the estimates of the vectors π_j one can write the augmentd system of equations

$$w_{ij}^{*} = \Phi(X'\hat{\pi})s_{ij}(.) + \delta\phi(X'\hat{\pi}) + \xi_{ij} \quad (7)$$

where $\xi_{ij} = w_{ij} - E(w_{ij}|X'\hat{\pi})$.

Using Shonkwiler and Yen's (1999) approach has two main advantages: 1) it is easy to implement as it necessitates the estimation of *J* probit equation and a system of *J*-1 linear (in the case of the LA/AIDS) equation via SUR; and 2) multiple households characteristic can be used to explain both stages of the decision making process (i.e. likelihood of observing a household purchasing a given product and the resulting expenditure share for that product) and, thanks to the simplicity of the estimation procedure, allows for the easy inclusion of multiple households characteristics. One shortcoming of this procedure is that the estimates, although consistent, are inefficient (see Shonkwiler and Yen (1999) for more details on how one could obtain efficient estimates).

Data and Estimation

For our analysis, we use one year (2009) of weekly, household-level milk purchases aggregated from daily household level purchases in the ACNielsen Homescan database, including households in the Northeastern United States. The initial sample, resulting in 594,776 observations, was constructed to yield a balanced panel of purchasing-only households. The sample is divided into a "below poverty" (BP) sample (N=118,612) and an "above poverty" (AP) sample (N=476,164), of households, segmented according to their household income, and using the 2009 official poverty threshold conditional on household size by the U.S. Census Bureau

(2009). In total, the initial data accounted for 11,438 Northeastern households, with 9,157 households above the poverty level, and 2,281 households below. Only households who purchased milk at least once in the data period were retained in the data.

Summary statistics for the two groups of households (including only purchasing households) indicate that the shares of purchases of milk in different package size and fat content combinations differ across BP and AP households. While AP households show preference for milk with lower fat content, such a pattern is not observed for BP households: the type of milk showing the largest share of purchases for the former is skim milk (30.3%), followed by reduced fat (27.9%), low fat (24.0%) and whole (17.7%). BP (low-income) households, instead, purchased reduced fat milk 31.3% of the time, 24.5% for whole milk, 23.6% for skim milk and 20.7% for low-fat milk. In terms of packaging size, BP households tend to purchase larger unitary volumes than AP ones, although the difference is not as marked as fat content: the share of purchases of one gallon size is 54.8% in BP households and 48.5% in non-low income ones, while the purchase shares for 1/2 gallon is 35.9% for low-income and 41.2% for AP ones. Retail prices paid (in $/gallon) follow the expected patterns, with ¼ gallon packages almost 50% higher than one-gallon for low income households, and slightly more for AP households. The most noticeable difference between prices paid by the two income groups is that while the highest retail prices paid by BP households are for the half-gallon milk sizes, AP households faced the highest retail prices when they purchased ¼ gallon. Overall, skim milk is the most expensive for 1/2 and ¼ gallon sizes, but prices are similar among gallon-sized alternatives.

As the Homescan database does not report prices for products that a household did not purchase, missing prices have to be imputed. The most common methods used to treat missing prices are (1) to discard observations with missing prices, (2) to substitute missing prices with

conditional sample means, or (3) to use the hedonic price imputation approach developed by Cox and Wohlgenant (1986) or other regression based imputation methods. As our choice set contains twelve products, option one was not feasible, since most of the households would be dropped. Additionally, although method 2 is simpler, Cox and Wohlgenant (1986) argue that accounting for regional and weekly specific variations in price is more appropriate. To generate the imputed prices, we regressed the regional-weekly mean price on a selection of household-specific demographic variables, including dummy variables for store types, regions, presence of a child 18 or younger, presence of a child five years and younger and two years and younger, an indicator capturing a household participating in WIC and one if the household is below the poverty threshold, income level, urban and suburban, race, education levels, employment, household size, and age, as well as product-specific binary indicator variables of whether the product was purchased on discount, one for the type of discount, and organic purchases. The coefficients from these regressions were used, along with characteristics of the non-purchasing households to construct the real deviations from the mean prices for the non-purchasing household, and added to the regional-weekly mean prices.[6]

Estimation

The estimation procedure we employ in this paper mimics the two-step estimation procedure of a system of censored equations by Shonkwiler and Yen (1999). The decision-making process for a household is considered a two-stage process, where the household initially chooses the type of product they wish to purchase. Subsequently, the household chooses how much of their income they should allocate towards that product. To effectively model this two-stage decision, we

[6] After imputation, negative prices were still present in the data and therefore these observations were dropped from the final sample used in the estimation. The final sample resulted in 223,787 observations (circa 80% AP and 20% BP).

separated some of the demographics between the first stage and the second stage. The second stage includes all of the demographics from the first stage; however, the first stage includes other demographic variables that might influence the choice of a product, but not necessarily influence the share of a household's income conditional on their product choice. The demographic variables included in both the first and second stage are household size, proxy of the household income level, an indicator variable for participation in WIC, one for the presence of a child of two years and younger, one for children five years and younger (the latter a requirement for the participation in WIC) and an indicator for presence of a child 18 or under. Not included in the second stage but accounted for in the first stage are binary indicators for store type, region, race of the household head, whether the household head is Hispanic, and household head having high-school education or higher.

As illustrated in the "Model" section, the first stage equations are estimated via Maximum Likelihood Probit and the second stage equations are estimated using SUR. Data manipulation and estimation were was performed using STATA version 12.

Results and Discussion

Estimated Coefficients and Elasticities

Selected first stage probit regression results are reported in table 2.[7] The estimated coefficients for demographic characteristics in the second stage SUR are reported in tables 3a-3c. In all cases we report results for the three samples of households (full, households below poverty – BP, and households above poverty – AP). We will discuss in detail some of the key coefficients for the household characteristics included in both first and second stage regressions and a summary of

[7] The complete first stage regression results are available in Appendix A.

the other first stage coefficients; a detailed discussion of the price and expenditure coefficients across samples is omitted for brevity.

Table 2 here.

- Household size: a result that holds across samples (and for most types of milk) is that the probability of a household choosing gallon-sized milk, increases with the size of the households; however, although the impact of household size on expenditure shares does not follow a clear pattern, we find that larger households (particularly in the BP sample), tend to spend a larger share of their milk budget on products with higher fat content (whole and 2% reduced fat);
- Proxy for household income: the proxy for household income does not seem to impact the probability of purchasing any particular one of the milk-types included in the analysis, result that holds across sample of households; with respect to the impact on expenditure shares, we observe that, in both the full and AP samples, higher income levels are associated with higher expenditure shares of lower fat milk; no clear pattern emerges for the BP sample.
- WIC participation: WIC participating households show a higher probability of choosing low-fat milk products in the BP sample, and skim milk in the AP sample, although participation only impacts negatively the probability of choosing products with higher fat content (some unexpected parameters' sign emerge for large packaging products); moving on to the second stage parameters, participating in WIC shows a negative, or no effect on BP household expenditure shares of milk products with higher fat content (whole and 2%), and, with the exception of the negative coefficient for 1% fat, gallon, a positive effect on the expenditure shares for low-fat and skim milk;

- The presence of children below 2 years of age is associated with an increase in the probability of purchasing whole milk products (as it is expected, since milk with a higher fat content is advisable for the diet of infants) and a lower probability of choosing skim milk (with some exceptions); such patterns appear less marked in the BP sample. No clear patterns emerge for the impact of this variable on the expenditure shares;
- Presence of children (below 18) in the household and Children below 5 years of age: while the former seems to have a positive (negative) effect on the likelihood of purchasing gallon sized (half gallon and quarter gallon) milk, particularly in the BP sample, the effect of the latter does not follow precise patterns. These variables behave similarly in the second stage, showing unclear patterns in impacting expenditure shares among AP households; however, in BP households they impact positively (negatively) expenditure shares for gallon (half gallon and quarter gallon) milk, regardless on the fat content (with the exception of reduced fat milk).

Tables 3a – 3c here.

Other first stage results worth mentioning are: 1) household living in areas categorized as urban, show higher probability of purchasing milk with lower fat content (the result is consistent across samples and packaging size); 2) household head having a high school degree or higher, have higher probability of purchasing milk with higher fat content, and lower probability of purchasing lower fat milk-types in the AP sample; 3) Hispanic households tend to show higher (lower) probabilities of purchasing milk with smaller (larger) packaging size, especially in the BP sample; and 4) while race of the household head does not reveal particular patterns in impacting the probability of purchasing different types of milk for the BP sample, a household

head being black is associated with higher probability of purchasing smaller packaging size and higher fat content products, particularly in the AP sample.

In table 4 we report second-stage coefficients for the error covariance between first and second stages, and leave the remaining second stage results for Appendix B. These results are notable from a methodological perspective. The estimate coefficients capture the error covariance between the unconditional share equation and the first stage choice model, and are all positive and significant at the 0.01 level. This suggests the results obtained from SUR without considering the first-stage truncation would be biased for all household groups.

Table 4 here.

Average own-price and expenditure elasticities are reported in Table 5. Discussion of expenditure elasticities are excluded for brevity. Considering fat content, three patterns emerge:

1) The demand for milk becomes more elastic as the fat content increases; in other words, the demand for milk containing less fat is more inelastic than that for milk-types with higher fat content;
2) The demand for whole milk appears more elastic for below poverty households than for above poverty ones, in particular for the gallon-size products (difference in elasticity of circa 10%); such difference becomes trivial for the quarter gallon size;
3) For skim milk, the demand for large package products is 4% more elastic for AP households than for BP ones, while the demand for quarter size is 5% more elastic for AP households compared to AP ones.

Considering instead packaging size, three patterns emerge:

1) The demand for milk sold in larger packages is more elastic – up to 30% in the case of reduced fat and low fat milk – than those for smaller packages;

2) Products sold in half-gallon packages present the most inelastic demand across different fat content levels;
3) For the quarter size, the most elastic demand is that for skim milk; for this packaging size the elasticity of demand of below poverty households is 5% more elastic than that of above poverty ones.

Discussion

These results suggest that packaging size and fat content do play a role in impacting the demand for milk among households in the Northeastern U.S.; however, the results also indicate that differences across income groups are not marked (in the case of low fat, gallon the values of the estimated elasticities are virtually identical). As a consequence, our results cannot fully explain differences in purchasing patterns illustrated and summarized in table 1. For example, in spite of BP household showing a 10% more elastic demand for whole milk gallon than AP households, the price paid for this product by the two group of households is virtually identical. That is, when facing the same prices, we would expect BP households to purchase relatively less whole fat, gallon sized milk than AP households, however, this product is purchased much more often (relatively speaking) by the former group of households than the latter (70% more). Also, although BP households' demand for skim milk products sold in smaller sizes, is slightly less elastic than that of AP households (circa 4%), they pay (on average) 10-12% lower prices; one would expect shares of household of the two groups purchasing these product to be relatively similar, however, relatively speaking AP households purchase 72% more times ½ gallon and quarter gallon milk with than BP ones.

Furthermore, considering the patterns of the coefficients for some of the first stage and second stage coefficients for the household characteristics, it seems more likely that price per se does not have a large impact on the decision of purchasing products with different fat contents or a specific packaging size. Clear patterns suggest that larger households and households with children prefer larger size packaging, while other characteristics (presence of young children, ethnicity, and in very small extent income level for AP households) may have an impact on the choice of purchasing milk with a certain level of fat content. Product availability and access may also be an issue, as we find that household living in urban areas to have a higher likelihood of purchasing milk with lower fat content.

From a policy perspective, the results do not suggest that there is an important difference in the demand for healthful food characteristics across income levels. A number of caveats apply, most importantly in this case that we are only examining a single product category. However it is a product category for which the relative healthfulness across substitutes, particularly for adults, is highly transparent. Moreover, milk is highly homogenous across brands, which eliminates common potential confounders such as brand effects or advertising. A large number of studies across various disciplines have highlighted important differences in dietary quality, or related health issues, across income levels among U.S. consumers (Adelaja, et al., 1997, Blisard, et al., 2004, Chang and Lauderdale, 2005, Volpe and Okrent, 2012). Our study supports those findings that suggest these differences are a largely a function of access to healthy food options or the relative prices of foods among smaller vendors, rather than differences in information or intrinsic preferences attributable to income.

Conclusions

The debate around the healthfulness of food choices for low-income households is very alive and relevant as policymakers tend to incentivize consumption of healthier foods in different ways (e.g., allowing redemption of SNAP benefits at farmers markets). Motivating consumption of healthier alternatives inside one product category may need to rely on manipulations of relative prices across options and capitalizing on other factors (habits with respect of economizing strategies) that may impact such decisions.

Using fluid milk as a case study, and one year of household-level weekly milk purchases of households in the northeaster US, we find that, in spite of fat content and packaging size playing a role in impacting the demand for milk, the behavior of estimated elasticities differs little across samples of households with income above and below poverty levels. Even in cases where differences emerge, the estimated values, along with price differences experienced by purchasing households seem not to justify the different purchasing patterns of the two households groups. However, we find household characteristics to show differences in impacting the demand of milk across households with different income levels.

Table 1: Data Summary: Milk Purchasing Households in the Northeast by Income Levels.

	Full (N = 223,787)		Below Poverty (N = 44,607)		Above Poverty (N = 179,180)	
	Percent of Purchasing Households					
Whole						
Gallon	10.02%	(0.300)	14.94%	(0.357)	8.80%	(0.283)
Half Gallon	8.05%	(0.272)	8.75%	(0.283)	7.87%	(0.269)
Quarter Gallon	3.33%	(0.179)	3.54%	(0.185)	3.28%	(0.178)
Reduced Fat						
Gallon	17.37%	(0.379)	20.81%	(0.406)	16.52%	(0.371)
Half Gallon	11.97%	(0.325)	11.33%	(0.317)	12.13%	(0.327)
Quarter Gallon	2.81%	(0.165)	2.71%	(0.163)	2.83%	(0.166)
Low Fat						
Gallon	14.39%	(0.351)	13.28%	(0.339)	14.67%	(0.354)
Half Gallon	9.94%	(0.299)	8.18%	(0.274)	10.37%	(0.305)
Quarter Gallon	1.97%	(0.139)	1.55%	(0.124)	2.07%	(0.143)
Skim						
Gallon	14.15%	(0.348)	12.01%	(0.325)	14.68%	(0.354)
Half Gallon	15.22%	(0.359)	11.75%	(0.322)	16.08%	(0.367)
Quarter Gallon	3.26%	(0.178)	2.47%	(0.155)	3.46%	(0.183)
	Expenditure Share					
Whole						
Gallon	9.04%	(0.278)	13.76%	(0.335)	7.86%	(0.260)
Half Gallon	6.81%	(0.241)	7.49%	(0.253)	6.64%	(0.238)
Quarter Gallon	2.63%	(0.153)	2.88%	(0.161)	2.57%	(0.151)
Reduced Fat						
Gallon	16.08%	(0.358)	19.55%	(0.388)	15.21%	(0.350)
Half Gallon	10.52%	(0.297)	10.03%	(0.292)	10.63%	(0.298)
Quarter Gallon	2.38%	(0.147)	2.30%	(0.145)	2.40%	(0.148)
Low Fat						
Gallon	13.33%	(0.332)	12.30%	(0.321)	13.59%	(0.335)
Half Gallon	8.76%	(0.274)	7.23%	(0.251)	9.14%	(0.279)
Quarter Gallon	1.64%	(0.123)	1.26%	(0.107)	1.74%	(0.126)
Skim						
Gallon	12.91%	(0.326)	11.07%	(0.306)	13.37%	(0.331)
Half Gallon	13.25%	(0.326)	10.18%	(0.291)	14.02%	(0.334)
Quarter Gallon	2.66%	(0.154)	1.94%	(0.131)	2.84%	(0.159)
	Expenditure by Product					
Whole						
Gallon	$3.63	(1.698)	$3.62	(3.622)	$3.64	(1.692)
Half Gallon	$2.38	(1.282)	$2.26	(2.262)	$2.41	(1.317)
Quarter Gallon	$1.35	(0.614)	$1.39	(1.393)	$1.33	(0.59)
Reduced Fat						

Gallon	$3.45	(1.686)	$3.49	(3.488)	$3.44	(1.662)
Half Gallon	$2.37	(1.371)	$2.20	(2.199)	$2.41	(1.414)
Quarter Gallon	$1.36	(0.685)	$1.32	(1.317)	$1.37	(0.685)
Low Fat						
Gallon	$3.35	(1.628)	$3.35	(3.355)	$3.35	(1.624)
Half Gallon	$2.37	(1.328)	$2.24	(2.237)	$2.40	(1.33)
Quarter Gallon	$1.36	(0.67)	$1.29	(1.291)	$1.37	(0.691)
Skim						
Gallon	$3.15	(1.548)	$3.12	(3.122)	$3.16	(1.564)
Half Gallon	$2.77	(1.735)	$2.57	(2.57)	$2.80	(1.741)
Quarter Gallon	$1.61	(1.139)	$1.71	(1.713)	$1.60	(0.912)
			Price per Gallon[a]			
Whole						
Gallon	$3.03	(0.005)	$2.96	(0.023)	$3.06	(0.005)
Half Gallon	$4.12	(0.01)	$3.94	(0.031)	$4.17	(0.01)
Quarter Gallon	$4.83	(0.01)	$4.85	(0.038)	$4.83	(0.01)
Reduced Fat						
Gallon	$2.84	(0.005)	$2.78	(0.022)	$2.85	(0.005)
Half Gallon	$4.08	(0.011)	$3.85	(0.03)	$4.13	(0.012)
Quarter Gallon	$4.95	(0.014)	$4.80	(0.037)	$4.99	(0.014)
Low Fat						
Gallon	$2.75	(0.005)	$2.71	(0.021)	$2.76	(0.005)
Half Gallon	$4.05	(0.011)	$3.79	(0.03)	$4.10	(0.011)
Quarter Gallon	$4.83	(0.012)	$4.76	(0.037)	$4.84	(0.012)
Skim						
Gallon	$2.63	(0.006)	$2.62	(0.02)	$2.64	(0.006)
Half Gallon	$4.66	(0.015)	$4.21	(0.033)	$4.74	(0.015)
Quarter Gallon	$5.59	(0.018)	$5.15	(0.04)	$5.67	(0.019)

Standard errors are in parentheses.

a: Standard errors reported for Price per Gallon are in terms of $/oz.

Table 2: Selected First-Stage Probit (equation 3) Coefficients for Whole Milk, by Size and Income Group.

	Full Sample			Below Poverty			Above Poverty		
	Gallon	½ Gallon	¼ Gallon	Gallon	½ Gallon	¼ Gallon	Gallon	½ Gallon	¼ Gallon
Household Size	0.18***	-0.02***	-0.11***	0.15***	-0.07***	-0.18***	0.20***	-0.01	-0.10***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Income proxy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.000)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
WIC	0.05	-0.23***	0.26***	-0.02	-0.32***	0.10	0.34***	-0.13	0.26***
	(0.04)	(0.05)	(0.07)	(0.05)	(0.08)	(0.10)	(0.06)	(0.08)	(0.11)
Child < 2 years	0.63***	0.44***	0.05	0.45***	0.47***	-0.21***	0.69***	0.44***	0.20***
	(0.03)	(0.03)	(0.06)	(0.05)	(0.07)	(0.11)	(0.03)	(0.04)	(0.07)
Child < 18 years	0.11***	0.06***	0.07	-0.09***	0.04	0.44***	0.19***	0.06***	-0.09***
	(0.02)	(0.03)	(0.04)	(0.04)	(0.05)	(0.08)	(0.02)	(0.03)	(0.05)
Child < 5 years	0.02	-0.09***	-0.23***	0.13***	0.01	-0.17***	-0.05***	-0.13***	-0.25***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.05)	(0.01)	(0.02)	(0.02)
Hispanic HH Head	-0.14***	-0.03	-0.06***	-0.28***	-0.31***	-0.35***	-0.13***	0.02	0.04
	(0.02)	(0.02)	(0.03)	(0.04)	(0.05)	(0.06)	(0.02)	(0.02)	(0.03)
White HH head	-0.23***	-0.08***	0.01	0.13***	0.12***	-0.06	-0.31***	-0.11***	0.07***
	(0.02)	(0.02)	(0.03)	(0.04)	(0.05)	(0.06)	(0.02)	(0.02)	(0.03)
Black HH head	-0.08***	0.09***	0.30***	0.04	0.19***	0.10	-0.10***	0.08***	0.40***
	(0.02)	(0.02)	(0.03)	(0.05)	(0.06)	(0.07)	(0.02)	(0.03)	(0.04)
High School	0.14***	0.10***	0.07***	0.06***	0.08***	0.07***	0.17***	0.10***	0.07***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)
Urban	-0.24***	-0.12***	0.07***	-0.28***	-0.05***	-0.06***	-0.20***	-0.15***	0.15***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)	(0.01)	(0.02)

* 10%, ** 5%, *** 1% significance levels; Standard errors in parentheses.
The complete first-stage regression results are available in Appendix A.

Table 3a: Second-Stage SUR (Equation 4) Demographic Coefficients by Milk Type, Full Sample of Households.

	Whole Milk			Reduced Fat Milk		
	Gallon	*Half Gallon*	*Quarter Gallon*	*Gallon*	*Half Gallon*	*Quarter Gallon*
Intercept	-2.354***	1.141***	5.118***	-2.837***	1.929***	5.908***
	(0.060)	(0.078)	(0.071)	(0.045)	(0.06)	(0.099)
Household Size	-0.025***	0.028***	0.171***	0.055***	0.057***	0.093***
	(0.004)	(0.007)	(0.011)	(0.003)	(0.006)	(0.016)
Income	0.000	0.000	-0.002***	-0.002***	-0.001***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
WIC	-0.058***	0.087	0.278***	-0.233***	-0.072	-0.870***
	(0.023)	(0.076)	(0.082)	(0.04)	(0.061)	(0.353)
UnderTwo	0.154***	-0.097***	-0.047	-0.258***	0.052	0.456***
	(0.020)	(0.043)	(0.102)	(0.024)	(0.053)	(0.18)
UnderFive	0.015	0.000	-0.272***	-0.029***	-0.027	0.634***
	(0.016)	(0.038)	(0.076)	(0.015)	(0.039)	(0.139)
Under18	0.048***	-0.019	0.093***	0.100***	-0.151***	-0.126***
	(0.013)	(0.021)	(0.039)	(0.01)	(0.02)	(0.068)
	Low Fat Milk			**Skim Milk**		
Intercept	-2.834***	-0.983***	6.096***	-3.598***	-0.966***	
	(0.048)	(0.072)	(0.093)	(0.047)	(0.045)	
Household Size	-0.035***	-0.084***	0.086***	-0.096***	-0.080***	
	(0.004)	(0.007)	(0.016)	(0.004)	(0.006)	
Income	0.000***	0.001***	-0.003***	0.001***	0.002***	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
WIC	0.105***	-0.114	0.514***	-0.080	0.113***	
	(0.033)	(0.085)	(0.099)	(0.07)	(0.054)	
UnderTwo	-0.278***	-0.047	-0.140	-0.212***	-0.015	
	(0.025)	(0.067)	(0.148)	(0.035)	(0.046)	
UnderFive	0.039***	-0.090***	-0.066	-0.044***	-0.160***	
	(0.015)	(0.05)	(0.123)	(0.019)	(0.032)	
Under18	0.005	-0.258***	0.381***	-0.037***	0.024	
	(0.011)	(0.023)	(0.054)	(0.011)	(0.016)	

* 10%, ** 5%, *** 1% significance levels; Standard errors in parentheses.

Table 3b: Second-Stage SUR (Equation 4) Demographic Coefficients by Milk Type, Households Below Poverty.

	Whole Milk			Reduced Fat Milk		
	Gallon	*Half Gallon*	*Quarter Gallon*	*Gallon*	*Half Gallon*	*Quarter Gallon*
Intercept	-3.026***	1.065***	4.472***	-2.961***	0.584***	6.316***
	(0.058)	(0.064)	(0.056)	(0.043)	(0.017)	(0.104)
Household Size	0.001	0.033***	0.194***	0.040***	0.024***	0.070***
	(0.004)	(0.006)	(0.01)	(0.004)	(0.005)	(0.015)
Income	-0.002***	-0.001***	-0.002***	-0.003***	0.002***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
WIC	-0.029	-0.147***	-0.152***	-0.270***	-0.070	-0.410
	(0.030)	(0.077)	(0.074)	(0.038)	(0.054)	(0.409)
UnderTwo	0.267***	0.094***	0.087	-0.264***	0.063***	0.472***
	(0.023)	(0.034)	(0.065)	(0.028)	(0.029)	(0.153)
UnderFive	0.124***	0.026	-0.367***	-0.063***	0.187***	0.469***
	(0.019)	(0.029)	(0.043)	(0.016)	(0.024)	(0.106)
Under18	0.072***	-0.034***	0.181***	0.147***	-0.251***	-0.142***
	(0.013)	(0.017)	(0.034)	(0.011)	(0.016)	(0.07)
	Low Fat Milk			**Skim Milk**		
Intercept	-3.033***	-2.120***	2.775***	-2.799***	-0.416***	
	(0.043)	(0.078)	(0.05)	(0.033)	(0.032)	
Household Size	-0.028**	-0.066***	0.013	-0.042***	-0.066***	
	(0.004)	(0.009)	(0.011)	(0.003)	(0.004)	
Income	0.000***	0.005***	-0.002***	-0.001***	0.003***	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
WIC	-0.073***	0.322***	0.250***	0.002	0.189***	
	(0.028)	(0.062)	(0.049)	(0.072)	(0.074)	
UnderTwo	-0.209***	0.141	0.085***	0.090***	0.031	
	(0.025)	(0.096)	(0.036)	(0.05)	(0.036)	
UnderFive	0.038***	-0.202***	0.030	0.062***	-0.156***	
	(0.015)	(0.079)	(0.034)	(0.016)	(0.028)	
Under18	0.061***	-0.425***	0.096***	-0.003	-0.025***	
	(0.01)	(0.033)	(0.028)	(0.008)	(0.013)	

* 10%, ** 5%, *** 1% significance levels; Standard errors in parentheses.

Table 3c: Second-Stage SUR (Equation 4) Demographic Coefficients by Milk Type, Households Above Poverty.

	Whole Milk			Reduced Fat Milk		
	Gallon	*Half Gallon*	*Quarter Gallon*	*Gallon*	*Half Gallon*	*Quarter Gallon*
Intercept	-2.254***	1.196***	5.091***	-2.435***	1.429***	5.845***
	(0.056)	(0.075)	(0.072)	(0.043)	(0.058)	(0.097)
Household Size	-0.011***	0.016***	0.163***	0.038***	0.052***	0.127***
	(0.004)	(0.007)	(0.011)	(0.003)	(0.006)	(0.016)
Income	-0.001***	0.000***	-0.003***	-0.002***	-0.001***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
WIC	-0.073***	0.095	0.398***	-0.174***	-0.014	-0.792***
	(0.019)	(0.065)	(0.09)	(0.04)	(0.062)	(0.302)
UnderTwo	0.192***	-0.123***	-0.213***	-0.223***	0.034	0.454***
	(0.018)	(0.043)	(0.124)	(0.022)	(0.058)	(0.204)
UnderFive	-0.021	-0.010	-0.124	-0.019	-0.172***	0.687***
	(0.015)	(0.039)	(0.1)	(0.014)	(0.042)	(0.161)
Under18	0.073***	0.010	0.090***	0.077***	-0.153***	-0.078
	(0.013)	(0.022)	(0.04)	(0.01)	(0.019)	(0.07)
	Low Fat Milk			**Skim Milk**		
Intercept	-2.668***	-1.143***	6.424***	-3.380***	-0.856***	
	(0.046)	(0.073)	(0.103)	(0.044)	(0.044)	
Household Size	-0.039***	-0.111***	0.080***	-0.095***	-0.083***	
	(0.003)	(0.008)	(0.016)	(0.004)	(0.006)	
Income	0.001***	0.001***	-0.003***	0.001***	0.002***	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
WIC	0.193***	0.690	0.904***	-0.185***	0.064***	
	(0.04)	(0.771)	(0.302)	(0.05)	(0.038)	
UnderTwo	-0.273***	-0.062	-0.364	-0.212***	-0.004	
	(0.025)	(0.069)	(0.232)	(0.03)	(0.042)	
UnderFive	0.047***	-0.118***	0.281	-0.060***	-0.190***	
	(0.014)	(0.049)	(0.171)	(0.018)	(0.029)	
Under18	0.004	-0.233***	0.435***	-0.032***	0.010	
	(0.01)	(0.023)	(0.056)	(0.011)	(0.015)	

* 10%, ** 5%, *** 1% significance levels; Standard errors in parentheses.

Table 4: Second-Stage SUR (Equation 4) Error Variance-Covariance Coefficients, by Household Type.

	Full Sample	Below Poverty	Above Poverty
δ1	0.541***	0.715***	0.629***
	(0.024)	(0.024)	(0.021)
δ2	0.467***	0.659***	0.472***
	(0.039)	(0.03)	(0.036)
δ3	1.080***	0.732***	1.180***
	(0.031)	(0.022)	(0.03)
δ4	1.289***	1.498***	1.109***
	(0.017)	(0.016)	(0.017)
δ5	0.450***	1.019***	0.489***
	(0.03)	(0.02)	(0.032)
δ6	1.608***	2.034***	1.478***
	(0.047)	(0.048)	(0.046)
δ7	0.807***	0.634***	0.788***
	(0.015)	(0.015)	(0.014)
δ8	1.592***	1.638***	1.654***
	(0.036)	(0.035)	(0.037)
δ9	0.830***	0.729***	0.781***
	(0.04)	(0.018)	(0.045)
δ10	0.7080***	0.408***	0.732***
	(0.015)	(0.014)	(0.014)
δ11	0.884***	1.005***	0.870***
	(0.026)	(0.016)	(0.025)

* 10%, ** 5%, *** 1% significance levels; Standard errors in parentheses.

Table 5. Estimated Average Own Price and Expenditure Elasticities; Full Sample, Households Belove Poverty, and Households Above Poverty

Own Price Elasticities	Full		Below Poverty		Above Poverty	
Whole						
Gallon	-1.0963	(0.004)	-1.1892	(0.006)	-1.0757	(0.003)
Half Gallon	-0.8376	(0.004)	-0.8545	(0.004)	-0.8253	(0.005)
Quarter Gallon	-0.9786	(0.002)	-0.9851	(0.002)	-0.9783	(0.002)
Reduced Fat						
Gallon	-1.1854	(0.006)	-1.2339	(0.007)	-1.1699	(0.005)
Half Gallon	-0.9609	(0.005)	-0.9649	(0.004)	-0.9712	(0.005)
Quarter Gallon	-0.9898	(0.002)	-0.9804	(0.002)	-0.9909	(0.002)
Low Fat						
Gallon	-1.2477	(0.005)	-1.2390	(0.004)	-1.2389	(0.005)
Half Gallon	-0.9182	(0.004)	-0.9867	(0.005)	-0.9177	(0.005)
Quarter Gallon	-0.9731	(0.001)	-0.9894	(0.000)	-0.9706	(0.001)
Skim						
Gallon	-1.1966	(0.004)	-1.1409	(0.003)	-1.1879	(0.004)
Half Gallon	-1.0546	(0.003)	-1.0142	(0.002)	-1.0538	(0.003)
Quarter Gallon	-1.1199	(0.004)	-1.1768	(0.004)	-1.1146	(0.004)

Expenditure Elasticities	Full		Below Poverty		Above Poverty	
Whole						
Gallon	1.0579	(0.001)	1.0968	(0.001)	1.0461	(0.001)
Half Gallon	0.9775	(0.001)	0.9683	(0.001)	0.9781	(0.001)
Quarter Gallon	0.9373	(0.001)	0.9483	(0.000)	0.9364	(0.001)
Reduced Fat						
Gallon	1.0796	(0.001)	1.0921	(0.001)	1.0723	(0.001)
Half Gallon	0.9459	(0.001)	0.9597	(0.001)	0.9595	(0.001)
Quarter Gallon	0.9383	(0.000)	0.9302	(0.001)	0.9402	(0.000)
Low Fat						
Gallon	1.0768	(0.001)	1.0851	(0.001)	1.0734	(0.001)
Half Gallon	0.9772	(0.001)	1.0042	(0.001)	0.9783	(0.001)
Quarter Gallon	0.9623	(0.000)	0.9844	(0.000)	0.9592	(0.000)
Skim						
Gallon	1.1139	(0.001)	1.0830	(0.001)	1.1081	(0.001)
Half Gallon	1.0227	(0.001)	0.9948	(0.001)	1.0212	(0.001)
Quarter Gallon	1.1237	(0.001)	1.1955	(0.002)	1.1037	(0.001)

Note: all estimated average elasticities are significant at the 1% level

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Table A.1: Complete First Stage (Equation 3) Results.

	Full Sample											
	Whole Fat Milk						*Reduced Fat Milk*					
	Gallon		Half Gallon		Quarter Gallon		Gallon		Half Gallon		Quarter Gallon	
Size	0.18	***	-0.02	***	-0.11	***	0.13	***	-0.04	***	-0.18	***
	(0.004)		(0.005)		(0.007)		(0.003)		(0.004)		(0.008)	
Income	0.00		0.00		0.00		0.00		0.00		0.00	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
WIC	0.05		-0.23	***	0.26	***	-0.16	***	0.13	***	-0.28	***
	(0.038)		(0.054)		(0.068)		(0.041)		(0.046)		(0.128)	
UnderTwo	0.63	***	0.44	***	0.05		-0.18	***	0.07	***	0.10	
	(0.025)		(0.032)		(0.058)		(0.026)		(0.033)		(0.072)	
UnderFive	0.11	***	0.06	***	0.07		-0.02		0.00		0.13	***
	(0.019)		(0.025)		(0.041)		(0.017)		(0.023)		(0.052)	
Under18	0.02		-0.09	***	-0.23	***	0.19	***	-0.21	***	-0.31	***
	(0.012)		(0.014)		(0.021)		(0.01)		(0.012)		(0.025)	
Hispanic	-0.14	***	-0.03		-0.06	***	-0.08	***	0.01		0.00	
	(0.019)		(0.021)		(0.028)		(0.018)		(0.021)		(0.034)	
Race1	-0.23	***	-0.08	***	0.01		-0.06	***	-0.10	***	0.05	
	(0.018)		(0.019)		(0.027)		(0.017)		(0.018)		(0.031)	
Race2	-0.08	***	0.09	***	0.30	***	-0.13	***	0.16	***	0.29	***
	(0.022)		(0.023)		(0.031)		(0.021)		(0.022)		(0.036)	
HighSchool	0.14	***	0.10	***	0.07	***	0.09	***	0.00		0.04	***
	(0.008)		(0.008)		(0.011)		(0.007)		(0.007)		(0.012)	
Urban	-0.24	***	-0.12	***	0.07	***	-0.14	***	0.00		0.10	***
	(0.011)		(0.012)		(0.019)		(0.009)		(0.011)		(0.02)	
ID1	-0.15	***	0.12	***	0.63	***	-0.93	***	-0.07		0.49	***
	(0.052)		(0.063)		(0.15)		(0.043)		(0.057)		(0.16)	
ID2	0.02		0.25	***	0.91	***	-0.94	***	0.15	***	0.87	***
	(0.052)		(0.063)		(0.15)		(0.044)		(0.058)		(0.16)	
ID3	-0.14	***	0.38	***	1.07	***	-1.08	***	-0.09		0.80	***

	(0.053)		(0.064)		(0.15)		(0.046)		(0.059)		(0.161)	
ID4	-0.16	***	0.12	***	0.70	***	-0.91	***	0.17	***	0.57	***
	(0.055)		(0.066)		(0.152)		(0.046)		(0.06)		(0.163)	
ID5	-0.27	***	0.24	***	0.12		-0.47	***	0.17	***	0.49	***
	(0.093)		(0.095)		(0.234)		(0.072)		(0.089)		(0.209)	
ID6	-0.08		0.18	***	0.63	***	-0.78	***	0.18	***	0.66	***
	(0.052)		(0.063)		(0.15)		(0.043)		(0.057)		(0.16)	
ID7	-0.28	***	0.06		0.42	***	-0.51	***	0.36	***	0.69	***
	(0.053)		(0.063)		(0.15)		(0.044)		(0.058)		(0.161)	
ID8	-0.05		0.16	***	0.59	***	-0.67	***	0.22	***	0.53	***
	(0.055)		(0.065)		(0.152)		(0.046)		(0.059)		(0.163)	
ID9	-0.33	***	-0.34	***	0.23		-0.49	***	0.07		0.46	***
	(0.052)		(0.063)		(0.15)		(0.043)		(0.057)		(0.16)	
ID10	0.01		0.07		0.63	***	-0.99	***	-0.05		0.58	***
	(0.053)		(0.065)		(0.151)		(0.045)		(0.059)		(0.162)	
ID11	-0.19	***	0.18	***	0.47	***	-0.73	***	0.20	***	0.43	***
	(0.053)		(0.063)		(0.15)		(0.044)		(0.058)		(0.161)	
ID12	-0.07		0.11	***	0.64	***	-0.77	***	0.10		0.33	***
	(0.054)		(0.065)		(0.152)		(0.046)		(0.06)		(0.164)	
ID13	-0.26	***	-0.04		0.45	***	-0.56	***	0.18	***	0.49	***
	(0.054)		(0.065)		(0.151)		(0.045)		(0.058)		(0.162)	
ID14	-0.29	***	0.17	***	0.61	***	-0.73	***	0.09		0.49	***
	(0.052)		(0.063)		(0.15)		(0.043)		(0.057)		(0.16)	
Chain1	-0.02		0.11	***	0.31	***	0.11	***	0.10	***	0.30	***
	(0.014)		(0.015)		(0.023)		(0.012)		(0.014)		(0.026)	
Chain2	0.22	***	0.17	***	0.02		0.34	***	0.32	***	0.03	
	(0.024)		(0.025)		(0.038)		(0.021)		(0.022)		(0.042)	
Chain3	0.09	***	0.15	***	-0.34	***	0.31	***	0.14	***	-0.27	***
	(0.022)		(0.024)		(0.05)		(0.019)		(0.022)		(0.052)	
Chain4	0.03	***	0.14	***	-0.01		0.18	***	0.15	***	-0.03	
	(0.017)		(0.018)		(0.03)		(0.014)		(0.016)		(0.032)	
Chain5	0.22	***	-0.59	***	-0.37	***	0.44	***	-0.56	***	-0.64	***
	(0.019)		(0.029)		(0.042)		(0.016)		(0.025)		(0.063)	
Chain6	0.01		0.08	***	0.15	***	0.21	***	-0.01		0.07	***
	(0.021)		(0.022)		(0.032)		(0.018)		(0.021)		(0.036)	
Intercept	-0.80	***	-1.34	***	-2.43	***	-0.37	***	-1.19	***	-2.48	***

	(0.064)		(0.076)		(0.160)		(0.056)		(0.070)		(0.174)	
	Low-Fat Milk						*Skim Milk*					
	Gallon		Half Gallon		Quarter Gallon		Gallon		Half Gallon		Quarter Gallon	
Size	0.10	***	-0.07	***	-0.15	***	0.03	***	-0.12	***	-0.18	***
	(0.004)		(0.004)		(0.009)		(0.004)		(0.004)		(0.007)	
Income	0.00		0.00		0.00		0.00		0.00		0.00	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
WIC	0.16	***	0.07		0.30	***	-0.12	***	0.23	***	0.39	***
	(0.04)		(0.053)		(0.084)		(0.05)		(0.045)		(0.073)	
UnderTwo	-0.21	***	0.05		0.14	***	-0.25	***	0.01		-0.12	***
	(0.027)		(0.036)		(0.072)		(0.03)		(0.032)		(0.067)	
UnderFive	0.06	***	-0.02		0.03		-0.09	***	0.00		0.09	***
	(0.018)		(0.026)		(0.054)		(0.02)		(0.022)		(0.045)	
Under18	0.14	***	-0.18	***	-0.14	***	0.14	***	-0.13	***	-0.19	***
	(0.011)		(0.013)		(0.026)		(0.011)		(0.012)		(0.022)	
Hispanic	-0.05	***	0.13	***	0.29	***	-0.12	***	0.13	***	0.36	***
	(0.019)		(0.022)		(0.042)		(0.02)		(0.02)		(0.038)	
Race1	0.07	***	0.08	***	0.00		0.28	***	0.07	***	-0.09	***
	(0.017)		(0.02)		(0.033)		(0.019)		(0.018)		(0.027)	
Race2	-0.30	***	-0.01		0.09	***	-0.29	***	0.04	***	-0.08	***
	(0.024)		(0.024)		(0.039)		(0.026)		(0.022)		(0.033)	
HighSchool	0.00		-0.08	***	-0.08	***	-0.10	***	-0.07	***	-0.06	***
	(0.007)		(0.008)		(0.013)		(0.007)		(0.007)		(0.011)	
Urban	0.09	***	-0.04	***	0.09	***	0.14	***	0.13	***	0.07	***
	(0.011)		(0.012)		(0.024)		(0.01)		(0.011)		(0.019)	
ID1	0.75	***	1.09	***	3.72		-0.23	***	0.48	***	0.71	***
	(0.068)		(0.117)		(79.903)		(0.055)		(0.069)		(0.196)	
ID2	0.32	***	1.06	***	3.86		-0.50	***	0.66	***	1.08	***
	(0.069)		(0.117)		(79.903)		(0.055)		(0.07)		(0.196)	
ID3	0.22	***	1.20	***	4.16		-0.65	***	0.59	***	1.05	***
	(0.07)		(0.117)		(79.903)		(0.057)		(0.07)		(0.197)	
ID4	0.54	***	1.04	***	3.82		-0.40	***	0.60	***	1.01	***
	(0.07)		(0.118)		(79.903)		(0.057)		(0.071)		(0.198)	
ID5	0.14		0.77	***	0.00		0.37	***	0.36	***	0.06	
	(0.104)		(0.145)		(0.000)		(0.081)		(0.101)		(0.32)	
ID6	0.36	***	1.04	***	3.61		-0.15	***	0.53	***	0.86	***

	(0.068)		(0.117)		(79.903)		(0.054)		(0.069)		(0.196)	
ID7	0.22	***	0.74	***	3.08		-0.12	***	0.55	***	0.67	***
	(0.069)		(0.117)		(79.903)		(0.055)		(0.07)		(0.197)	
ID8	0.45	***	0.83	***	3.23		-0.09		0.30	***	0.82	***
	(0.07)		(0.119)		(79.903)		(0.057)		(0.072)		(0.198)	
ID9	0.73	***	0.76	***	3.50		0.31	***	0.04		0.58	***
	(0.068)		(0.117)		(79.903)		(0.054)		(0.07)		(0.196)	
ID10	0.72	***	1.23	***	3.74		-0.38	***	0.39	***	0.76	***
	(0.069)		(0.118)		(79.903)		(0.056)		(0.071)		(0.198)	
ID11	0.46	***	0.86	***	3.46		0.00		0.49	***	0.67	***
	(0.069)		(0.117)		(79.903)		(0.055)		(0.07)		(0.197)	
ID12	0.53	***	0.96	***	3.71		-0.16	***	0.54	***	0.78	***
	(0.07)		(0.118)		(79.903)		(0.057)		(0.071)		(0.198)	
ID13	0.51	***	0.88	***	3.61		0.12	***	0.29	***	0.65	***
	(0.069)		(0.118)		(79.903)		(0.055)		(0.071)		(0.198)	
ID14	0.56	***	0.93	***	3.56		-0.06		0.55	***	0.71	***
	(0.068)		(0.117)		(79.903)		(0.054)		(0.069)		(0.196)	
Chain1	-0.03	***	0.20	***	0.31	***	0.11	***	0.28	***	0.25	***
	(0.013)		(0.015)		(0.029)		(0.013)		(0.014)		(0.024)	
Chain2	-0.08	***	0.26	***	0.06		0.01		0.03		-0.35	***
	(0.024)		(0.024)		(0.045)		(0.025)		(0.024)		(0.05)	
Chain3	0.12	***	0.23	***	-0.10	***	0.22	***	0.04	***	-0.25	***
	(0.021)		(0.023)		(0.052)		(0.021)		(0.022)		(0.046)	
Chain4	0.04	***	0.14	***	-0.10	***	0.09	***	0.24	***	-0.04	
	(0.016)		(0.018)		(0.041)		(0.016)		(0.016)		(0.031)	
Chain5	0.39	***	0.15	***	-0.54	***	0.68	***	-0.64	***	-0.76	***
	(0.017)		(0.02)		(0.064)		(0.017)		(0.025)		(0.059)	
Chain6	0.74	***	-0.05	***	-0.05		-0.28	***	-0.14	***	-0.33	***
	(0.017)		(0.022)		(0.043)		(0.022)		(0.021)		(0.042)	

Below Poverty Households

	Whole Milk						*Reduced Fat Milk*					
	Gallon		Half Gallon		Quarter Gallon		Gallon		Half Gallon		Quarter Gallon	
Intercept	-2.01	***	-2.56	***	-6.24		-1.38	***	-1.98	***	-3.13	***
	(0.078)		(0.125)		(79.903)		(0.068)		(0.080)		(0.210)	
Size	0.15	***	-0.07	***	-0.18	***	0.10	***	-0.08	***	-0.12	***
	(0.008)		(0.01)		(0.017)		(0.007)		(0.01)		(0.017)	

Income	0.00		0.00		0.00		0.00		0.00		0.00	
	(0.001)		(0.001)		(0.002)		(0.001)		(0.001)		(0.002)	
WIC	-0.02		-0.32	***	0.10		-0.09		0.04		-0.42	***
	(0.053)		(0.075)		(0.096)		(0.054)		(0.064)		(0.181)	
UnderTwo	0.45	***	0.47	***	-0.21	***	-0.27	***	0.13	***	-0.06	
	(0.051)		(0.065)		(0.113)		(0.053)		(0.062)		(0.146)	
UnderFive	-0.09	***	0.04		0.44	***	-0.04		0.29	***	0.30	***
	(0.037)		(0.05)		(0.075)		(0.035)		(0.045)		(0.1)	
Under18	0.13	***	0.01		-0.17	***	0.24	***	-0.19	***	-0.30	***
	(0.022)		(0.028)		(0.047)		(0.021)		(0.027)		(0.053)	
Hispanic	-0.28	***	-0.31	***	-0.35	***	0.03		-0.13	***	-0.03	
	(0.042)		(0.047)		(0.059)		(0.042)		(0.048)		(0.081)	
Race1	0.13	***	0.12	***	-0.06		-0.23	***	0.04		0.30	***
	(0.042)		(0.048)		(0.058)		(0.038)		(0.045)		(0.087)	
Race2	0.04		0.19	***	0.10		-0.24	***	0.21	***	0.48	***
	(0.051)		(0.057)		(0.068)		(0.047)		(0.054)		(0.096)	
HighSchool	0.06	***	0.08	***	0.07	***	0.02		-0.03	***	0.19	***
	(0.016)		(0.018)		(0.025)		(0.015)		(0.017)		(0.029)	
Urban	-0.28	***	-0.05	***	-0.06	***	-0.07	***	0.14	***	0.15	***
	(0.019)		(0.023)		(0.034)		(0.018)		(0.021)		(0.037)	
ID1	-0.23	***	-0.15	***	0.82	***	-0.84	***	0.30	***	0.40	
	(0.076)		(0.092)		(0.259)		(0.07)		(0.114)		(0.27)	
ID2	-0.12		0.00		0.91	***	-0.97	***	0.32	***	0.71	***
	(0.08)		(0.096)		(0.262)		(0.077)		(0.118)		(0.272)	
ID3	-0.44	***	-0.01		1.31	***	-1.21	***	0.29	***	0.87	***
	(0.083)		(0.097)		(0.26)		(0.079)		(0.119)		(0.272)	
ID4	-0.25	***	-0.14		0.93	***	-0.69	***	-0.06		0.35	
	(0.091)		(0.109)		(0.268)		(0.084)		(0.134)		(0.289)	
ID5	-0.31	***	-0.44	***	0.00		-0.26	***	-0.41	***	0.00	
	(0.136)		(0.173)		(0.44)		(0.116)		(0.233)		(0)	
ID6	-0.25	***	-0.03		0.82	***	-0.88	***	0.47	***	0.54	***
	(0.076)		(0.091)		(0.259)		(0.07)		(0.114)		(0.27)	
ID7	-0.38	***	-0.21	***	0.67	***	-0.42	***	0.50	***	0.72	***
	(0.076)		(0.092)		(0.259)		(0.07)		(0.114)		(0.269)	
ID8	-0.21	***	0.17		1.21	***	-0.55	***	0.10		0.26	
	(0.088)		(0.102)		(0.264)		(0.081)		(0.129)		(0.29)	

ID9	-0.35	***	-0.65	***	0.31		-0.39	***	0.43	***	0.56	***
	(0.075)		(0.093)		(0.259)		(0.069)		(0.113)		(0.269)	
ID10	-0.16	***	0.08		1.00	***	-0.91	***	0.26	***	0.41	
	(0.082)		(0.098)		(0.262)		(0.078)		(0.12)		(0.277)	
ID11	-0.36	***	-0.06		0.84	***	-0.64	***	0.41	***	0.36	
	(0.079)		(0.094)		(0.26)		(0.073)		(0.116)		(0.274)	
ID12	-0.03		0.07		0.81	***	-0.93	***	0.29	***	-0.08	
	(0.082)		(0.099)		(0.265)		(0.079)		(0.122)		(0.303)	
ID13	-0.39	***	-0.12		0.71	***	-0.41	***	0.44	***	0.42	
	(0.078)		(0.094)		(0.261)		(0.071)		(0.116)		(0.274)	
ID14	-0.38	***	-0.02		0.64	***	-0.63	***	0.55	***	0.58	***
	(0.075)		(0.09)		(0.258)		(0.069)		(0.113)		(0.269)	
Chain1	0.01		0.13	***	0.23	***	0.25	***	0.06	***	0.06	
	(0.027)		(0.033)		(0.049)		(0.026)		(0.03)		(0.057)	
Chain2	0.23	***	0.22	***	0.08		0.30	***	0.39	***	-0.17	***
	(0.047)		(0.053)		(0.076)		(0.045)		(0.047)		(0.092)	
Chain3	-0.06		0.24	***	-0.45	***	0.31	***	0.16	***	-0.36	***
	(0.046)		(0.05)		(0.112)		(0.042)		(0.048)		(0.112)	
Chain4	-0.02		0.09	***	-0.02		0.35	***	0.04		-0.27	***
	(0.031)		(0.037)		(0.058)		(0.028)		(0.034)		(0.068)	
Chain5	0.28	***	-0.99	***	-0.55	***	0.24	***	-0.70	***	-0.82	***
	(0.046)		(0.123)		(0.15)		(0.046)		(0.087)		(0.203)	
Chain6	-0.05		0.12	***	0.08		0.48	***	0.16	***	-0.41	***
	(0.043)		(0.049)		(0.073)		(0.038)		(0.045)		(0.11)	
Intercept	-0.53	***	-0.74	***	-1.61	***	-0.50	***	-1.42	***	-2.63	***
	(0.106)		(0.125)		(0.281)		(0.103)		(0.144)		(0.314)	
	Low Fat Milk						*Skim Milk*					
	Gallon		Half Gallon		Quarter Gallon		Gallon		Half Gallon		Quarter Gallon	
Size	0.07	***	-0.01		-0.27	***	0.00		-0.06	***	-0.19	***
	(0.008)		(0.01)		(0.025)		(0.009)		(0.01)		(0.02)	
Income	0.00		-0.01		0.00		0.01		0.01		0.01	
	(0.001)		(0.001)		(0.002)		(0.001)		(0.001)		(0.002)	
WIC	0.38	***	0.33	***	0.24	***	-0.04		-0.08		-0.44	***
	(0.053)		(0.067)		(0.111)		(0.075)		(0.075)		(0.187)	
UnderTwo	-0.21	***	0.20	***	0.23	***	-0.68	***	0.18	***	-0.38	***
	(0.057)		(0.079)		(0.125)		(0.088)		(0.075)		(0.177)	

UnderFive	0.13	***	-0.15	***	0.47	***	-0.21	***	-0.02		0.38	***
	(0.039)		(0.059)		(0.105)		(0.045)		(0.054)		(0.098)	
Under18	-0.01		-0.15	***	0.14	***	0.10	***	-0.38	***	-0.25	***
	(0.024)		(0.03)		(0.064)		(0.025)		(0.028)		(0.056)	
Hispanic	-0.20	***	0.11	***	0.55	***	0.45	***	0.31	***	0.59	***
	(0.045)		(0.053)		(0.112)		(0.062)		(0.058)		(0.101)	
Race1	0.03		-0.02		-0.23	***	0.08		0.37	***	-0.42	***
	(0.043)		(0.049)		(0.081)		(0.05)		(0.055)		(0.064)	
Race2	-0.09		-0.05		0.01		-0.28	***	0.43	***	-0.66	***
	(0.055)		(0.058)		(0.091)		(0.064)		(0.062)		(0.087)	
HighSchool	-0.04	***	0.00		-0.02		-0.17	***	0.02		0.08	***
	(0.016)		(0.019)		(0.034)		(0.016)		(0.017)		(0.029)	
Urban	0.10	***	-0.03		0.18	***	0.03		0.04	***	0.25	***
	(0.021)		(0.025)		(0.053)		(0.021)		(0.022)		(0.04)	
ID1	1.23	***	1.52	***	3.64		-0.38	***	0.67	***	3.69	
	(0.143)		(0.332)		(161.191)		(0.086)		(0.15)		(176.242)	
ID2	0.69	***	1.45	***	3.30		-0.34	***	1.09	***	3.97	
	(0.147)		(0.333)		(161.191)		(0.091)		(0.152)		(176.242)	
ID3	0.49	***	1.90	***	4.43		-0.87	***	0.87	***	4.00	
	(0.15)		(0.333)		(161.191)		(0.102)		(0.153)		(176.242)	
ID4	1.11	***	1.51	***	4.15		-0.66	***	1.03	***	3.37	
	(0.151)		(0.336)		(161.191)		(0.107)		(0.157)		(176.242)	
ID5	0.83	***	1.72	***	0.00		0.11		0.87	***	0.00	
	(0.186)		(0.35)		(0)		(0.134)		(0.189)		(0)	
ID6	0.70	***	1.55	***	3.58		-0.28	***	1.02	***	4.02	
	(0.144)		(0.332)		(161.191)		(0.085)		(0.149)		(176.242)	
ID7	0.62	***	1.12	***	3.28		-0.24	***	0.97	***	3.62	
	(0.144)		(0.332)		(161.191)		(0.085)		(0.149)		(176.242)	
ID8	0.32	***	1.21	***	3.00		-0.51	***	0.95	***	4.30	
	(0.159)		(0.338)		(161.192)		(0.105)		(0.157)		(176.242)	
ID9	1.08	***	1.18	***	3.49		0.01		0.34	***	3.67	
	(0.143)		(0.332)		(161.191)		(0.084)		(0.149)		(176.242)	
ID10	0.99	***	1.68	***	3.64		-0.44	***	0.69	***	3.22	
	(0.147)		(0.334)		(161.191)		(0.094)		(0.154)		(176.242)	
ID11	0.81	***	1.36	***	3.76		0.00		0.66	***	3.64	
	(0.146)		(0.333)		(161.191)		(0.087)		(0.151)		(176.242)	

ID12	1.14	***	1.73	***	3.97		-0.64	***	0.69	***	3.60	
	(0.147)		(0.334)		(161.191)		(0.099)		(0.155)		(176.242)	
ID13	0.97	***	1.11	***	3.59		-0.25	***	0.53	***	3.79	
	(0.145)		(0.333)		(161.191)		(0.087)		(0.152)		(176.242)	
ID14	1.01	***	1.21	***	3.56		-0.31	***	0.83	***	3.94	
	(0.143)		(0.332)		(161.191)		(0.084)		(0.149)		(176.242)	
Chain1	-0.05	***	0.12	***	0.19	***	0.05		0.15	***	0.19	***
	(0.028)		(0.033)		(0.072)		(0.03)		(0.032)		(0.057)	
Chain2	-0.39	***	0.34	***	-0.51	***	-0.02		0.02		-0.21	***
	(0.062)		(0.052)		(0.155)		(0.055)		(0.053)		(0.103)	
Chain3	0.15	***	0.25	***	-0.29	***	0.24	***	-0.02		-0.23	***
	(0.045)		(0.051)		(0.14)		(0.047)		(0.052)		(0.11)	
Chain4	0.11	***	0.13	***	-0.21	***	0.02		-0.02		-0.02	
	(0.032)		(0.038)		(0.093)		(0.033)		(0.036)		(0.065)	
Chain5	0.37	***	0.23	***	0.00		0.59	***	-0.75	***	-0.77	***
	(0.046)		(0.058)		(0.000)		(0.048)		(0.089)		(0.225)	
Chain6	0.57	***	-0.38	***	-0.21	***	-0.49	***	-0.35	***	-0.38	***
	(0.04)		(0.063)		(0.122)		(0.057)		(0.056)		(0.113)	
Intercept	-2.01	***	-2.88	***	-6.50		-2.01	***	-2.95	***	-6.59	
	(0.165)		(0.345)		(161.192)		(0.145)		(0.185)		(176.242)	

Above Poverty Households

	Whole Milk						*Reduced Fat Milk*					
	Gallon		Half Gallon		Quarter Gallon		Gallon		Half Gallon		Quarter Gallon	
Size	0.20	***	-0.01		-0.10	***	0.16	***	-0.03	***	-0.20	***
	(0.005)		(0.006)		(0.008)		(0.004)		(0.005)		(0.009)	
Income	0.00		0.00		0.00		0.00		0.00		0.00	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
WIC	0.34	***	-0.13		0.26	***	-0.24	***	0.12		-0.16	
	(0.058)		(0.081)		(0.106)		(0.067)		(0.072)		(0.181)	
UnderTwo	0.69	***	0.44	***	0.20	***	-0.16	***	0.05		0.13	
	(0.029)		(0.037)		(0.07)		(0.03)		(0.04)		(0.084)	
UnderFive	0.19	***	0.06	***	-0.09	***	0.01		-0.09	***	0.08	
	(0.023)		(0.029)		(0.052)		(0.02)		(0.028)		(0.062)	
Under18	-0.05	***	-0.13	***	-0.25	***	0.16	***	-0.21	***	-0.30	***
	(0.014)		(0.016)		(0.024)		(0.012)		(0.014)		(0.029)	
Hispanic	-0.13	***	0.02		0.04		-0.11	***	0.03		0.00	

	(0.022)		(0.024)		(0.034)		(0.021)		(0.023)		(0.037)	
Race1	-0.31	***	-0.11	***	0.07	***	-0.02		-0.13	***	0.01	
	(0.019)		(0.021)		(0.031)		(0.019)		(0.02)		(0.034)	
Race2	-0.10	***	0.08	***	0.40	***	-0.10	***	0.15	***	0.26	***
	(0.024)		(0.026)		(0.036)		(0.023)		(0.024)		(0.039)	
HighSchool	0.17	***	0.10	***	0.07	***	0.11	***	0.00		0.01	
	(0.009)		(0.009)		(0.012)		(0.008)		(0.008)		(0.013)	
Urban	-0.20	***	-0.15	***	0.15	***	-0.17	***	-0.06	***	0.07	***
	(0.014)		(0.014)		(0.024)		(0.011)		(0.012)		(0.024)	
ID1	-0.03		0.31	***	0.52	***	-0.94	***	-0.22	***	0.49	***
	(0.074)		(0.089)		(0.184)		(0.056)		(0.068)		(0.202)	
ID2	0.15	***	0.43	***	0.81	***	-0.93	***	0.03		0.87	***
	(0.074)		(0.089)		(0.184)		(0.057)		(0.068)		(0.202)	
ID3	0.05		0.59	***	0.95	***	-1.05	***	-0.23	***	0.76	***
	(0.075)		(0.09)		(0.184)		(0.058)		(0.07)		(0.203)	
ID4	-0.03		0.30	***	0.58	***	-0.94	***	0.09		0.58	***
	(0.076)		(0.092)		(0.186)		(0.059)		(0.07)		(0.205)	
ID5	-0.25	***	0.61	***	0.12		-0.58	***	0.29	***	0.69	***
	(0.131)		(0.122)		(0.28)		(0.094)		(0.104)		(0.248)	
ID6	0.06		0.35	***	0.51	***	-0.76	***	0.04		0.67	***
	(0.073)		(0.089)		(0.184)		(0.056)		(0.068)		(0.202)	
ID7	-0.16	***	0.25	***	0.27		-0.52	***	0.28	***	0.65	***
	(0.075)		(0.09)		(0.186)		(0.057)		(0.068)		(0.203)	
ID8	0.11		0.29	***	0.37	***	-0.67	***	0.13	***	0.54	***
	(0.076)		(0.091)		(0.186)		(0.058)		(0.07)		(0.204)	
ID9	-0.27	***	-0.14		0.15		-0.51	***	-0.09		0.39	***
	(0.074)		(0.09)		(0.185)		(0.056)		(0.068)		(0.203)	
ID10	0.15	***	0.17	***	0.48	***	-1.00	***	-0.18	***	0.59	***
	(0.075)		(0.091)		(0.186)		(0.058)		(0.07)		(0.204)	
ID11	-0.04		0.35	***	0.29		-0.74	***	0.07		0.42	***
	(0.074)		(0.09)		(0.185)		(0.057)		(0.069)		(0.203)	
ID12	0.01		0.24	***	0.55	***	-0.72	***	-0.02		0.36	***
	(0.076)		(0.091)		(0.186)		(0.058)		(0.07)		(0.206)	
ID13	-0.11		0.06		0.31	***	-0.60	***	0.06		0.48	***
	(0.076)		(0.091)		(0.187)		(0.058)		(0.069)		(0.204)	
ID14	-0.16	***	0.32	***	0.57	***	-0.75	***	-0.11	***	0.42	***

	(0.074)		(0.089)		(0.184)		(0.056)		(0.068)		(0.203)	
Chain1	-0.03	***	0.10	***	0.33	***	0.07	***	0.12	***	0.36	***
	(0.016)		(0.017)		(0.026)		(0.014)		(0.015)		(0.029)	
Chain2	0.22	***	0.15	***	-0.02		0.36	***	0.30	***	0.08	
	(0.028)		(0.029)		(0.045)		(0.024)		(0.025)		(0.047)	
Chain3	0.13	***	0.12	***	-0.31	***	0.31	***	0.14	***	-0.25	***
	(0.026)		(0.028)		(0.056)		(0.022)		(0.025)		(0.059)	
Chain4	0.06	***	0.16	***	-0.03		0.13	***	0.19	***	0.04	
	(0.021)		(0.021)		(0.036)		(0.017)		(0.018)		(0.037)	
Chain5	0.19	***	-0.56	***	-0.34	***	0.44	***	-0.54	***	-0.60	***
	(0.021)		(0.031)		(0.044)		(0.018)		(0.027)		(0.066)	
Chain6	0.02		0.06	***	0.17	***	0.13	***	-0.06	***	0.16	***
	(0.024)		(0.025)		(0.035)		(0.02)		(0.023)		(0.039)	
Intercept	-1.05	***	-1.61	***	-2.75	***	-0.35	***	-1.01	***	-2.43	***
	(0.086)		(0.102)		(0.197)		(0.069)		(0.082)		(0.216)	
	Low Fat Milk						*Skim Milk*					
	Gallon		Half Gallon		Quarter Gallon		Gallon		Half Gallon		Quarter Gallon	
Size	0.11	***	-0.08	***	-0.13	***	0.05	***	-0.14	***	-0.19	***
	(0.005)		(0.005)		(0.010)		(0.005)		(0.005)		(0.008)	
Income	0.00		0.00		0.00		0.00		0.00		0.00	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
WIC	-0.11		-0.99	***	-0.22		0.03		0.55	***	0.77	***
	(0.07)		(0.183)		(0.206)		(0.072)		(0.061)		(0.086)	
UnderTwo	-0.23	***	0.00		0.08		-0.19	***	-0.02		-0.05	
	(0.031)		(0.041)		(0.092)		(0.033)		(0.036)		(0.075)	
UnderFive	0.05	***	0.01		-0.06		-0.08	***	0.00		0.02	
	(0.021)		(0.029)		(0.066)		(0.022)		(0.025)		(0.051)	
Under18	0.17	***	-0.18	***	-0.19	***	0.14	***	-0.07	***	-0.19	***
	(0.012)		(0.015)		(0.029)		(0.012)		(0.013)		(0.025)	
Hispanic	-0.02		0.15	***	0.24	***	-0.20	***	0.10	***	0.32	***
	(0.022)		(0.025)		(0.046)		(0.022)		(0.021)		(0.041)	
Race1	0.08	***	0.11	***	0.04		0.29	***	0.02		-0.02	
	(0.019)		(0.022)		(0.036)		(0.021)		(0.019)		(0.03)	
Race2	-0.34	***	0.00		0.10	***	-0.32	***	-0.04	***	0.03	
	(0.026)		(0.027)		(0.044)		(0.029)		(0.023)		(0.037)	
HighSchool	0.01		-0.10	***	-0.09	***	-0.09	***	-0.09	***	-0.09	***

	(0.008)		(0.008)		(0.015)		(0.008)		(0.008)		(0.012)	
Urban	0.09	***	-0.05	***	0.06	***	0.17	***	0.15	***	0.02	
	(0.012)		(0.014)		(0.027)		(0.012)		(0.013)		(0.022)	
ID1	0.54	***	0.95	***	3.76		-0.09		0.38	***	0.59	***
	(0.08)		(0.129)		(101.71)		(0.073)		(0.08)		(0.207)	
ID2	0.13	***	0.93	***	3.92		-0.39	***	0.52	***	0.96	***
	(0.08)		(0.13)		(101.71)		(0.074)		(0.081)		(0.207)	
ID3	0.05		1.00	***	4.14		-0.50	***	0.47	***	0.93	***
	(0.081)		(0.13)		(101.71)		(0.075)		(0.081)		(0.207)	
ID4	0.31	***	0.89	***	3.81		-0.25	***	0.46	***	0.92	***
	(0.082)		(0.131)		(101.71)		(0.075)		(0.082)		(0.208)	
ID5	-0.22	***	0.11		0.00		0.54	***	0.14		0.10	
	(0.131)		(0.203)		(0.000)		(0.103)		(0.124)		(0.336)	
ID6	0.18	***	0.89	***	3.64		-0.03		0.37	***	0.70	***
	(0.08)		(0.129)		(101.71)		(0.073)		(0.08)		(0.207)	
ID7	0.04		0.62	***	3.02		0.01		0.39	***	0.56	***
	(0.081)		(0.13)		(101.71)		(0.074)		(0.081)		(0.208)	
ID8	0.32	***	0.69	***	3.27		0.08		0.12		0.60	***
	(0.082)		(0.131)		(101.71)		(0.075)		(0.082)		(0.209)	
ID9	0.56	***	0.63	***	3.54		0.49	***	-0.08		0.42	***
	(0.08)		(0.13)		(101.71)		(0.073)		(0.081)		(0.207)	
ID10	0.55	***	1.08	***	3.78		-0.25	***	0.26	***	0.68	***
	(0.081)		(0.13)		(101.71)		(0.075)		(0.082)		(0.208)	
ID11	0.28	***	0.70	***	3.42		0.11		0.39	***	0.54	***
	(0.08)		(0.13)		(101.71)		(0.074)		(0.081)		(0.208)	
ID12	0.29	***	0.74	***	3.68		0.01		0.43	***	0.67	***
	(0.082)		(0.131)		(101.71)		(0.075)		(0.082)		(0.209)	
ID13	0.30	***	0.80	***	3.64		0.33	***	0.18	***	0.47	***
	(0.081)		(0.130)		(101.71)		(0.074)		(0.082)		(0.209)	
ID14	0.35	***	0.84	***	3.60		0.10		0.44	***	0.51	***
	(0.08)		(0.129)		(101.71)		(0.073)		(0.08)		(0.207)	
Chain1	-0.03	***	0.22	***	0.33	***	0.13	***	0.32	***	0.27	***
	(0.014)		(0.016)		(0.032)		(0.015)		(0.015)		(0.027)	
Chain2	-0.02		0.24	***	0.15	***	0.01		0.02		-0.39	***
	(0.027)		(0.027)		(0.048)		(0.028)		(0.027)		(0.058)	
Chain3	0.10	***	0.23	***	-0.05		0.21	***	0.06	***	-0.24	***

	(0.023)			(0.026)			(0.056)			(0.024)			(0.025)			(0.051)	
Chain4	0.02			0.15	***		-0.07			0.11	***		0.31	***		-0.05	
	(0.018)			(0.02)			(0.046)			(0.018)			(0.018)			(0.035)	
Chain5	0.38	***		0.15	***		-0.51	***		0.69	***		-0.62	***		-0.74	***
	(0.018)			(0.022)			(0.066)			(0.018)			(0.026)			(0.061)	
Chain6	0.77	***		0.00			-0.02			-0.24	***		-0.10	***		-0.30	***
	(0.019)			(0.024)			(0.046)			(0.024)			(0.023)			(0.045)	
Intercept	-1.88	***		-2.46	***		-6.22			-1.39	***		-1.74	***		-2.92	***
	(0.091)			(0.139)			(101.71)			(0.086)			(0.091)			(0.222)	

* 10%, ** 5%, *** 1% significance levels; Standard errors in parentheses.

Appendix B: Second Stage SUR (Equation 4) Regression Results

Table B.1: Price and Expenditure Coefficients from the Second Stage SUR, by Household Type.

	Full Sample			Below Poverty			Above Poverty		
Parameters	**Estimate**		**St. err.**	**Estimate**		**St. err.**	**Estimate**		**St. err.**
γ1,1	-0.3976	***	(0.034)	-0.6176	***	(0.035)	-0.3508	***	(0.033)
γ1,2	-0.2054	***	(0.028)	-0.1966	***	(0.027)	-0.1963	***	(0.028)
γ1,3	-0.0244		(0.020)	-0.0208		(0.017)	0.0071		(0.021)
γ1,4	0.2901	***	(0.025)	0.4065	***	(0.026)	0.2775	***	(0.024)
γ1,5	0.1811	***	(0.025)	0.2113	***	(0.025)	0.1533	***	(0.024)
γ1,6	0.0419	***	(0.017)	-0.0043		(0.015)	0.0501	***	(0.018)
γ1,7	0.2353	***	(0.026)	0.2790	***	(0.025)	0.2071	***	(0.025)
γ1,8	-0.1470	***	(0.022)	-0.1151	***	(0.020)	-0.1450	***	(0.022)
γ1,9	0.0242	***	(0.008)	0.0060		(0.007)	0.0232	***	(0.008)
γ1,10	0.0340		(0.025)	0.0617	***	(0.021)	-0.0103		(0.024)
γ1,11	-0.1487	***	(0.018)	-0.1091	***	(0.018)	-0.1468	***	(0.018)
γ1,12	0.1166	***	(0.017)	0.0990	***	(0.015)	0.1309	***	(0.017)
γ2,2	1.5079	***	(0.046)	1.1578	***	(0.037)	1.6747	***	(0.048)
γ2,3	-0.4152	***	(0.03)	-0.3002	***	(0.023)	-0.5079	***	(0.032)
γ2,4	0.1659	***	(0.024)	0.1027	***	(0.024)	0.1554	***	(0.024)
γ2,5	-0.3700	***	(0.029)	-0.2423	***	(0.024)	-0.3549	***	(0.028)
γ2,6	0.2916	***	(0.025)	0.2042	***	(0.018)	0.3495	***	(0.026)
γ2,7	-0.0636	***	(0.028)	-0.0376		(0.025)	-0.0854	***	(0.027)
γ2,8	-0.5306	***	(0.029)	-0.3794	***	(0.026)	-0.5994	***	(0.03)
γ2,9	0.0155		(0.011)	0.0010		(0.008)	0.0147		(0.011)
γ2,10	0.0367		(0.027)	0.0472	***	(0.02)	0.0495	***	(0.026)
γ2,11	-0.2229	***	(0.021)	-0.2479	***	(0.017)	-0.2523	***	(0.021)
γ2,12	-0.2098	***	(0.024)	-0.1090	***	(0.019)	-0.2476	***	(0.026)
γ3,3	-0.6669	***	(0.052)	-0.6243	***	(0.043)	-0.6730	***	(0.053)
γ3,4	-0.0473	***	(0.012)	0.0212	***	(0.013)	-0.0770	***	(0.011)
γ3,5	0.2800	***	(0.024)	0.3079	***	(0.022)	0.2822	***	(0.021)
γ3,6	0.2828	***	(0.033)	0.1769	***	(0.029)	0.2933	***	(0.034)
γ3,7	0.2056	***	(0.024)	0.2797	***	(0.022)	0.1701	***	(0.023)
γ3,8	-0.0337		(0.031)	0.0570	***	(0.032)	0.0139		(0.031)
γ3,9	0.0457	***	(0.017)	-0.0008		(0.01)	0.0583	***	(0.02)
γ3,10	0.0862	***	(0.021)	-0.0274	***	(0.015)	0.1174	***	(0.021)
γ3,11	0.2304	***	(0.021)	0.0422	***	(0.017)	0.2324	***	(0.021)
γ3,12	0.0568	***	(0.033)	0.0886	***	(0.028)	0.0833	***	(0.034)
γ4,4	-0.5958	***	(0.029)	-0.6661	***	(0.03)	-0.5763	***	(0.029)
γ4,5	-0.0075		(0.023)	0.0043		(0.022)	0.0030		(0.022)
γ4,6	-0.0806	***	(0.011)	-0.0501	***	(0.011)	-0.0771	***	(0.011)

γ4,7	0.1952	***	(0.023)	0.2083	***	(0.023)	0.1831	***	(0.023)
γ4,8	0.0686	***	(0.014)	0.0856	***	(0.015)	0.0587	***	(0.013)
γ4,9	-0.0762	***	(0.005)	-0.0700	***	(0.005)	-0.0700	***	(0.005)
γ4,10	0.1340	***	(0.022)	0.0369	***	(0.018)	0.1532	***	(0.021)
γ4,11	0.1304	***	(0.016)	0.1184	***	(0.017)	0.1308	***	(0.016)
γ4,12	-0.1768	***	(0.011)	-0.1977	***	(0.011)	-0.1613	***	(0.011)
γ5,5	-0.0618	***	(0.034)	-0.0043		(0.028)	-0.0489		(0.032)
γ5,6	0.1691	***	(0.021)	0.2380	***	(0.019)	0.1677	***	(0.019)
γ5,7	-0.0074		(0.025)	-0.0816	***	(0.022)	-0.0099		(0.024)
γ5,8	-0.2080	***	(0.025)	-0.3764	***	(0.024)	-0.2510	***	(0.023)
γ5,9	-0.0100		(0.007)	0.0144	***	(0.007)	-0.0274	***	(0.006)
γ5,10	0.1804	***	(0.023)	0.1044	***	(0.017)	0.1755	***	(0.022)
γ5,11	0.0360	***	(0.018)	-0.0362	***	(0.015)	0.0596	***	(0.018)
γ5,12	-0.1817	***	(0.02)	-0.1396	***	(0.018)	-0.1492	***	(0.018)
γ6,6	-1.2659	***	(0.044)	-1.2223	***	(0.047)	-1.2436	***	(0.044)
γ6,7	0.1251	***	(0.017)	0.0152		(0.014)	0.1196	***	(0.017)
γ6,8	0.0408		(0.025)	-0.0512	***	(0.03)	0.0604	***	(0.025)
γ6,9	-0.0167		(0.014)	-0.0267	***	(0.013)	-0.0190		(0.014)
γ6,10	0.0460	***	(0.018)	-0.0458	***	(0.013)	0.0272		(0.018)
γ6,11	-0.1290	***	(0.017)	-0.1047	***	(0.015)	-0.1385	***	(0.016)
γ6,12	0.4949	***	(0.035)	0.8708	***	(0.039)	0.4102	***	(0.035)
γ7,7	-1.1361	***	(0.031)	-1.1163	***	(0.028)	-1.0791	***	(0.03)
γ7,8	0.1086	***	(0.024)	-0.0163		(0.022)	0.1642	***	(0.024)
γ7,9	0.0576	***	(0.01)	0.0346	***	(0.009)	0.0631	***	(0.009)
γ7,10	0.2153	***	(0.023)	0.2454	***	(0.019)	0.1895	***	(0.022)
γ7,11	0.0207		(0.017)	0.1459	***	(0.016)	0.0290	***	(0.017)
γ7,12	0.0437	***	(0.018)	0.0437	***	(0.015)	0.0487	***	(0.017)
γ8,8	0.5471	***	(0.038)	0.1837	***	(0.049)	0.5371	***	(0.038)
γ8,9	0.1137	***	(0.014)	0.1344	***	(0.018)	0.1128	***	(0.013)
γ8,10	-0.3257	***	(0.023)	-0.0757	***	(0.016)	-0.3476	***	(0.023)
γ8,11	0.1505	***	(0.019)	0.2598	***	(0.018)	0.1341	***	(0.018)
γ8,12	0.2158	***	(0.024)	0.2936	***	(0.034)	0.2618	***	(0.024)
γ9,9	-0.1898	***	(0.031)	-0.1009	***	(0.018)	-0.1911	***	(0.033)
γ9,10	-0.0215	***	(0.008)	-0.0211	***	(0.005)	-0.0225	***	(0.008)
γ9,11	0.0196	***	(0.007)	0.0251	***	(0.005)	0.0136	***	(0.007)
γ9,12	0.0382		(0.03)	0.0040		(0.02)	0.0444		(0.031)
γ10,10	-0.5979	***	(0.026)	-0.4939	***	(0.019)	-0.5552	***	(0.025)
γ10,11	0.0620	***	(0.018)	0.0514	***	(0.012)	0.0852	***	(0.017)
γ10,12	0.1505	***	(0.017)	0.1169	***	(0.012)	0.1380	***	(0.016)
γ11,10	0.0620	***	(0.018)	0.0514	***	(0.012)	0.0852	***	(0.017)
γ11,11	-0.1994	***	(0.018)	-0.1376	***	(0.014)	-0.1919	***	(0.018)
γ11,12	0.0502	***	(0.017)	-0.0073		(0.014)	0.0448	***	(0.016)
γ12,12	-0.5983	***	(0.051)	-1.0631	***	(0.051)	-0.6039	***	(0.052)

β1	0.5222	***	(0.007)	0.5969	***	(0.008)	0.4689	***	(0.007)
β2	-0.2365	***	(0.01)	-0.3104	***	(0.008)	-0.2345	***	(0.01)
β3	-1.4868	***	(0.012)	-1.1893	***	(0.01)	-1.5190	***	(0.013)
β4	0.4241	***	(0.007)	0.4165	***	(0.007)	0.4032	***	(0.006)
β5	-0.3968	***	(0.008)	-0.3151	***	(0.005)	-0.2928	***	(0.007)
β6	-1.8604	***	(0.014)	-2.1665	***	(0.016)	-1.7893	***	(0.014)
β7	0.4937	***	(0.007)	0.5928	***	(0.006)	0.4635	***	(0.007)
β8	-0.2025	***	(0.009)	0.0452	***	(0.013)	-0.1843	***	(0.009)
β9	-1.5883	***	(0.016)	-0.7890	***	(0.011)	-1.6419	***	(0.016)
β10	0.7346	***	(0.007)	0.6365	***	(0.005)	0.6708	***	(0.007)
β11	0.1298	***	(0.007)	-0.0380	***	(0.005)	0.1148	***	(0.006)
β12	3.4670	***	(0.020)	2.5205	***	(0.019)	3.5405	***	(0.020)

* 10%, ** 5%, *** 1% significance levels
Standard errors in parentheses.