Economic Incentives for Dietary Improvement Among Food Stamp Recipients

By

Biing-Hwan Lin, Steven T. Yen, Diansheng Dong,

and David M. Smallwood

Presented at the 2009 Pre-Conference Workshop, August 16, 2009, Diet and Obesity: Role of Prices and Policies

August 2009

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BIING-HWAN LIN [a], STEVEN T. YEN [b,*], DIANSHENG DONG [a],
and DAVID M. SMALLWOOD [a]

[a] Economic Research Service
U.S. Department of Agriculture
1800 M Street NW
Washington, DC 20036-5831

[b] Department of Agricultural Economics
The University of Tennessee
302 Morgan Hall, 2621 Morgan Circle
Knoxville, TN 37996-4518

June 2009

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[*] Corresponding author. Tel. +1 865 974 7474; Fax. +1 865 974 4829.
E-mail address: syen@utk.edu (S.T. Yen)

Research for this paper was supported by USDA-ERS Cooperative Agreements No. 58-5000-7-0123 and 43-3AEM-2-80063. The views in this paper are those of the authors and do not necessarily reflect the views or policies of the U.S. Department of Agriculture.

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Abstract

Most Americans need to consume more fruits, vegetables, and dairy products. This need is particularly acute among low-income individuals. The objective of this study is to examine the cost effectiveness of two economic policies that use alternative policy levers available within the Supplemental Nutrition Assistance Program (formerly Food Stamp Program) to increase consumption of these under-consumed foods. Data from three nationally representative surveys are used to estimate demand elasticities, marginal propensity to spend on food out of food stamp benefits, and consumption amount of and spending on under-consumed foods among food stamp recipients. Results of the analyses suggest that a 10% price subsidy would curtail consumption deficiencies by 4–7% at an estimated cost of $734 million a year. When the same $734 million is used to finance food stamp benefits, consumption deficiencies are predicted to narrow by only 0.35 to 0.40%.

JEL Classification: C34; D12; Q18

Keywords: CEX; Food stamps; Fruits; Milk; Vegetables; NFSPS; NHANES; Price subsidy; SNAP

ABBREVIATIONS

SNAP: Supplemental Nutrition Assistance Program

CEX: Consumer Expenditure Survey

NFSPS: National Food Stamp Program Survey

NHANES: National Health and Nutrition Examination Survey

MPS: Marginal Propensity to Spend

USDA: U.S. Department of Agriculture

WIC: Special Supplemental Nutrition Program for Women, Infants, and Children

I. INTRODUCTION

There are major dietary inadequacies facing Americans—high intake of fat and saturated fat, and low intake of fiber- and calcium-containing foods, such as fruits, vegetables, whole grains, and milk. During 1999–2000, only 1 in 10 Americans had a good diet (Basiotis et al., 2002). Dietary inadequacies have been linked to several chronic diseases, including coronary heart disease, cancer, stroke, diabetes, hypertension, overweight and osteoporosis. These diet-related problems are costly to the society. For example, diet-related premature deaths from coronary heart disease, cancer, stroke, and diabetes are estimated to account for 5.3 percent of all deaths in the U.S. and cost the society $71 billion in 1995 (Frazao, 1999). Overweight and obesity have been estimated to cost U.S. society as much as $117 billion annually (USDHHS, 2001). The need to identify effective intervention strategies to alleviate the costly diet-related health problems is a priority for the public.

Diet quality is particularly poor among low-income Americans, reflected in their under-consumption of fruits, vegetables, and milk (Lin, 2005). To help low-income Americans achieve a healthy, balanced diet, the U.S. Department of Agriculture (USDA) administers 15 domestic food and nutrition assistance programs, costing $61 billion in 2008 (USDA-ERS, 2009). In 2005, the Institute of Medicine (2005) recommended issuing vouchers redeemable for fruit and vegetable purchases in order to increase fruit and vegetable consumption among participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). The Federal Government has also implemented the WIC Farmers' Market Nutrition Program, the Senior Farmers' Market Nutrition Program, and informational campaigns to increase fruit and vegetable consumption among food assistance recipients (USDA-FNS, 2004).

The Supplemental Nutrition Assistance Program (SNSP, formerly Food Stamp Program) is the cornerstone of the Federal food assistance programs, accounting for 62% of USDA's total food assistance costs and serving 28.4 million Americans each month in 2008. It has been documented that food stamp recipients consumed fewer servings of fruits and vegetables than income-eligible non-participants as well as the income-ineligible (Fox and Cole, 2004). To help food stamp participants make more nutritious food choices, the USDA has expanded its nutrition education program by increasing funding from $0.66 million in 1992 to $247 million in 2006 (Guthrie et al., 2007).

Two economic intervention strategies have been contemplated to help food stamp recipients make more nutritious food choices. One strategy is to increase overall food spending by increasing food stamp benefits. This is a non-targeted strategy. The alternative is a targeted strategy which subsidizes the consumption of healthy foods such as fruits, vegetables, and dairy products and taxes the consumption of less healthy foods such as salty snacks (Guthrie et al., 2007; Kuchler, Tegene, and Harris, 2005).

The objective of this study is to estimate the size of consumer response to and the cost associated with these two strategies—increasing food stamp benefits and subsidizing the purchase of healthy food. Specifically, we estimate the costs of narrowing the gap between current consumption and dietary recommendation for the two strategies. These cost measures serve as the basis for comparing the effectiveness among alternative strategies. It is important to examine the dietary and health benefits associated with increased consumption of fruits, vegetables, and dairy products, but this is beyond the scope of this paper.

To accomplish the objective, we undertake several tasks. First, to examine demand responses to the incentives we estimate a system of food demand equations for food stamp households to obtain demand elasticities. Second, we estimate the marginal propensity to spend

(MPS) on food out of food stamp benefits and income. This MPS estimate projects the increase in overall food spending resulting from increased benefits. Third, we analyze household food consumption and expenditure survey data to estimate food consumption and spending by food stamp recipients. These consumption and spending amounts serve as the basis for quantifying consumption and cost using elasticity estimates. Using results from these analyses, we calculate the potential increases in consumption of under-consumed foods and the associated cost of both intervention strategies. Estimation of the demand system is presented first, followed by the analysis of subsidizing healthy food purchases, and then the analysis of increasing benefits.

II. FOOD DEMAND SYSTEM AMONG FOOD STAMP PARTICIPANTS

Our first empirical task is to estimate a demand system to obtain Marshallian price and expenditure elasticities. The literature of demand system methodology is far too large to review here. Popular functional forms include the almost ideal demand system (Deaton and Muellbauer, 1980) and the Translog demand system (Christensen, Jorgenson, and Lau, 1975). Barnett and Serletis (2008) are the last among many reviews during the last 40 years, and important recent contributions include the Exact Affine Stone Index (EASI) implicit Marshallian demand system (Lewbel and Pendakur, forthcoming). Combining the desirable features of Hicksian and Marshallian demand functions, the EASI demand system is an important tool for calculating the welfare impacts of policy changes. Another important class of models are the incomplete demand systems (Beatty and LaFrance, 2005; LaFrance, 2008; LaFrance et al., 2002), which have desirable aggregation properties and are capable of, among other things, explaining individual demand behavior with aggregate data. By combining demand estimates with data on the nutritional contents of food, these incomplete demand systems also allow inference on the nutritional impacts of changes in food consumption (e.g., Beatty and LaFrance, 2005).

Our choice of analytical framework is dictated by the utmost need for Marshallian price and expenditure elasticities among a *targeted population*, namely the food stamp recipients, to address the cost effectiveness of alternative intervention strategies to increase consumption of under-consumed goods among this population. While national survey data have been used to estimate food demand systems segmented by income (Park et al., 1996; Huang and Lin, 2000), a low-income sample does not correspond fully to food stamp recipients. There has existed only one nationally representative sample of food stamp receiving households—the 1996–97 National Food Stamp Program Survey (NFSPS). With a micro dataset, aggregation is less of a consideration and we opt for functional flexibility and use the Translog demand system, which is second-order approximation to any functional forms (Christensen, Jorgenson, and Lau, 1975) and, importantly, has been found to produce legitimate elasticity estimates with the NFSPS data (Yen, Lin, and Smallwood, 2003). In contrast to this earlier study with the NFSPS data, we separate fruits from vegetables to accommodate their different elasticities. Fruit juice is also separated from other beverages and fluid milk from other dairy products. Juice accounts for a large share in total fruit consumption and its nutritional value is superior to many other beverages. Previous studies found different elasticities for fluid milk and cheese (Schmit et al., 2002).

It should be noted that the nutrition profile varies among the food items in a group. For example, the *Dietary Guidelines for Americans* put forth different recommendations for different types of vegetables (USDA-USDHHS, 2005). However, while it is desirable to estimate a demand system with foods further disaggregated by nutritional contents, estimation of such a large and disaggregation system would be infeasible computationally, especially for micro data with censored dependent variables which require numerical evaluations of high-dimensioned probability integrals. Therefore, to avoid over-parameterizing the system, we estimate a demand system of 13 food groups—milk, other dairy, fats and oils, meat, poultry, fish, egg, grains, vegetables, non-juice fruits, juice, other drinks, and mixtures. Below we briefly explain the data and the econometric specification.

A. Data

Data for the demand system estimation are drawn from the 1996–97 National Food Stamp Program Survey (NFSPS), which is the most recent USDA survey to collect food use, food cost, and socio-demographic data among food stamp households (Cohen et al., 1999). The NFSPS collected food use data for home consumption only, and not for food consumed away from home. No national survey has been conducted since the NFSPS to collect data, which can be used to estimate household food demands, especially for the low-income population. Among the 1,109 households that participated in personal interviews, 920 completed the survey. After excluding households with missing information or with prices exceeding six standard deviations of corresponding sample means, the final sample contains 900 observations.

We derive unit values (prices) from reported expenditures (in dollars) and quantities (in pounds) to represent prices. Prices for non-consuming households are represented by regional averages reported by consuming households. In a demand system, the number of parameters increases exponentially with the number of equations and the number of explanatory variables in each equation, and this is an important consideration in specifying the demand equations. In addition to prices and total expenditure, we include household size to account for differences in household demand. Household size is the single most important noneconomic factor affecting household food demand (Prais and Houthakker, 1971; Smallwood and Blaylock, 1981). Sample statistics of all variables (expenditures, quantities, prices, and household size) used in the demand system estimation are presented in Table 1.

B. Econometric Model

The empirical analysis is carried out by estimating the Translog demand system (Christensen, Jorgenson, and Lau, 1975), with *n* deterministic expenditure shares

(1) $$s_i(\theta) = [\alpha_{i0} + \Sigma_{i\ell}\alpha_{i\ell}z_\ell + \Sigma_{j=1}^n \beta_{ij}\log(p_j / M)] / D, \quad i = 1,...,n,$$

where $D = 1 + \Sigma_{k=1}^n \Sigma_{j=1}^n \beta_{kj} \Sigma_{j=1}^n \beta_{ij} \log(p_j / M)$, θ is a vector containing all parameters, p_j are prices, M is total food budget, z_ℓ are demographic variables, and the α's and β's are parameters. Homogeneity holds by construction (by using standardized prices p_j / M) and the symmetry restrictions ($\beta_{ij} = \beta_{ji}$ for all i, j) are also imposed.

The demand system is estimated with a censored system procedure because some households did not purchase certain foods during the survey period. Ignoring the zero expenditure values would produce statistically inconsistent parameter estimates (Lee and Pitt, 1986; Wales and Woodland, 1983). We follow the maximum simulated likelihood procedure described in Yen, Lin, and Smallwood (2003), and estimate the first $n - 1$ share equations as a Tobit system (Amemiya, 1974; Pudney, 1989). The food category "mixtures" is omitted in the estimation. Observed expenditure shares w_i relate to the stochastic latent shares $s_i(\theta) + \varepsilon_i$ such that

(2) $$w_i = \max\{s_i(\theta) + \varepsilon_i, 0\}, \quad i = 1,...,n-1,$$

where error terms $[\varepsilon_1,...,\varepsilon_{n-1}]$ are distributed as multivariate normal with zero means and a finite contemporaneous covariance matrix. While this Tobit system approach is less structural than the Kuhn-Tucker (Wales and Woodland, 1983) and virtual-price (Lee and Pitt, 1986) alternatives, it is based on the reduced form which corresponds to the simultaneous equations system of Amemiya (1994) and resembles the Kuhn-Tucker model of Wales and Woodland (1983); it also avoids the conditions for statistical coherency, needed for the other approaches, which are difficult to impose for flexible functional forms (van Soest and Kooreman, 1990). Estimation details including the sample likelihood function and elasticity calculations are described in Yen, Lin, and Smallwood (2003).

C. Elasticity estimates

Uncompensated own-price, cross-price, and food expenditure elasticities for the 12 food categories are reported in Table 2. All own-price and expenditure elasticities are statistically different from zero at the 1% significance level, except for the omitted food category "mixtures".

Juice and other beverages have the largest own-price elasticities of –1.17 and –1.09, respectively. The own-price elasticities for vegetables and non-juice fruits are found to be –0.72 and –0.81, respectively. Three previous studies have provided own-price elasticities for low-income households: Park et al. (1996) reported the least elastic demand (–0.32 for vegetables and –0.34 for fruits); Raper, Wanzala, and Nayga (2002) reported the most elastic demand (–0.98 for vegetables and fruits combined); while Huang and Lin (2000) found own-price elasticities of –0.66 for fruits and –0.74 for vegetables.

The own-price elasticity for fluid milk is estimated to be –0.79, compared with –0.98 reported by Raper, Wanzala, and Nayga (2002) and –0.78 by Huang and Lin (2000) for total dairy products. Park et al. (1996) found an own-price elasticity of –0.53 for fluid milk. In sum, our estimated own-price elasticities are within the range of elasticities reported in the literature.

III. TARGETED INCENTIVE: THE PRICE SUBSIDY OPTION

To investigate the effect of a price subsidy for under-consumed foods, we consider a scenario with a 10% subsidy for fruits (juice and non juice), vegetables and fluid milk purchased by food stamp households. Figure 1 shows the costs of two policy scenarios: a price subsidy and an increase in food stamp benefits. The initial equilibrium price is at P_0 and quantity at Q_0. A price subsidy lowers the effective price to P_1 and increases quantity demanded to Q_1, along the demand curve D_0. Consumer response to a price subsidy depends on three components—price elasticity, current (pre-subsidy) quantity consumed, and price subsidy. The dollar value of the price subsidy is determined by the percentage of price subsidy (10% by assumption) and market equilibrium prices before and after the subsidy. The equilibrium price is determined by demand and supply. In Figure 1, the cost of a price subsidy of $\Delta P = P_0 - P_1$ is represented by the sum of areas C, E and F.

A. Assumptions

We assume that retail supply response to demand changes from food stamp participants is perfectly price elastic. This is a reasonable assumption since national data indicate that spending on fruits, vegetables, and milk by food stamp households accounts for only 3–5% of total U.S. spending on these food products. According to USDA administrative data for Fiscal Year 2008, the majority of food stamp benefits are spent in large stores: 87% of benefits were redeemed in superstores, supermarkets, or large grocery stores. Only 4% of the benefits were redeemed in convenience stores and another 4% in small to medium grocery stores. The NFSPS data show that the average distance to the nearest supermarket was 1.8 miles for food stamp participants, but they traveled on average 4.9 miles to the store they most often frequented. These data suggest food stamp households typically bypassed nearby supermarkets for shopping and hence support our assumption of a perfectly price elastic supply curve. Nevertheless, it has been documented that food stamp households may make up a much larger percentage of retailer clientele in some localities so that some food stamp households may face positively slopped supply curve (Sastry, Pebley, and Zonta, 2002). Under this condition, the estimated increases in consumption from price subsidy should be treated as upper bounds.

To estimate the change in each quantity we need to employ the general equilibrium demand elasticity to address feedback effects between markets (Buse, 1958). Subsidies apply only to fruits (juice and non-juice), vegetables and milk so that prices of un-subsidized foods remain unchanged. Among the four subsidized food groups, only non-juice fruits and milk are found to have significant cross-price elasticities. Insignificant cross-price elasticities are treated as zeros.

Consistent with current SNAP policy, we assume the food stamp benefits can only be used at retail (at-home) food outlets and not for away from home and commercial outlets. Further, we assume that price subsidies would be targeted at the retail market level for foods which contain mainly the subsidized foods. For example, subsidies would be applied to fresh apples and apple juice, but not for mixtures containing apples such as apple pies. Further, foods sold at commercial food service establishments are not subsidized. This assumption calls for separation of food consumed at home and away from home.

B. *Food consumption and distribution*

By applying the 10% price subsidy to the estimated price elasticities, we can obtain the percentage increase in consumption. The pre-subsidy consumption level is needed in order to translate the increase in percentage into physical amount. As discussed above, the subsidy is applied to at-home food consumption and the demand elasticities are for at-home consumption, we need to estimate the at-home share of total consumption level. The NFSPS data can be used to estimate food consumption at home but not away-from-home. Given the same increase in at-home consumption, the improvement in the total diet shrinks when the at-home share declines.

We use data from the 1999–2002 National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC, 2005) to estimate how much food is consumed by food stamp recipients and the shares consumed at home and away from home. The NHANES sample is nationally representative of non-institutionalized persons residing in the U.S. Respondents reported their 24-hour dietary intakes at home and away from home as well as food stamp benefits that had been received.

During 1999–2002, individuals receiving food stamp benefits on average consumed 1.39, 1.26 and 0.89 cups of dairy products, vegetables, and fruits (juice and non-juice). The at-home shares are estimated to be 74% for vegetables, 76% for juice, and 80% for non-juice fruits (Table 3). Among the 1.39 cups of total dairy products consumed by food stamp recipients, 0.88 cup was fluid milk and the remainder was cheese, yogurt and other dairy products. At-home consumption accounted for 82% of fluid milk and 52% of total dairy consumption. The potential increases in total consumption resulting from and the costs associated with the price subsidy will rise with the at-home share.

C. Quantity Response to Price Subsidy

By applying the own-price elasticity estimates and the 10% price subsidy to the at-home quantity, we estimate that at-home consumption of vegetables would increase from 0.94 to 1 cup, fruit juice from 0.31 to 0.35 cup, non-juice fruits from 0.38 to 0.42, and fluid milk from 0.72 to 0.79 cup (Table 4). Total consumption of vegetables (at and away from home) is predicted to increase to 1.33 cups (from 1.26 cups), fruits to 0.97 cup (from 0.89 cup), and milk and dairy products to 1.45 cups (from 1.39 cups).

The effectiveness of the price subsidy can be evaluated by comparing consumption gains to Federal consumption recommendations. We use the recommendations specified in the 2005 *Dietary Guidelines for Americans* (USDA/USDHHS, 2005). Food consumption recommendations are specified by energy requirements, which in turn are determined by age, gender, body weight, height, and physical activity (Institute of Medicine, 2002). The effect of physical activity on energy requirements is determined by the type, frequency, intensity, and duration of an activity. NHANES has the data on age, gender, body weight, and height, but it collects only leisure-time physical activity among individuals age 12 and above so that the data are deficient in estimating energy requirements for all respondents.

We follow the USDA's Thrifty Food Plan by assuming the low physical activity level in deriving energy requirements (Guenther et al., 2007). Under this assumption, the energy requirements are estimated to average 2,198 calories per person per day among food stamp recipients and the corresponding recommendations are 2.87, 2.75, and 1.89 cups for dairy products, vegetables, and fruits. The reported consumption levels of 1.39, 1.26, and 0.89 cups for dairy, vegetables, and fruits represent 46–48 percent of their respective recommendations. Under the assumption of an active physical activity level, the estimated energy requirement for food stamp recipients averages 2,542 calories, which raises recommendations to 2.94, 3.06, and 2.02 cups for dairy, vegetables, and fruits, respectively. Note that the recommendation for vegetables is larger than that for dairy for two reasons: recommendation for dairy has a ceiling of 3 cups but 4 cups for vegetables, and the relationship between caloric intakes and recommendations is a nonlinear step function.

In terms of consumption shortfall (gap between the actual and recommended consumption levels), a 10% price subsidy is predicted to close the deficiency of vegetables by 4.7% [i.e., (1.33–1.26) / (2.75–1.26) = 0.047], fruits by 7.0%, and dairy products by 4.22%. A price subsidy of 22% is required in order to close the consumption gap by 10% for vegetables. As stated earlier, the gap between reported and recommended consumption widens as physical activity increases. Consequently, larger price subsidies are required to close the consumption gaps identified for individuals with higher activity levels.

D. Cost of the Price Subsidy

The financial cost of a price subsidy is the product of the subsidy and the quantity purchased under the discounted price (see Figure 1). As shown below, food spending and own-price demand elasticity can be used to estimate the cost of offering the price subsidy. The own-price elasticity of demand can be expressed as

$$\varepsilon = \frac{\Delta Q / Q}{\Delta P / P}, \tag{3}$$

where P and Q are the current price and consumption level, and Δ indicates the change. The price subsidy is represented by ΔP. The total cost (i.e., subsidy outlay) (TC) can be expressed as a function of current spending PQ and the elasticity ε for a price subsidy $\Delta P/P$:

$$TC = (\Delta P)(Q + \Delta Q) = PQ\left[\frac{\Delta P}{P} + \left(\frac{\Delta P}{P}\right)^2 \frac{\Delta Q}{\Delta P}\frac{P}{Q}\right] = PQ\left[\frac{\Delta P}{P} + \left(\frac{\Delta P}{P}\right)^2 \varepsilon\right]. \tag{4}$$

Equation (4) suggests total cost can be decomposed into two components: the cost under pre-subsidy consumption level, PQ ($\Delta P/P$) (area C in Figure 1), and the cost associated with increased consumption, PQ $(\Delta P/P)^2$ ε (area $E + F$ in Figure 1).

We use data from the 2004 Consumer Expenditure Survey (CEX), collected by the Bureau of Labor Statistics, U.S. Department of Labor (2004) to estimate household spending on fruits, vegetables, and fluid milk for home consumption among food stamp recipients. In 2004, households that received food stamp benefits spent \$2.73 billion on vegetables, \$2.58 billion on fruits (\$1.70 billion on non-juice fruits and \$0.87 billion on fruit juice), and \$1.48 billion on fluid milk at retail outlets for home consumption. Using Equation (4), we estimate an annual outlay of $293 million for vegetables, $281 million for fruits (including $184 million for non-juice fruits and $97 million for fruit juice), and $160 million for fluid milk to pay for a 10% price subsidy.

IV. NON-TARGETED INCENTIVE: RAISING FOOD STAMP BENEFIT

Research has consistently shown that food stamp benefits increase food spending more than an equal amount of income (Fox, Hamilton, and Lin, 2004). Given an increase in food expenditure resulting from an increase in food stamp benefits, the expenditure elasticities obtained from the food demand system estimation can be used to predict consumption increases. In Figure 1, an increase in food stamp benefits shifts the demand curve from D_0 to D_1, and the cost of increase quantity demanded from Q_0 to Q_1 (as achieved by the subsidy) is represented by the sum of areas *B*, *E* and *F*. This cost is determined by the initial price and quantity demanded and the new quantity demanded, which depends on consumer response to an increase in food stamp benefits.

A. Quantity Response to Increased Food Expenditure

The expenditure elasticities for food stamp households are found to be 1.03, 1.19, 1.06, 1.15, and 1.10 for fluid milk, other dairy, vegetables, non-juice fruits, and fruit juice, respectively (Table 2). These expenditures are for food purchased at retail outlets for home consumption. To illustrate, we assume that food stamp benefits are raised sufficiently to bring about a 10% increase in food expenditure. Later, we will estimate the increase in food stamp benefits in order to induce a 10% increase in food spending.

By applying the expenditure elasticity estimates and the 10% increase in food expenditure, we estimate that at-home consumption of vegetables would increase from 0.94 to

1.04 cups, fruit juice from 0.31 to 0.35 cup, non-juice fruits from 0.38 to 0.43 cup, fluid milk from 0.72 to 0.8 cup, and other dairy products from 0.37 to 0.41 cup (Table 3). Total consumption of vegetables is predicted to increase to 1.36 cups (from 1.26 cups), fruits to 0.97 cup (from 0.89 cup), and dairy products to 1.5 cups (from 1.39 cups). These increases in consumption are predicted to close the consumption shortfalls by 7–8% for vegetables, fruits, and dairy products.

B. Cost of Raising Food Spending

The MPS on food (MPS_f) out of food stamp benefits has received considerable interest in the past three decades. Two comprehensive reviews of the literature indicate that a dose-response regression model is a popular approach to estimate MPS_f (Fox, Hamilton, and Lin, 2004; Fraker, 1990). The estimates of MPS_f vary by the data used and models specified, with reliable estimates ranging from \$0.17 to \$0.47 increase in food spending for every \$1 increase in food stamp benefits.

We estimate the MPS_f using the 1996–97 NFSPS data which contain information for food stamp benefits and income. Data used in previous studies on the topic are outdated. Following the literature (Levedahl, 1995; Senauer and Young, 1986), we estimate a double-log model of food expenditure. Specifically, household food expenditure (M) per capita is regressed on total income (sum of food stamp benefits (S) and other sources of income (Y)) per capita, ratio of food stamp benefits to total income, and a vector of shifter variables (D) which includes the number of meals consumed by the household, free food (ratio of value of free food to total food expenditure), race, and regional and seasonal dummy variables, as shown in Equation (5):

$$\log(M) = \alpha_1' D + \alpha_2 \log(S+Y) + \beta \frac{S}{S+Y}, \tag{5}$$

where scalars α_2 and β and vector α_1 are parameters to be estimated.

Judging from the signs of parameter estimates, the *t*-values, and adjusted *R*-squared, the results are deemed satisfactory (Table 5). MPS_f can be derived by differentiating Equation (5) with respect to food stamp benefits gives the MPS_f:

$$MPS_f = \frac{\partial M}{\partial S} = \frac{M}{S+Y}\left(\alpha_2 + \beta \frac{Y}{S+Y}\right). \quad (6)$$

Using the parameter estimates for α_2 and β and at the mean monthly values of household food stamp benefits (i.e., \$163), food expenditure (\$215), total income (\$855), MPS_f out of food stamp benefit is estimated to be \$0.22 (s.e. = 0.03) for each additional dollar of food, which falls within the range of \$0.17–\$0.47 reported in the literature.

With a mean food expenditure of \$215 and an MPS_f of \$0.22, a 10% increase in food expenditure (i.e., \$21.5) would require an increase of approximately \$100 in food stamp benefits (21.5 divided by 0.22). In 2006, there were 11.7 million households receiving food stamp on average; therefore it would cost about \$1.14 billion of food stamp benefits each month and approximately \$14 billion a year to induce a 10% increase in food expenditure by food stamp participants.

For the purpose of comparing the two economic incentives, we scale back the cost of increasing food stamp benefit to \$734 million a year-—the cost of providing a 10% price subsidy. Under such a cost, food stamp recipients would increase their food expenditure by about 0.5% and narrow their consumption deficiencies of fruits, vegetables, and dairy products by 0.35–0.40%, much smaller than the 4–7% projected under the price subsidy alternative.

V. CONCLUSION

It has been documented that Americans, especially low-income individuals who receive food stamp benefits, need to improve their diets. The Federal government, USDA in particular, is interested in implementing cost effective strategies to increase consumption of fruits, vegetables, and dairy products. Price subsidy and food stamps are two economic strategies under consideration. The objective of this study is to estimate the cost associated with a unit increase in consumption for the two economic strategies so that their effectiveness can be compared to alternative strategies, such as nutrition education campaign.

With a 10% price subsidy for these foods purchased at retail outlets for home consumption, total (at home and away) consumption of vegetables is predicted to increase from 1.26 cups to 1.33 cups per day (compared with 2.75 cups recommended of an inactive physical activity level), fruits from 0.89 cup to 0.97 cup (1.89 cups recommended), and dairy products from 1.39 cups to 1.45 cups (2.87 cups recommended). Such increases would close the gap between actual consumption and the recommended levels of vegetables by 4.7%, fruits by 7.0%, and dairy products by 4.22%. This 10% price subsidy is predicted to cost $293 million for vegetables, $281 million for fruits, and $160 million for dairy a year.

Another policy alternative is to increase food stamp benefits. Our expenditure elasticity estimates suggest that a 10% increase in food spending would increase the consumption of vegetables to 1.36 cups, fruits to 0.97 cups, and milk to 1.5 cups. These increases would close the consumption gaps by 7–8%. To induce a 10% increase in food spending, it would require an increase of food stamp benefits by about $100 per household per month, or an annual cost of $14 billion.

Demands for food have been found to be price inelastic. Therefore, price manipulations alone will not induce large consumer responses. Taxing unhealthy food to improve diets and combat obesity has received heightened attention, but the empirical literature suggests that consumers are not very responsive to taxes on salty snacks (Kuchler, Tegene, and Harris, 2008).

This is the “first fundamental theorem of taxation: a tax has little effect on inelastic goods” (McCloskey, 1982, p. 309).

It is important to point out that even though the increase in consumption appears to be small, it could result in substantial economic benefits by reducing cases of diet-related illness especially when there are a large number of individuals who consume just below the recommended amount. The 1999–2002 national data indicate that 18.5% and 10.7% of food stamp recipients met the recommended consumption levels of fruits and vegetables. Only 19.7% and 11.5% of individuals consumed at least 95% of the recommended amounts for fruits and vegetables, with only a very small proportion of the sub-population consuming just below the recommended amount. In fact, only slightly over one-third of the food stamp recipients consumed at least half of the recommended amounts; the rest consumed considerably less. Therefore, the increased consumption under the two economic strategies will not direct many food stamp recipients toward the current dietary recommendation. We also note that the U.S. population in general also under-consume fruits, vegetables, and dairy products. According to Huang and Lin (2000), the own-price elasticities do not vary much by household income so that high-income households also exhibit inelastic food demands. Therefore, our findings about the effectiveness of price subsidy among food stamp households also apply to households with higher income.

In this study, we make no attempt to estimate the nutritional and health benefits of increased consumption. These estimates are useful to policy makers. Starting from 1980, the Federal government has revised dietary guidelines every five years to help Americans make healthy food and lifestyle choices. A dietary guideline advisory committee is convened to review the scientific evidence in updating the guidelines. The nutritional and health benefits of consuming fruits, vegetables, whole grains, and milk are reviewed and recommendations specified in the 2005 *Dietary Guidelines for Americans*. The economic measure of health benefit from improved diet can play an important role in the deliberation of dietary guidelines. Cash, Sunding, and Zilberman (2005) conducted a Monte Carlo simulation to estimate the cost of saving a statistical life by subsidizing the purchase of fruits and/or vegetables. They found that subsidizing the purchase of fruits and vegetables is more cost effective in saving life, compared to many government programs, such as the federal toxics and pesticide programs. In our study, we use the most recent food use data for food stamp receiving households to estimate their food demands and to calculate fruit, vegetable, and milk consumption at and away from home. Although somewhat dated, the NFSPS data allow us to address the effects of the specific policy tools on the targeted population. Our research aims at estimating the cost associated with increased consumption. Further studies might consider estimating the nutritional effects of changing consumption, perhaps along the lines of Beatty and LaFrance (2005).

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TABLE 1

Sample Statistics: Food Consumption by Food Stamp Receiving Households

	Full Sample (*n* = 900)		Consuming Households		
Product	**Mean**	**SD**	**% Consuming**	**Mean**	**SD**
Expenditures (dollars / week)					
Other dairy	4.21	6.64	85.00	4.95	6.94
Fats & oils	1.25	1.52	87.00	1.43	1.55
Grains	9.39	8.54	99.78	9.41	8.54
Meat	11.59	11.52	97.11	11.94	11.51
Poultry	3.12	3.58	81.44	3.83	3.61
Fish	2.06	5.23	52.44	3.94	6.70
Eggs	0.75	0.84	82.67	0.91	0.84
Vegetables	7.27	6.87	99.00	7.35	6.87
Non-juice fruits	2.77	3.32	77.78	3.57	3.37
Fruit juice	1.80	2.41	62.78	2.86	2.48
Other drinks	4.74	6.74	95.11	4.98	6.82
Milk	2.99	3.05	86.78	3.44	3.03
Quantities (lbs. / week)					
Other dairy	2.44	3.38		2.87	3.49
Fats & oils	1.22	1.51		1.40	1.54
Grains	7.07	6.42		7.08	6.42
Meat	6.59	6.76		6.79	6.76
Poultry	2.19	2.58		2.69	2.62
Fish	0.83	1.75		1.58	2.15
Eggs	0.98	1.02		1.19	8.64
Vegetables	9.40	8.65		9.49	8.64
Non-juice fruits	4.06	5.22		5.22	5.38
Fruit juice	3.57	5.40		5.68	5.88
Other drinks	10.38	13.65		11.55	10.17
Milk	10.03	10.25		2.37	2.75
Prices (dollars / lb.)					
Other dairy	2.04	1.12		2.04	1.20
Fats & oils	1.12	0.52		0.12	0.56
Grains	1.42	0.53		1.42	0.53
Meat	1.93	0.76		1.93	0.77
Poultry	1.68	0.94		1.68	1.03
Fish	2.77	1.70		2.65	2.20
Eggs	0.79	0.28		0.78	0.31
Vegetables	0.87	0.42		0.87	0.43
Non-juice fruits	0.77	0.33		0.77	0.37

Fruit juice	0.66	0.35		0.65	0.43
Other drinks	1.75	3.56		1.76	3.64
Milk	0.32	0.10		0.32	0.10
Demographic variable					
Household size	3.01	1.81			

TABLE 2

Uncompensated Price and Total Expenditure Elasticities

Product	**Milk**	**Other Dairy**	**Fats & Oils**	**Meat**	**Poultry**	**Fish**	**Egg**
Milk	–0.790***	0.045	–0.048	–0.092	0.060	–0.070	0.005
Other dairy	0.022	–0.847***	–0.011	0.049	–0.007	–0.021	–0.027*
Fats & oils	–0.120	–0.034	–0.654***	0.105	–0.120**	–0.098	–0.050
Meat	–0.026	0.041	0.018*	–0.758***	–0.056**	0.025	0.000
Poultry	0.057	0.009	–0.039*	–0.140**	–0.831***	–0.137***	–0.040**
Fish	–0.081	–0.048	–0.044*	0.004	–0.164***	–0.815***	0.007
Egg	0.021	–0.128*	–0.073	0.006	–0.171	0.045	–0.471***
Grains	0.023	–0.067**	0.002	–0.152***	–0.004	–0.031	–0.018*
Vegetables	–0.017	–0.021	–0.025*	–0.161***	–0.015	0.061*	0.002
Non-juice fruits	–0.130**	–0.092*	0.004	–0.019	0.039	–0.131**	0.013
Juice	0.008	–0.002	0.021	–0.083	0.055	–0.055	–0.019
Other drinks	0.013	–0.055	0.003	0.030	0.018	0.014	–0.001

TABLE 2

Continued

Variable	Grains	Vegetables	Non-juice Fruits	Juice	Other Drinks	Total Expenditure
Milk	0.045	–0.033	–0.118**	0.010	0.025	1.031***
Other dairy	–0.146***	–0.051	–0.063*	–0.002	–0.063**	1.189***
Fats & oils	–0.019	–0.138*	0.011	0.043	0.006	1.150***
Meat	–0.117***	–0.095***	0.004	–0.016	0.025	0.990***
Poultry	0.000	–0.011	0.042	0.046	0.037	0.920***
Fish	–0.124**	0.068	–0.129***	–0.049	–0.007	1.334***
Egg	–0.156*	0.026	0.055	–0.053	0.006	0.952***
Grains	–0.550***	–0.122***	–0.020	0.007	–0.011	0.965***
Vegetables	–0.158***	–0.717***	–0.003	0.019	0.022	1.056***
Non-juice fruits	–0.078	–0.023	–0.813***	0.008	0.011	1.152***
Juice	0.001	0.037	0.008	–1.165***	0.088***	1.099***
Other drinks	–0.040*	0.022	0.010	0.053***	–1.087***	1.109***

Note: Asterisks *** indicate statistical at the 1% level, ** at the 5% level, and * at the 10% level.

TABLE 3

Distribution of Vegetable, Fruit, and Milk Consumption at and away from Home

Food Category	**Vegetables**	**Fruits**		**Dairy Products**	
Food Subcategory		**Non-juice**	**Juice**	**Fluid milk**	**Cheese/Yogurt**
		------------ Percent --------------			
Share by subcategory [a]		53.55	46.45	63.23	36.26
Share by eating location					
At home[b]	74.35	79.96	75.57	82.30	72.70
Away from home[b]	25.65	20.04	24.43	17.70	27.30

[a]The distribution of a sub-category in total fruits and dairy products. For example, 46% of fruit consumption was in the form of juice and 54% was consumed as non-juice fruits.

[b]The distribution between at and away from home for each category or sub-category. For example, 76% of juice was consumed at home and 24% away from home.

Source: 1999–2002 National Health and Nutrition Examination Survey.

TABLE 4

Quantity Responses to Economic Incentives (Unit = Cup)

Program	**Before program**		**Price subsidy**		**Increased Benefits**		**Recommendations**[a]	
Food group	**At Home**	**Total**	**At Home**	**Total**	**At Home**	**Total**	**Low**	**Active**
Vegetable	0.94	1.26	1.00	1.33	1.04	1.36	2.75	3.06
Fruits	0.69	0.89	0.77	0.97	0.77	0.97	1.89	2.02
Non-juice	0.38	0.48	0.42	0.52	0.43	0.52		
Juice	0.31	0.41	0.35	0.45	0.35	0.45		
Total dairy	1.09	1.39	1.16	1.45	1.21	1.50	2.87	2.94
Fluid milk	0.72	0.88	0.79	0.95	0.80	0.95		
Other dairy	0.37	0.50	0.37	0.50	0.41	0.55		

Note: Numbers may not add up due to rounding errors.

[a] Based on 2005 *Dietary Guidelines for Americans* (USDA/USDHHS, 2005) where ‘low’ is a 2,198 calorie diet and ‘active’ is a 2,542 calorie diet.

TABLE 5

OLS Estimates of Log-linear Model of Food Expenditure

(Dependent Variable = Log(Total Food Expenditure)

Variable	**Coefficient**	***t*-value**
Log (total income) [a]	0.29	7.71
Food stamp benefits / total income [b]	0.76	7.44
Log(number of meals eaten)	–0.11	–3.58
Free food/total expenditure [c]	0.01	9.00
Spring	–0.04	–0.69
Summer	–0.05	–0.87
Fall	–0.10	–1.58
Northeast	–0.15	–1.95
South	–0.18	–3.72
Midwest	–0.12	–2.32
Urban	–0.05	–1.07
Rural	–0.11	–1.87
White	0.09	1.53
Black	–0.01	–0.23
Constant	2.14	6.01
Adj. R-squared	0.21	
Sample size	918	

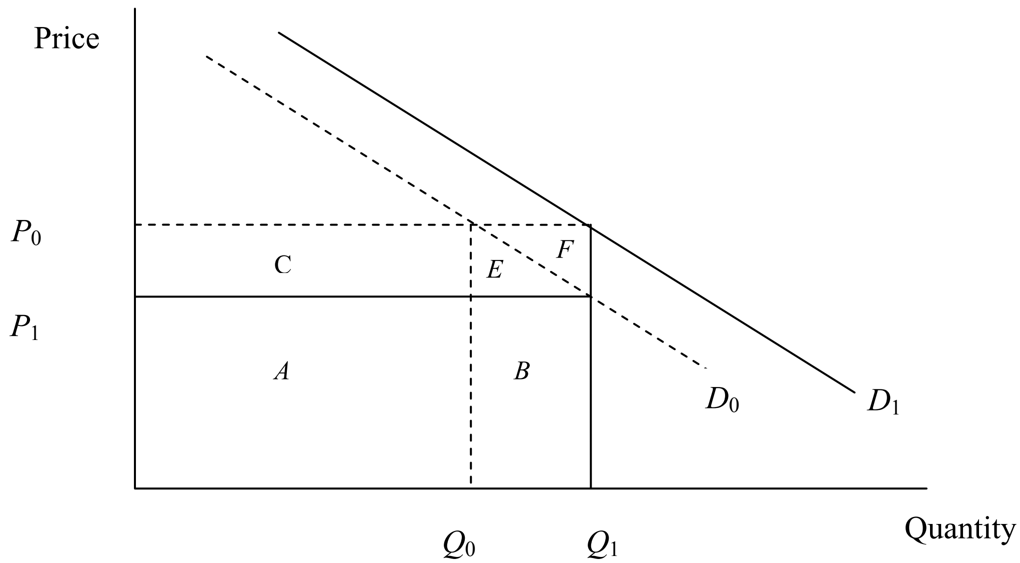
[a] Both total food expenditure and total income are deflated by household size to adjust for nutrition requirements.

[b] Total income is sum of food stamp benefits and other sources of income.

[c] Free foods obtained from sources such as community feeding program are assigned a market value.

FIGURE 1

Costs of a Price Subsidy and an Increase in Food Stamp Benefits



Cost of a price subsidy = $C + E + F$

Cost of increased food stamp benefits = $B + E + F$