Forward Looking Decision Making: The Effects of the Food Stamp Program Participation on Women's Obesity in the NLSY*

by

Ying Huang
Department of Economic
Renmin University
Shanghi, China
e-mail: huangying822@yahoo.com

and

Wallace Huffman
Department of Economics
Iowa State University
Ames, IA
e-mail: whuffman@iastate.edu

Abstract

This paper formulates and estimates a structural intertemporal model of a woman's household participating in the Supplemental Nutrition Assistance Program (SNAP) and her likelihood of being obese. We use an economic model of lifetime behavior in a finite life model to provide the structure of the econometric model, instrumental variable estimation is applied to control for endogeneity of SNAP participation decision, and individual fixed effects control for individual heterogeneity in panel data. Primary data are the panel, NLSY 79 with geocodes. We find that if a woman is in a SNAP household her BMI and probability of being obese are reduced by 15.7% and 56.3 percentage points, respectively. However, individual fixed effects account for much of the variation in her BMI and probability of being obese, suggesting early life attention to women's weight is an important public policy issue.

Introduction

Over the past thirty-five years, the U.S. adult obesity rate has more than doubled from roughly 15% to 35%, reflecting a general diffusion of obesity across all segments of the adult population (United States Department of Health and Human Services). Obesity is a concern because it increases the risk for cardiovascular diseases, diabetes, and most forms of cancer, except for lung. In addition, when adults are obese, their labor productivity and quality of life decline, medical expenditures increase dramatically and many die prematurely. The U.S. obesity rate is the highest in the world, and obese adults are a major financial burden to families and also the U.S. Medicare and Medicaid Programs. In 2008, medical costs associated with obesity were estimated at $147 billion; the per capita medical costs paid by third-party payers for people who are obese were $1,429 higher than for those of normal weight (Ogden and Carroll 2010).

Food (and drink) purchased for at home uses is targeted by the USDA's Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program (FSP). The FSP was initiated in the 1960s when the major concern among low income households was inadequate calories and nutrition, sometimes called food insecure (Caswell and Yaktine 2013). In addition, over this time period family structure has change; single parenting has become an increasing U.S. phenomena (Phillips 2011, Sweeney 2001, Heckman, Stixrud and Urzua 2006, Heckman and Masterov 2007), and Currie and Grogger (2001) show that single parent households are roughly three times as likely to be SNAP participants as two-parent households. Roughly 87% of these households are headed by women (U.S. Census Bureau 2012).

Currently, SNAP benefits can be used to purchase most foods and beverages sold in grocery stores and supermarkets for home consumptions, including nutrient-rich whole grains, fruit, and vegetables as well as nutrient-poor salty snacks, sweets, baked goods, and sugar-sweetened beverages, milk and dairy products, and processed and raw meats. Deli, hot or prepared foods, dietary supplements, alcohol and tobacco are excluded. However, Leung et al. (2012) report that SNAP participants have higher consumption of fruit juices, potatoes, red meat and sugar-sweetened beverages and lower consumption of whole grains than other adults from low income households. They also report that SNAP participants have a lower

frequency of daily dietary intakes meeting two or more of ten food and nutrient intake guidelines than adults in other low income households.

Figure 1 charts SNAP benefits and number of participating individuals from 1970-2012. The amount of benefits and individual's participating were quite low before 1970, but the trend has been upward since then. In 1994, total benefits paid were about $38 billion (2012 dollars) with 27.5 million individuals participating, but some reforms were implemented and participation fell to 2000 and then started rising again; more rapidly with the onset of the most recent Great Recession in 2007. In 2012, benefits totaled $75.0 billion and 46.6 million individuals or 15% of the population participated. However, since 1970, FSP/SNAP

Figure 1. SNAP Participation and Total Benefits Paid, 1970-2012
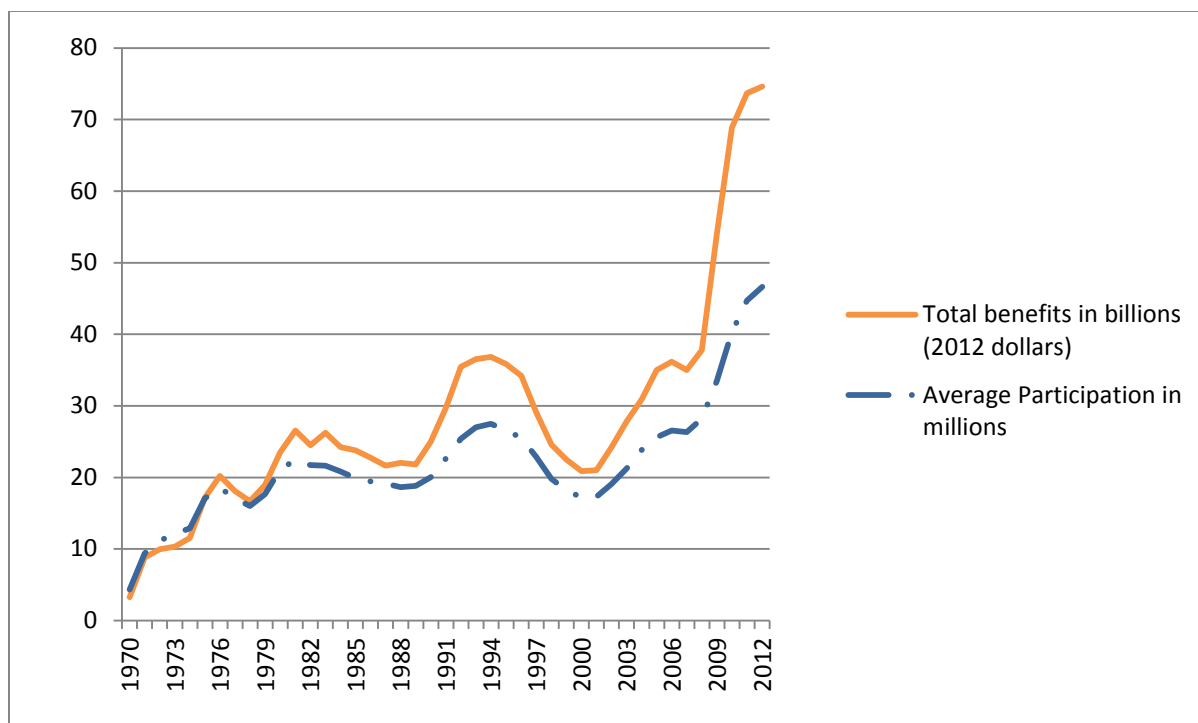
participation is approximately 1 billion person-years and $1.2 trillion (constant 2012 dol.) of benefits have been paid to recipient households. Hence, the program is expensive.

Although the FSP was launched with the aim to improve food security of low-income people, it is now frequently criticized for causing overweight and obesity in participants,

including women who are or who have been participants in the program (Ver Ploeg and Ralston 2008). Supporting this hypothesis, Chen, Yean, and Eastwood (2005), who used the data from the 1994-1996 Continuing Survey of Food Intakes by Individuals (CSFII), found that FSP participation was positively related to bodyweight and to the likelihood of women being obese. Meyerhoefer and Pylypchuk (2008), using the 2000-2003 Medical Expenditure Panel Survey (MEPS) and information on state-level FSP characteristics, found that when a woman's household participates in the FSP, she was 5.9% more likely to be overweight or obese and also to have higher medical expenditures. Gibson (2003, 2004), using a short panel and a static model, found that both current and long-term FSP participation were significantly related to the obesity of women. Baum (2010) used models assuming one period decision making and the NLSY data, subsample of low income men and women, to explain weight changes over time and relate it to current and past participation in the FSP. He found that FSP participation has a significant positive effect on obesity, but the effect is relatively small. In a study related to the current one, Huang and Huffman (2012), using a model of single-period decision making and the NLSY79 panel, found that women in households that currently participated in SNAP had a higher BMI and also a higher probability of being obese.

Some shortcomings of this literature include: the use of static one-period models of decision making and overlooking endogeneity of a household's SNAP participation. This endogeneity arises from overweight or obese women being more likely to participate in SNAP or FSP, or having higher benefits because they are more likely to suffer from health limitations resulting in lower household incomes. Even when income is held constant, SNAP participation and BMI may still be correlated. For instance, Townsend et al. (2001) found that food insecurity was positively related to the likelihood of women being obese. Meanwhile, food insecure women are more likely to participate in the FSP.

Over the past 30 years, some have alleged that falling real prices of food, increased consumption of processed and fast foods, reduced exercise and rising incomes have resulted in a general problem in the U.S. and Western Europe with people consuming too much food. Others suggest that altered birthing modes and human host-bacterial interactions, which are related to more than diet or exercise, are to blame, e.g., Nicholson et al. 2012. What is clear is

that there is a growing obesity problem, but its exact cause has not been identified. However, a known fact is that it is a new phenomenon for low income households to have sufficient purchasing power to acquire and consume enough calories to be dangerously over weight (Fogel 2004).

The objective of this paper is to identify key factors that affect women's healthy weight, as reflected in body mass index (BMI) or being obese (having a body mass index of 30 or larger), including the effects of a woman's household participating in SNAP and the prices of food and drink. To carry this out, we develop a model of household life-cycle utility maximization subject to the technology of health production, time and wealth constraints. Dynamic programming analysis of this utility maximization problem provides insights for the structure of the econometric model, instrumental variable estimation is applied to control for endogenous SNAP participation, and individual fixed effects are used to control for unchanging individual heterogeneity.

The econometric model is fitted to panel data consisting of individual-level data on adult women for the National Longitudinal Survey of Youth, 1979 Cohort (NLSY79). This is a data set of women with diverse household incomes, but earlier studies that have focused only on poor women may have used an un-necessarily restrictive sample because women's economic status can change abruptly due to sudden unemployment or divorce. Our panel data are augmented with area level prices on food, drink and simple health care items obtained from the American Chamber of Commerce Research Association (ACCRA) Cost of Living Index. Access to geocode data in the NLSY is what enables us to link the women in the NLSY to secondary data on local food, drinks and health care prices as well as labor market conditions.

This paper provides new insights on women's obesity in the United States and makes contributions to the literature in the following ways. First, we develop an economic model to support the use of the instrumental variable strategy and individual fixed effects in our empirical model. This step is missing in most previous studies. Second, most economists have used data for a single cross-section or one round of a panel survey to examine the relationship between SNAP participation and BMI or obesity. With our longitudinal panel

data, we bring more information to bear on the econometric model. Third, most findings in the literature are challenged because they overlooked the endogeneity of SNAP participation. The methodology used in this paper can also be applied to analyze and evaluate other government policies that aim to improve participants' nutrition or health.

The rest of the paper is organized as follows. In Section 2, we develop a theoretical model of decision making, derive the econometric model, and discuss important hypotheses to be tested. In Section 3, we introduce the primary and secondary data sets to be used and describe the sample. Section 4 presents empirical results. Section 5 concludes. Appendix I provides detailed information on the food items in each food category and gives an example of how to calculate the relative price of each food category. Appendix II is the questionnaire used to collect data on non-cognitive abilities in NLSY79.

A Life-Cycle Model of Household Decision Making

We develop a model of decision making by the head of a household who is forward-looking. Hence, the household head maximizes the household's lifetime utility, assuming no uncertainty. She/he makes decisions on life styles at the beginning of adult life and sticks to them in each following period. The corresponding empirical econometric model is least squares IV with individual fixed-effects. This type of model was popularized by MaCurdy (1981) for labor supply studies.

Theoretical Model

The particular conceptual model developed here is based on the life-cycle model discussed in Blundell and McCurdy (1999). In this model, marginal-utility-of-wealth-constant labor supply functions, known as Frisch functions, provide an extremely useful method for analyzing life-cycle decision problems, and also lay out the theoretical foundation for using individual fixed effects in an associated econometric model.

The representative household makes its lifetime decisions on labor supply, leisure activities, consumption (including food, medical care and other consumption goods), demand for health status and participation in SNAP according to the value function at time t, with κ representing the household's utility discount factor:

$$V(A_t, t) = \max\left[U(F_t, C_t, H_t, LP_t, LO_t; Z_t, \varphi) + S(FS_t; Z_t, \varphi) + \kappa V(A_{t+1}, t+1)\right].\text{[1]}$$

Here $U(\cdot)$ is a strictly concave utility function of goods consumed, in which F_t represents the food and drink consumed in period t; C_t represents all other consumption of goods excluding purchased medical care in period t; H_t represents the current health status of the household members in period t; LP_t represents physically active leisure time in period t; LO_t represents other types of leisure time in period t; Z_t denotes the observable characteristics of the household, such as the household head's gender, race, education, family structure, urban residency and so on; and ϕ denotes other unobservables impacting the household's preferences. In the utility function, food and drink, other consumption goods, current health, and other types of leisure time are assumed to provide a positive marginal utility, while physically active leisure time is assumed to provide a negative marginal utility. We also assume that participation in SNAP has a disutility, represented by $S(\cdot)$, since the literature has attributed a part of the decline in participation to the welfare-reform-related stigma (Moffitt 1983). Specifically, with FS_t representing the quantity of food purchased with the SNAP payments to the household in period t, the disutility function satisfies the following conditions:

$$\begin{cases} S(0; Z_t, \varphi) = 0, \quad S(FS_t; Z_t, \varphi) \to c_1 < 0 \text{ if } FS_t \to 0, \\ \dfrac{dS}{dFS_t} \to c_2 > 0 \text{ if } FS_t \to 0, \quad \dfrac{d^2 S}{dFS_t^2} \le 0 \end{cases}$$

In other words, if the household doesn't participate in the program, the disutility associated with participation is 0. If the household participates in the program, the disutility associated with participation is lower, bounded by a constant $c_1 < 0$, and increases as the quantity of food purchased from SNAP payments increase, which implies a positive marginal disutility. To permit a corner solution for FS_t, we also impose an upper bound, $c_2 > 0$, for marginal

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[1] Note that this value function implies two underlying assumptions. First, it assumes intertemporal strong separability of preferences. Second, the household can completely predict its income, the value of food stamps it receives and adult health status in each period. In addition, since individuals live a finite number of periods, the value function is a function. In contrast, in many stationary dynamic programs all of the time indexes are dropped, which is consistent with infinite-horizon dynamic programming.

disutility.

The household can improve the woman's current health status by its choices of food and drink, physical exercise and medical care services (denoted by *M*). Specifically, the woman's health production function is a strictly concave function given by

$$H_t = H(F_t, LP_t, M_t; Z_t, H_e, \varphi),$$

where H_e denotes the woman's early health status, and φ denotes other unobservable factors that affect the efficiency in producing good health, for instance, distress and genetic predisposition for good/bad health. Some foods, for instance, fresh fruits and vegetables that are high in fiber, vitamins and minerals, are called healthy foods because they have a positive marginal product on health output. Some foods, such as alcoholic beverages, nonalcoholic beverages and fast food that contain added sugar, and added salt and fat, are called unhealthy foods when they have a negative marginal product in the production of good health. Finally, in each period, the household receives an endowment of time *T* that is allocated to work for pay L_t, physically active leisure LP_t, and other types of leisure LO_t, i.e., $L_t + LP_t + LO_t = T$.

Let the price of *C* be the numeraire good with a price of 1. P_j denotes the real price of good *j*, and *W* denotes the real wage rate. Then, the household intertemporal budget constraint can be represented by the time path of assets, *A*, as:

$$A_{t+1} = (1 + r_{t+1})[A_t + B_t + W_t L_t - C_t - P_{F,t}(F_t - FS_t) - P_{M,t}M_t],$$

where A_{t+1} is the real value of assets at the beginning of period $t+1$, r_{t+1} is the real rate of return earned on assets between t and $t+1$, and B_t represents unearned-non-asset income. Note that since SNAP can be used to purchase food and drink, $(F_t - FS_t)$ is the amount of food and drinks that the household purchases out of its own pocket.

Therefore, the representative household chooses total food, food from SNAP income, (good) health, active leisure, other leisure (labor supply), quantity of other consumption goods (C_t) and assets at ($t +1$) by maximizing the value function:

$$V(A_t, t) = \max \left[U(F_t, C_t, H(F_t, LP_t, M_t; H_e, Z_t, \phi), LP_t, LO_t; Z_t, \varphi) + S(FS_t; Z_t, \varphi) + \kappa V(A_{t+1}, t+1) \right],$$

subject to:

$$A_{t+1} = (1+r_{t+1})(A_t + B_t + P_{F,t}FS_t + W_tT - W_tLP_t - W_tLO_t - C_t - P_{F,t}F_t - P_{M,t}M_t).$$

Thus, we have the Lagrange equation:

$$L_t = U(F_t, C_t, H(F_t, LP_t, M_t; H_e, Z_t, \phi), LP_t, LO_t; Z_t, \varphi) + S(FS_t; Z_t, \varphi) + \kappa V(A_{t+1}, t+1)$$
$$+ \lambda_t[A_t + B_t + P_{F,t}FS_t + W_tT - W_tLP_t - W_tLO_t - C_t - P_{F,t}F_t - P_{M,t}M_t - \frac{A_{t+1}}{1+r_{t+1}}].$$

Standard dynamic programming techniques yield the following first-order conditions:

$$\begin{cases} \dfrac{\partial U_t}{\partial F_t} + \dfrac{\partial U_t}{\partial H_t} \cdot \dfrac{\partial H_t}{\partial F_t} = \lambda_t P_{F,t} \\[2mm] \dfrac{\partial U_t}{\partial C_t} = \lambda_t \\[2mm] \dfrac{\partial U_t}{\partial H_t} \cdot \dfrac{\partial H_t}{\partial M_t} = \lambda_t P_{M,t} \\[2mm] \dfrac{\partial U_t}{\partial LP_t} + \dfrac{\partial U_t}{\partial H_t} \cdot \dfrac{\partial H_t}{\partial LP_t} = \lambda_t W_t \\[2mm] \dfrac{\partial U_t}{\partial LO_t} = \lambda_t W_t \\[2mm] \dfrac{dS}{dFS_t} + \lambda_t P_{F,T} \leq 0, \ FS_t \geq 0, \ FS_t(\dfrac{dS}{dFS_t} + \lambda_t P_{F,T}) = 0 \\[2mm] \dfrac{\partial V_{t+1}}{\partial A_{t+1}} = \dfrac{\lambda_t}{\kappa(1+r_{t+1})} = \lambda_{t+1}. \end{cases}$$

Basically, these first-order conditions imply that the household chooses such that the marginal returns from these choices equal the marginal costs associated with them. Specifically, the first-order condition with respect to FS_t indicates that the household would choose not to participate in SNAP when the marginal return from participation $\lambda_t P_{F,t}$ is less than the marginal disutility $-\dfrac{dS}{dFS_t}$, and vice versa. The last equation in the set above is also called the Euler equation, in which λ_t is the Lagrange multiplier of the intertemporal budget

constraint, representing the marginal utility of wealth $\frac{\partial V_t}{\partial A_t}$, by the Envelope theorem.[2]

These first-order conditions imply that the demand functions for different goods (F^*, FS^*, C^*), medical care (M^*), time allocation of adults (LP^*, LO^*, L^*), adult health status (H^*) are of the form:

$$\begin{cases} F_t^* = F(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon) \\ C_t^* = C(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon) \\ M_t^* = M(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon) \\ L_t^* = L(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon) \\ LP_t^* = LP(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon) \\ LO_t^* = LO(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon) \\ FS_t^* = FS(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon) \\ H_t^* = H(F_t^*, LP_t^*, M_t^*; Z_t, H_e, \phi) = H(\lambda_t, P_{F,t}, P_{M,t}, W_t; Z_t, H_e, \varepsilon), \end{cases}$$

where ε includes ϕ and φ, i.e., all the unobservable factors that affect the household's preferences and efficiency in accumulating good health of adults.

The above set of equations reveals the set of variables that explains the above seven behavioral outcomes, and also provides the structural model for our empirical analysis. Goods consumption, labor supply and health status merely depend on components observed in the current period: the current prices of food and drink $P_{F,t}$, the current price of medical services $P_{M,t}$, the current wage rate W_t, the household current observable characteristics Z_t, as well as λ_t, which summarizes the relevant information from all other periods. Variables such as future wealth, wages, or personal characteristics affect current behavioral outcomes only through the change of λ_t.

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[2] In particular, this equation is obtained by combining two conditions. If we iterate forward one period and then differentiate the value function with respect to A_{t+1}, we obtain $dV(A_{t+1}, t)/dA_{t+1} = \lambda_{t+1}$. To get the other equation, directly substitute the constraint into $V(A_{t+1}, t)$ and differentiate the left side and right side of the Bellman equation to obtain $dV(A_t, t) = \kappa(1 + r_{t+1})dV(A_{t+1}, t)/dA_{t+1}$. Combining these two equation, $\lambda_t = \kappa(1 + r_{t+1})\lambda_{t+1}$.

The Euler equation implies a time path for λ of the form:

$$\ln \lambda_{t+1} = -\ln(\kappa(1+r_{t+1})) + \ln \lambda_t = b_t + \ln \lambda_t.$$

Repeat substitutions yield:

$$\ln \lambda_t = \sum_{j=0}^{t-1} b_j + \ln \lambda_0,$$

where $b_t = -\ln(\kappa(1+r_{t+1}))$. Hence, λ_t in the outcome functions can be divided into two parts: λ_0, which can be treated as an unobservable individual fixed effect, plus b_t, which depends on the interest rate and the household's utility discount rate that can be captured by observable individual characteristics (age and its squared term by Blundell and McCurdy [1999]). This provides the fundamental structure of the individual fixed effects model that is incorporated into our econometric model of obesity and SNAP participation.[3]

Comparative static results for the model are difficult to derive because substitution effects and income effects of various foods and consumption goods are unclear, and also because it is hard to specify the characteristics of the health production function. For example, if the household participates in the SNAP in period t, λ_t will fall because an increase in food from SNAP is an increase in wealth combined with diminishing marginal utility. Holding other factors constant, the household increases adult's other leisure time and consumption of other goods in the current period. But it is hard to predict the changes in food consumption and physically active leisure time, and thus health status as a result.

Alternatively, if the household does not participate in the SNAP and the price of medical services increases marginally, holding other factors constant, the household will reduce consumption of medical services, and resort to a healthier diet (with eating more healthy food and less unhealthy food) and more physical exercise to build up good health. The household will also increase the labor supply to compensate for the higher living cost, and as a result, the time for other leisure activities would decrease. But we do not know for sure whether the adult's health status will be better, worse, or even remain unchanged, or whether the

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[3] This economic model provides one plausible rationale for using individual fixed effects to represent random individual effects at the beginning of the decision making period. However, other research might develop other rationales for using the individual fixed effects models.

consumption of other goods would change at all. Because SNAP can be used to purchase more or less healthy foods, it becomes more difficult to predict the effect of a change in the price of medical services.

A marginal increase in the price of healthy foods will have stronger negative effects since the declined consumption of healthy foods does not only worsen the health status, but also directly decreases the household utility. The household will attempt to increase income and input of medical services and physical activities to build up good health. Again, for the households that participate in SNAP, if they can somehow offset the negative effects by using the subsidy more wisely, the changes in their consumption behavior and health status may be moderated.

The effects of an increase in the price of unhealthy food and drink are more complicated. A marginal increase in the price is expected to reduce a individual's consumption, which directly decreases the household's utility, but also increases the household's utility indirectly by improving the individual's health status. Thus, the net change in utility depends on which effect is dominant. Some unhealthy drinks, such as sweet soda, can be purchased using SNAP. As a result, their price effects will be different for households that participate in SNAP and those that do not. On the other hand, alcohol, cannot be purchased using SNAP. Thus, their price effects will be the same irrespective of whether the household participates in SNAP.

Now, let us take a look at the individual fixed-effect term λ_0. Inserting the optimal demand functions into the intertemporal budget constraint gives us

$$A_{t+1} = (1 + r_{t+1})[A_t + B_t + W_t L_t^* - C_t^* - P_{F,t}(F_t^* - FS_t^*) - P_{M,t} M_t^*],$$

which is an implicit function for λ_t or λ_0. Although we cannot obtain the explicit function of λ_0, we at least know that it depends on the household's asset values at the beginning and at the end of each period, the unearned-non-asset income, the cost of goods, the real wage rate and all the unobservable factors that affect the household's preferences and efficiency in accumulating good health of adults.

Although we can make some predictions about household behaviors based on normal

assumptions as discussed above, we cannot draw explicit conclusions, because they require an explicit and restrictive functional form. Hence, the theoretical model provides only a broad framework for viewing intertemporal household decisions under finite life conditions.

The Econometric Model

The econometric model focuses on estimating a structural equation for women's health status (Equation 1) and reduced-form equations for women's household decision on the SNAP participation (Equation 2) and for women's market wage or opportunity cost of time (Equation 3). *MSA* and *Inc* are include in the FSP equation and *Age*NonCogScale* in the ln(Wage) equation but excluded from the BMI and Obesity equations to aid with identification. Hence, an instrumental variable estimation strategy is applied to control for endogeneity of SNAP participation and of the opportunity cost of time. This strategy reduces the problem with elaborate simultaneous equation models.

Equation 1: Health Status Equation

Based on the theoretical model, a woman's health status depends on her household's decision to participate in SNAP, her current opportunity cost of time, the current prices of local food and medical services, observable characteristics (including marriage status, the number of kids in the household and current residence region), her age and age squared, and an individual fixed effects:

$$
\begin{aligned}
\ln BMI_{it}[\text{or } Obese^*_{it}] = X_{1it}B + \mu_{1it} = & \ \beta_1 + \beta_2 D(FSP)_{it} + \beta_3 \ln Wage_{it} + \beta_4 PR\_FFruVeg_{it} + \beta_5 PR\_PFruVeg_{it} \\
& + \beta_6 PR\_Meat_{it} + \beta_7 PR\_Dairy_{it} + \beta_8 PR\_Alco_{it} + \beta_9 PR\_NAlco_{it} + \beta_{10} PR\_FF_{it} + \beta_{11} PR\_HC_{it} + \beta_{12} Age_{it} \\
& + \beta_{13} Age^2_{it} + \beta_{14} Married_{it} + \beta_{15} Kids_{it} + \beta_{16} Urban_{it} + \beta_{17} NC_{it} + \beta_{18} South_{it} + \beta_{19} West_{it} + \beta_{20} preg_{it} + \delta_{1i} + \varepsilon_{it}.
\end{aligned}
$$

$Obese^*_{it}$ is a latent variable and not observed, and what we observe is

$$
D(Obese)_i = \begin{cases} 1 & if \ Obese^*_i > 0 \\ 0 & otherwise \end{cases}.
$$

Ignoring the *t* subscript, the probability of a woman being obese can now be expressed as

$$
p_{1i} = \Pr(D(Obese)_i = 1) = \Pr(Obese^*_i > 0) = \Pr(X_{1i}B + \mu_{1i} > 0) = \Pr(\mu_{1i} > -X_{1i}B) = \Pr(\mu_{1i} < X_{1i}B) = F(X_{1i}B)
$$

where $F(\cdot)$ is a cumulative distribution function for μ_{1i}, evaluated at $X_{1i}B$. If μ_{1i} is a proper

Table 1: Symbols and a Brief Variable Definition

Variable	Definition
BMI	Body Mass Index, defined as weight/square of height (in kg/m^2)
D(Obese)	=1 if the individual was obese (BMI $\geq$ 30); =0 otherwise
D(FSP)	=1 if the individual participated in SNAP; =0 otherwise
Wage	The individual's average hourly real wage rate
PR_FFruVeg	Price of fresh fruits and vegetables
PR_PFruVeg	Price of processed fruits and vegetables
PR_Meat	Price of meat and fish
PR_Dairy	Price of diary food
PR_Alco	Price of alcoholic drinks
PR_NAlco	Price of non-alcoholic drinks
PR_FF	Price of fast food
PR_HC	Price of health care
Edu	The highest grade completed by the individual
Rotter Scale	The Rotter Internal-External Locus of Control Scale
Internal Scale	Reversed Rotter Internal-External Locus of Control Scale
Rosenberg Scale	The Rosenberg Self-Esteem Scale
Noncog Scale	Comprehensive index for non-cognitive abilities, combine Internal and Rotter Scales
Inc	Predicted household real non-labor income (in 1,000 dollars)
Age	Age of the individual
Married	=1 if the individual was married and the spouse was present; =0 otherwise
Kids	Number of children in the household
Urban	=1 if the individual lived in an urban area; =0 otherwise
MSA	=1 if the individual lived in a metropolitan statistical area; =0 otherwise
NC	=1 if the individual lived in north central or middle west; =0 otherwise
South	=1 in the individual lived in south; =0 otherwise
West	=1 if the individual lived in west; =0 otherwise
preg	=1 if the female respondent was pregnant; =0 otherwise

diffuse or uniform distribution centered at zero, it has a triangular cumulative distribution function indexed on $X_{1i}B$. Hence, $p_{1i} = \Pr(D(Obese)_i = 1) = F(X_{1i}B) = X_{1i}B$, because of the special form of $F(\cdot)$. The linear probability model for obesity is then,

$$D(Obese)_i = X_{1i}B + e_{1i}, \text{ where } e_{1i} = \begin{cases} 1 - X_{1i}B & \text{with probability } X_{1i}B \\ -X_{1i}B & \text{with probability } (1 - X_{1i}B) \end{cases}, \text{ with } E(e_{1i}) = 0.$$

Among the X_1 factors, we are particularly interested in the effect of the decision of the household to participate in SNAP. Based on our review of the literature, we hypothesize that adults who live in a household that participate in SNAP are more likely to be obese.

Second, an adult's opportunity cost of time is important to decisions on time and goods allocation. Purchasing the raw food ingredients and preparing nutritious meal for one's self and family members require a significant amount of time; some would say that it is time intensive. Women who have a high opportunity cost of time may conserve on these activities by buying more highly processed foods and fast food, which are generally considered to be of lower nutrient quality, and engaging in less physically active leisure, leading to low physical fitness or hiring a physical trainer to make for more efficient use of exercise time . Women who have a high opportunity cost of time may skimp on these activities, and it would be expected to lower their future health status and increase the probability of them being obese.

Third, households purchase food and drink to obtain nutrients for their members (carbohydrates, fats, protein, vitamins and minerals), but food and drink consumption are frequently associated with social activities and may make individuals feel good (comfort food). The demand for food and drink are expected to be price responsive, and cheap unhealthy foods have been associated with obesity (Chen 2009). Similarly, high prices for fresh fruits and vegetables are expected to reduce a household's demand for these products, which may lead to higher women's BMI or the probability of being obese. An increase in the price of processed fruits and vegetables, which generally contain significant amounts of added sugar, is expected to reduce the demand for these foods, which may lower women's BMI and the probability of being obese. An increase in the price of meat and fish is expected to reduce a household's demand for these foods, which tend to be calorie dense, and this may

lower women's BMI and the probability of being obese. Similarly, most fast foods are calorie dense, and an increase in their price is expected to reduce women's consumption of them, which may lower their BMI and the probability of being obese. We are uncertain about the effects of the prices of dairy products, alcoholic drinks and non-alcoholic drinks on women's BMI and the probability of being obese. A higher price of simple health care is expected to shift attention to lifestyle production of good health and reduce the probability that an individual is obese.

Fourth, there is strong empirical evidence that adult BMI tends to vary with age, generally increasing from young adulthood to the 60s, and then tending to decline. Hence, an individual's age is expected to have a non-linear effect on ln(BMI) and the probability that an individual is obese.

Fifth, an individual's lifestyle choices are affected by his/her family structure. Having a spouse or other adult in the household adds to the time available for supervision of children and doing household work. Also, married individuals or individuals with more children are expected to live to older ages and to choose healthier lifestyles, including a normal weight.

Sixth, an individual's current urban (versus rural) residence and regional location may affect his/her health supply because of the different costs of health production. In more rural areas, including the North Central, West and South, space for physically active leisure is cheaper, and space and good soils are more likely to be available for a vegetable garden. Finally, pregnant women tend to have a higher BMI or a higher probability of being obese.

Equation 2: Supplemental Nutrition Program Assistance

This equation explains a household's decision to participate in SNAP. Most SNAP rules are set at a federal level, but states do have a say about some administrative features such as the length of eligibility certification periods, the design of outreach programs and about any "workfare" requirements for participation in the program. Currently, SNAP operates as follows: a SNAP household is defined as either a person living alone or a group of people who live together and customarily purchase food and prepare meals together. Households have to go through an eligibility determination, and monthly cash income is the primary factor considered.

The quantity of food that can be purchased from SNAP benefits and other income are reduced when local prices of food and drink are higher because there are not local cost of living adjustments (Caswell and Yaktine 2013). Likewise, the price of simple medical services, age of adults, marriage status of adults, and the number of kids at home. For identification purposes, an index of residence in a metropolitan statistical area (*MSA*) and the amount of household non-wage income (*Inc*) are included to help identify the SNAP and BMI/Obesity equations. We argue that these variables help define the benefits to be awarded to households under the rules of SNAP.

$$FSP_{it}^* = X_{2it}\Theta + \mu_{2it} = \theta_1 + \theta_2 PR\_FFruVeg_{it} + \theta_3 PR\_PFruVeg_{it} + \theta_4 PR\_Meat_{it} + \theta_5 PR\_Dairy_{it} + \theta_6 PR\_Alco_{it}$$
$$+ \theta_7 PR\_NAlco_{it} + \theta_8 PR\_FF_{it} + \theta_9 PR\_HC_{it} + \theta_{10}Age_{it} + \theta_{11}Age_{it}^2 + \theta_{14}Married_{it} + \theta_{15}Kids_{it}$$
$$+ \theta_{15}MSA_{it} + \theta_{16}Inc_{it} + \delta_{2i} + \mu_{it}$$

However, FSP_{it}^* is a latent variable and not observed. Ignoring time subscript *t*; what we observe is

$$D(FSP)_i = \begin{cases} 1 & if\ FSP_i^* > 0 \\ 0 & otherwise \end{cases}.$$

Now the probability of a woman's house participating in SNAP can be expressed as,

$$p_{2i} = \Pr(D(FSP)_i = 1) = \Pr(FSP_i^* > 0) = \Pr(X_{2i}\Theta + \mu_{2i} > 0) = \Pr(\mu_{2i} > -X_{2i}\Theta) = \Pr(\mu_{2i} < X_{2i}\Theta) = F(X_{2i}\Theta).$$

$F(\cdot)$ is a cumulative uniform distribution function for μ_{2i}, evaluated at $X_{2i}\Theta$. If μ_{2i} is a proper diffuse or uniform distribution centered at zero, it has a triangular cumulative distribution function indexed on $X_{2i}\Theta$. Hence, $p_{2i} = F(X_{2i}\Theta) = X_{2i}\Theta$, because of the special form of $F(\cdot)$. The linear probability model for SNAP participation is then,

$$D(FSP)_i = X_{2i}\Theta + e_{2i}, \text{ where } e_{2i} = \begin{cases} 1 - X_{2i}\Theta & \text{with probability } X_{2i}\Theta \\ -X_{2i}\Theta & \text{with probability } (1 - X_{2i}\Theta) \end{cases}, \text{ and } E(e_{2i}) = 0.$$

Since SNAP provides a substitute for some directly purchased food, an individual is more likely to participate in the program as the prices of healthy food increase. However, we are uncertain about the effects of local prices of unhealthy food, because they depend on the tradeoff between the reduced utility from less consumption and the increased utility from better health.

Retirement-aged adults are expected to be in households that are more likely to participate in SNAP because they usually have less current income. However, because they can obtain social security, starting at age 60, and Medicare at age 65, a non-linear effect of an adult's age is permitted in the model to capture life-stage effects.

Married individuals have a lower probability of participating in SNAP because they can get financial support from their spouse, but individuals with more children are more likely to participate because of the heavier financial burden.

Equation 3: Hourly Wage Equation

Our interest in a women's wage equation is primarily to obtain an estimate of the opportunity cost of her time for explaining her BMI and probability of being obese.   It's abbreviated nature, relative to cross-sectional studies, reflects the inclusion of individual fixed effects, which captures the effects of variables that do not change over time or are not interacted with variables that do change over time. The wage equation is

$$\ln Wage_i = \pi_1 + \pi_2 Age_{it} + \pi_3 Age_{it}^2 + \pi_4 Age_{it} * Edu_{it} + \pi_5 Age_{it} * NonCogScale_{it} + \pi_6 South_{it} + \delta_{3i} + \omega_{it}.$$

An individual's age, rather than his or her labor market experience, is used to represent current and past incentives to invest in experience, given schooling.   We expect an individual's wage to increase but at a decreasing rate as he or she becomes older.

A long history of prior studies has shown that an individual's wage increases with his or her cognitive skills (as indexed by education level), but more recently, noncognitive ability has been shown to affect wage rates (Heckman et al. 2006). In our data set, all the women were at least 22 years old in the first sampling year. Hence, women's education level rarely changed over our study period. In addition, tests to assess women's noncognitive ability were administered far before the first sampling year, so we have access to a measure of noncognitive ability that is fixed before our sample years. Therefore, the interaction terms of *age* x *educ* and *age* x *NonCogScale* are used in Equation 3 for two purposes. First, the cognitive skill and non-cognitive ability serve as instrumental variables that help identify our model. Second, the interaction term between *Age* and *NonCogScale* allow us to examine whether the effects of noncognitive ability increase or decrease with potential years of

experience, which is highly correlated with an individual's age.

At last, an index of residence in southern areas is used in the equation because individuals that currently live in a poorer area are expected to earn less.

Data and the Sample

The women for this study are from the National Longitudinal Survey of the Youth, 1979 Cohort (NLSY79), and to these data, we append area level price data obtained from the American Chamber of Commerce Research Association (ACCRA) Cost of Living Index. See Appendix I.

The National Longitudinal Survey of the Youth, 1979 Cohort, is a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. The survey was conducted annually from 1979 to 1994 and has been conducted biennially since 1996. Each round collected detailed information on the respondents' health status, number of family members, schooling, labor market behaviors, income and expenditures, and so on. We extract observations from 6 rounds taken at four-year intervals, i.e. 1986, 1990, 1994, 1998, 2002 and 2006, to create a working sample. This strategy was followed for two reasons. First, after 1986, all respondents were at least of age 21 and passed their juvenescent phase, which tends to stabilize one's weight. Second, with a four-year interval, we ignore autocorrelation. Third, we excluded those respondents in the military from our sample because their health status or BMI may be related to special training, and thus are less representative. As a result, there are 11,406 female respondents in our sample before dropping those having missing data for key variables.

We use a balanced sample in which each individual has complete records in all six sampling years.[4] There are a total of 1,638 individuals with six observations per individual in the female balanced sample, after dropping out those observations with missing data on key variables, and table 1 provides a brief definition of key variables and Appendix I provides detailed information on the variables included in the empirical model, including

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[4] In preliminary analysis we did not find a significant effect of SNAP participation in on body weight of adult males, so we focus our analysis on the female sample.

food and drink prices.

The NLSY contains two measures of noncognitive ability taken in 1980: the Rosenberg self-esteem scale (Rosenberg 1965), and the Rotter internal (vs. external locus of) control (1966). (See Appendix II.) The Rosenberg scale was designed to measure an individual's self-evaluation, determined by responses to ten statements of self-approval or disapproval. The scale for each statement ranges from 1 to 4, and is scored in the self-approval direction—higher scores are interpreted to mean higher self-esteem. The Rotter scale was designed to measure the extent to which individuals believe they have control over their lives through self-motivation or self-determination (internal control), as opposed to the extent to which the environment (change, fate, luck) controls their lives (external control). For each question, the respondent choses a number between 1 to 4 with a higher number indicating stronger external control.

As a measure of noncognitive ability, we reverse the Rotter Scale and combine it with the Rosenberg scale, so that a large value means more self-esteem and internal control.[5]

From year 1986 to year 2006, the average BMI of these women increased by over 19% from 22.64 to 27, while their obesity rate also increased by over 20 percentage points. This trend is consistent with the increasing obesity rate in the U.S. over that last twenty year.

Table 2 contains selected summary statistics for our working sample. About 56.5% of women are white, 28.8% are black, and 14.7% are of other races. At the sample mean, the women have almost 13 years of completed schooling. The proportion of women who are married increased in the first two sampling years and remained steady thereafter. The number of kids in the household increased until 1998 and decreased thereafter. The proportion of pregnant women fluctuated at a higher level in the first three sampling years and then kept at a much lower level in the last three sampling years. We believe that all of these changing patterns are normal as the respondents aged.

The real hourly wage rate and the annual real non-wage income are rising over the study period. The residence location of these respondents didn't change much, except that the proportion of respondents living in metropolitan statistical areas more than doubled in the

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[5] We divide each of the measures of noncognitive ability by its mean before adding the two indexes together.

Table 2: Summary Statistics for the Female Balanced Sample

Part 1: Summary Statistics of Key Demographic Variables

Variable	Mean	Std. Dev.	Min	Max
age (in 1986)	24.56	2.23	21	29
Black	0.288	0.453	0	1
RaceOth	0.147	0.354	0	1
Edu	12.79	2.10	0	20
Rosenberg Scale	32.09	3.97	19	40
Internal Scale	8.35	1.49	4	12
Noncog Scale	13.70	1.55	9.41	17.89

Part 2: Means of Variables in each sampling year

Variable	1986	1990	1994	1998	2002	2006
BMI	22.64	23.79	24.77	25.67	26.37	27.00
D(Obese)	4.46%	8.55%	13.98%	18.86%	23.44%	26.50%
D(FSP)	13.37%	14.96%	16.24%	10.19%	7.57%	6.11%
Wage (if worked for pay)	5.99	9.57	10.43	13.62	17.22	19.49
Married	44.44%	55.31%	56.47%	56.65%	58.55%	57.88%
Kids	0.89	1.37	1.55	1.73	1.57	1.32
preg	7.14%	6.29%	8.42%	1.59%	0.98%	0.24%
Urban	79.30%	78.57%	77.84%	68.74%	75.34%	68.32%
NC	28.51%	29.55%	29.61%	29.30%	29.18%	29.12%
South	41.09%	40.72%	41.39%	41.94%	41.94%	42.06%
West	18.75%	18.50%	18.19%	18.19%	18.01%	18.19%
MSA	49.82%	48.66%	44.63%	30.40%	79.61%	91.94%
Inc (in 1,000 dollars)	5.90	15.16	15.39	26.34	33.69	38.71

last two sampling years. We are not sure if it is because more respondents moved to MSAs or because the U.S. Census Bureau revised the standards for MSAs in the year 2000.

Econometric Results

The econometric model is estimated by least squares, with instrumental variables and individual fixed-effects. The estimated coefficients of the model are reported in Table 3. Estimation of the wage equation shows that a woman's age has a reversed U-shaped effect on her hourly wage rate, with the peak projected to occur at age 55; but given the age range of our sample, older female workers tend to earn more. The age-noncognitive ability interaction has a positive and significant effect on women's wages, but the effect of the age-education interaction is not statistically significant. The implication is that the magnitude of the effect of noncognitive ability on women's wages becomes larger as they become older or have larger potential labor market experience. No North-South regional difference exists in women's real wage rates.

Women's household SNAP participation decision is shown to respond to the local prices of fresh fruits and vegetables, fast food and dairy products, but not to the local prices of other food and services. As expected, a one dollar increase in the price of fresh fruits and vegetables increases the participation probability; the exact magnitude is about 11 percentage points, and a one dollar increase in the price of fast food increases the participation probability by almost 20 percentage points. But contrary to our expectation, a one dollar increase in the price of dairy products decreases the probability of a woman's household participating by almost 16 percentage points.

A woman's age has a reversed U-shaped effect on her household's SNAP participation rate, projected to peak at age 56. Women who have larger numbers of children are more likely to participate in SNAP, which is consistent with the facts that, as in 2006, 52% of food stamp households included children; but contrary to our expectation, married women are also more likely to participate in the program although single-parent families are its main target group.

Inc and *MSA* are instruments and have statistically significant coefficients in the SNAP

participation equation and pass the over-identification test in the BMI and Obesity equations. The test for weak instruments also suggests that these two variables are fairly strong because the F-statistic for joint significance is larger than 10 (Stock and Yogo 2005). Also, women living in MSAs are more likely to participate in SNAP than those not living in MSAs, and women with higher non-wage household income are less likely to participate in SNAP than those with lower non-wage household income.

Across the estimated BMI and Obesity equations, the signs of the estimated coefficients for a given regressor are generally the same, but the significance levels are usually different. Women with a higher opportunity cost of time, as reflected in their predicted wage, are less likely to be obese. Women currently participating in SNAP have a lower BMI and a lower probability of being obese than women who are not in the program. But the magnitudes of the effects are much larger than expected. Specifically, if a woman's household participates in SNAP, she has a lower BMI by 15.67% and a lower probability of being obese by 56.33 percentage points.

An increase in the price of dairy products reduces a women's BMI and the probability of being obese, suggesting that low prices and popular use of dairy products may be contributing to women's obesity in the U.S. An increase in the price of alcoholic drinks increases women's BMI but not probability of being obese, while a higher price of non-alcoholic drinks increases both women's BMI and the probability of being obese. These results suggest that women are substituting toward some other high calorie drinks and perhaps food. Contrary to popular belief, an increase in the price of fast food increases women's BMI, but not the probability of being obese. Food items we included in the category "fast food" do not include those frozen ready-to-eat meals available in supermarkets or fatty or high calorie and processed foods, so as the price of fast food increases, this could cause women to substitute toward even more unhealthy ready-to-eat meals or processed foods.[6] An increase in the price of simple medical services reduces women's BMI, but not the probability of being obese. The first of these results suggests a possible change in behavior to reduce the negative health effects of a higher BMI.

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[6] More and more female adults, especially those working for pay, purchase ready-to-eat meals instead of preparing meals using all fresh materials, which is believed to be a reason for obesity.

Not surprising, the results show that as women become older, their BMI increases up to a projected age of 48 years, and thereafter BMI decreases gradually with each passing year. Married women have a higher BMI, on average, than unmarried women, but not a significantly higher probability of being obese. Women, who are pregnant or who have larger numbers of children usually have a higher BMI or a higher probability of being obese, supporting the tendency of women to experience net weight gain with each additional pregnancy. Those living in urban areas tend to have a lower BMI, but the probability of being obese is not significantly lower residing in urban areas. Compared to women living in Northeast, those living in the Midwest and West have a larger BMI, and those living in the South have a lower probability of being obese. These results are contrary to the popular reports of obesity being quite high in the South, but this can be explained by the fact that other co-variates are accounting for this crude tendency.

MaCurdy (1981) has shown that the distribution of estimated individual fixed effects contains useful information. Figure 3 presents a plot of the relative frequency of the estimated individual fixed effects for women from the ln(BMI) equation. We see that the distribution looks similar to a normal distribution with a mean close to 0. In Figure 3, we can see that the plot of the relative frequency for actual BMI and predicted BMI are similar, so the model of ln(BMI) does a good job of predicting BMI, except that the actual values have a thicker upper tail. As a result, for those women that have a large BMI, the predicted BMI is less than their actual. This under-prediction of extreme values is common in econometric models and reflects the fact that it is a major challenge to explain outliers.

Figure 4 presents the frequency distribution of estimated fixed effects for the first equation, explaining the probability of women being obese. It has two obvious features. First, the negative sample mean suggests that on average, the individual fixed effects reduce women's probability of being obese. Second, the long upper tail suggests that unobservable fixed effects of some women make them very likely to be obese. We also calculate two predicted probabilities for being obese. The first one is for an individual woman's probability of being obese using her own characteristics and her own individual fixed effect. The second one uses sample "average" values for women's characteristics and a woman's own individual fixed effect. These two predicted probabilities for female obesity are plotted

in figure 5. Their coincidence in the upper tail suggests that for some women, the individual fixed effect is the main factor explaining their obesity. Put differently, for these women, the non-fixed effect variables play a minor role in explaining BMI or the probability of being obese. Hence, public policies that target food and drink prices or other variables in our model are unlikely to have much effect on women's BMI or probability of being obese. Excess weight in sample women is a more complex story, one that starts before adulthood.

Conclusion

In this paper, we use longitudinal panel data to examine the effects of a woman's household participating in SNAP on her BMI and the probability of her being obese. The effects of SNAP participation on the obesity of its progam participants is an important public policy issues since the goal of FSP/SNAP has been to help needy households—those who meet primarily an income standard. This is a diverse and sizeable population. Although the earlier studies contained methodological limitations, they have been cited as negative effects of the program.

We have undertaken new economic and econometric modeling of the effects of SNAP participation on women's BMI, and the probability of being obese. We have also used panel data of a diverse set of women, reflecting the fact that through divorce or unemployment almost any women can fairly quickly be thrust into the pool of eligible SNAP participants. In contrast to earlier studies, we model a representative household's decisions as life-time utility maximization subject to technology, human time and asset constraints. The logical econometric model contains individual fixed effects, which eliminates one of the main problems, when obesity is related to SNAP participation in cross-sectional data. Also, we use an instrumental variable strategy to control for the endogeneity of SNAP participation and the opportunity cost of women's time. Our results indicate that a woman who is in a household that participates in SNAP has a 16% reduction in BMI and a 56-percentage-point reduction in the probability of being obese. Hence, we conclude that SNAP participation reduces women's BMI and the probability of being obese, and these are major benefits of the program.

In this paper, we find that the estimated effects of SNAP participation on BMI and the

probability of being obese are larger than in prior studies. We believe that this is due both to the economic and econometric modeling strategy and the choice of the data set to which the model was fitted. Moreover, in a separate paper, we permit a household to update its life time utility maximizing problem at the start of each year, but the data set and variables to which the model is fitted are the same. The impacts of SNAP participation on women's BMI and probability of being obese remain negative, but smaller than in this paper.

We do find some statistically significant effect of prices of processed fruits and vegetables, dairy products, alcoholic drinks, non-alcoholic drinks on women's obesity and BMI. For example, an increase in the price of processed fruits and vegetables, alcoholic drinks, non-alcoholic drinks, and fast food increases women's weight and probability of being obese, while a higher price of dairy products reduces their weight and obesity. Because the demand for fast food is expected to be negatively sloped, we expected an increase in its price to reduce the quantity demanded and contribute to reduced obesity, yet our findings were in the opposite direction, suggesting that other effects are also operating. One possible explanation is that SNAP cannot be used to pay for fast food, but it can be used to pay for highly processed foods in grocery stores and super markets. Hence, an increase in the price of fast food may cause a substitution toward highly processed foods sold by grocery stores and supermarkets, which may be less healthy than fast food. However, many of these effects seem small.

Our overall finding of large effects of individual fixed effects on weight and obesity outcomes in panel data is in some sense a negative finding. Policies targeting food and drink prices, for example, would be expected to have little effect on women's BMI and probability of being obese—even in the long run. Hence, our results suggest that new programs to manipulate food and drink prices that women face would have little impact on future obesity rates of women.

Individual fixed effects reflect a number of personal attributes that have not changed over time. Following Fogel (2004), they include such things as an individual's gestation environment, genetic predisposition, birth weight, early random events and habits such as self-control, healthy eating, and persistence for regular exercise. But, Nicholson et al. (2012)

Table 3: Least Squares, IV Estimation with Individual Fixed-Effects for Female Balanced Sample (sample size of 9,828 = 6 x 1,638)

Variable	*lnBMI*	*D(Obese)*	*D(FSP)*	*lnWage*
D(FSP)	-0.1567** (-2.14)	-0.5633** (-2.42)		
lnWage	-0.0312 (-0.72)	-0.3485** (-2.54)		
PR_FFruVeg	0.0283 (1.24)	0.1107 (1.53)	0.1090* (1.77)	
PR_PFruVeg	0.0381 (1.19)	0.1119 (1.11)	-0.0401 (-0.43)	
PR_Meat	-0.0304 (-0.92)	-0.1084 (-1.03)	0.0699 (0.73)	
PR_Dairy	-0.0593** (-1.97)	-0.3078*** (-3.23)	-0.1591** (-1.97)	
PR_Alco	0.0644** (2.38)	0.0626 (0.73)	-0.0243 (-0.32)	
PR_NAlco	0.0562** (2.06)	0.2056** (2.37)	0.0834 (1.10)	
PR_FF	0.0913*** (3.29)	0.1395 (1.58)	0.1993*** (2.88)	
PR_HC	-0.0436* (-1.85)	0.0095 (0.13)	0.0663 (1.05)	
Age	0.0190** (2.52)	0.0706*** (2.96)	-0.0113*** (-2.43)	0.1535*** (12.24)
Age^2	-0.0002*** (-2.79)	-0.0006*** (-2.93)	0.0001*** (1.52)	-0.0014*** (-9.74)
Married	0.0099* (1.68)	-0.0140 (-0.74)	0.0604* (1.90)	
Kids	0.0082** (2.00)	0.0270** (2.06)	0.0614*** (15.58)	
Preg	0.0652*** (13.96)	0.0291* (1.96)		
Urban	-0.0059* (-1.98)	0.0056 (0.60)		

Table 3: (Continued)

Variable	*lnBMI*	*D(Obese)*	*SNAP*	*lnWage*
NC	0.0259**	-0.0298		
	(2.11)	(-0.76)		
South	0.0164	-0.0601*		-0.0574
	(1.55)	(-1.79)		(-1.09)
West	0.0209*	-0.0130		
	(1.66)	(-0.33)		
Age*Edu				0.0000
				(0.66)
Age*Noncog Scale				0.0018***
				(2.73)
MSA			0.0326***	
			(3.96)	
Inc			-0.0047***	
			(-4.29)	
Constant	2.6821***	-1.0361***	0.1179*	-2.4590***
	(26.09)	(-3.18)	(1.76)	(-14.77)
Test for Weak Instruments				
			11.86	3.94
Test for Overidentification in SNAP Equation				
Sargan Statistics	0.3838	2.2082		
P-Value	0.5356	0.1373		
R^2	0.402	0.105	0.061	0.531

Notes: (1) z-statistics in parentheses.

(2) *** represents statistical significant level in 1%, ** represents statistical significant level in 5%, and * represents statistical significant level in 10%.

Figure 2: Histogram: Predicted Individual Fixed-effects for ln BMI Equation
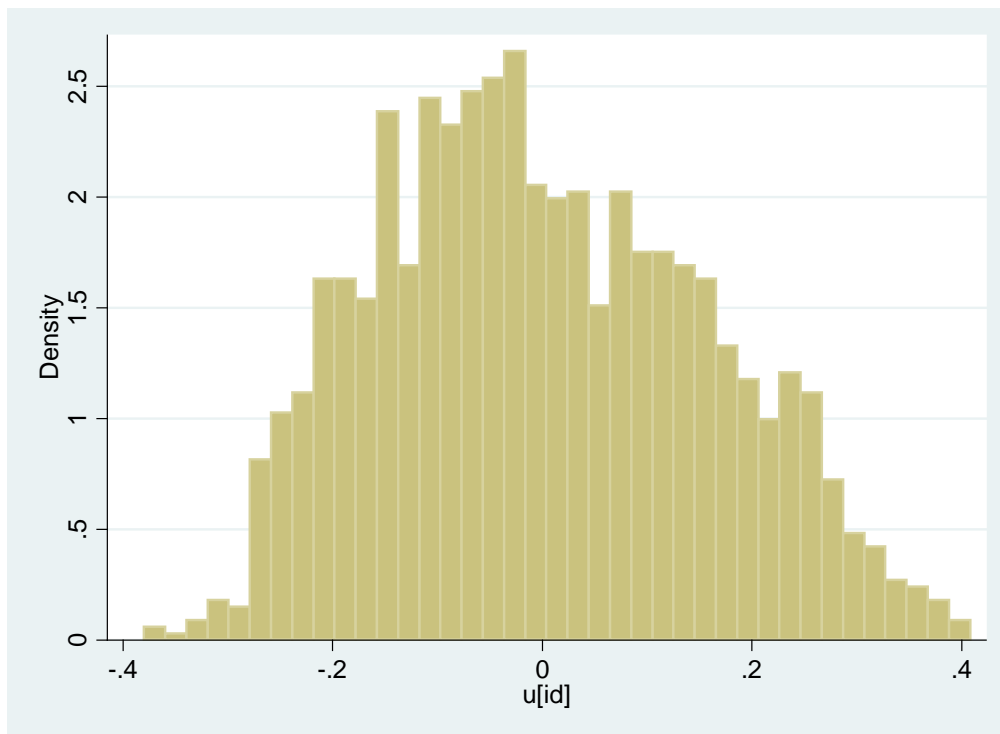

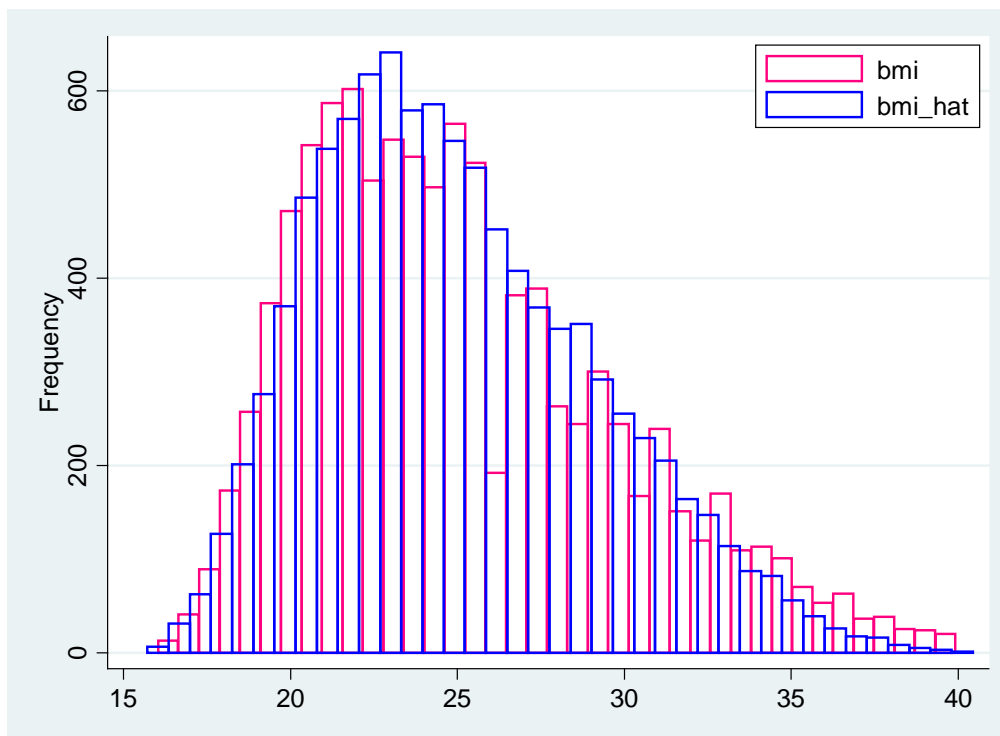**Figure 3: Histogram: Actual and Predicted BMI**

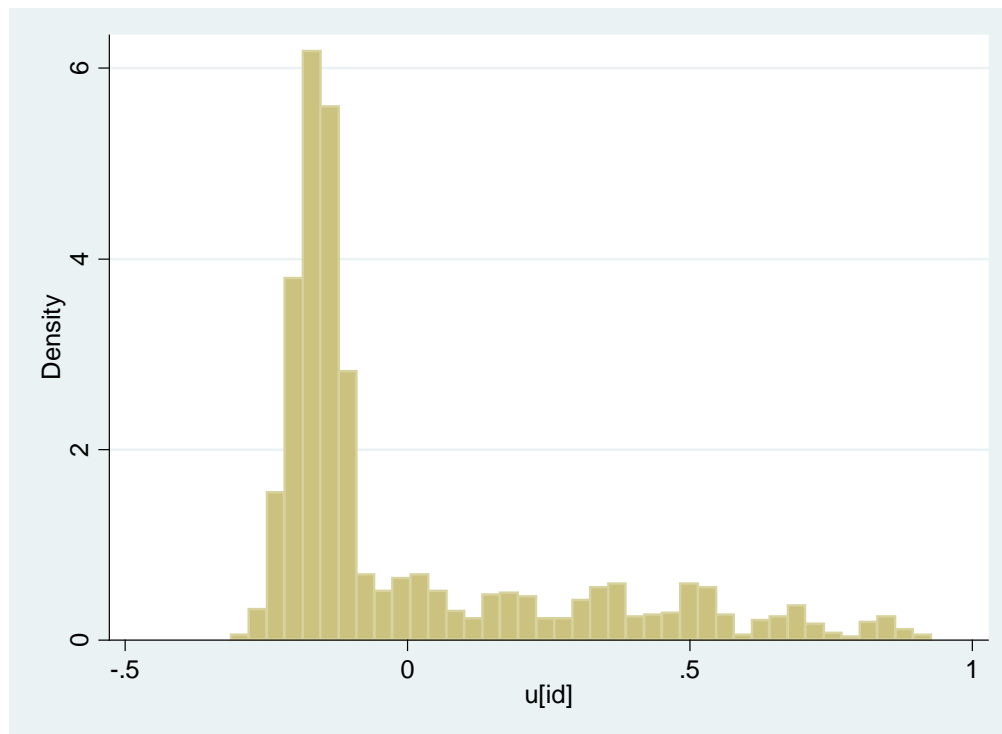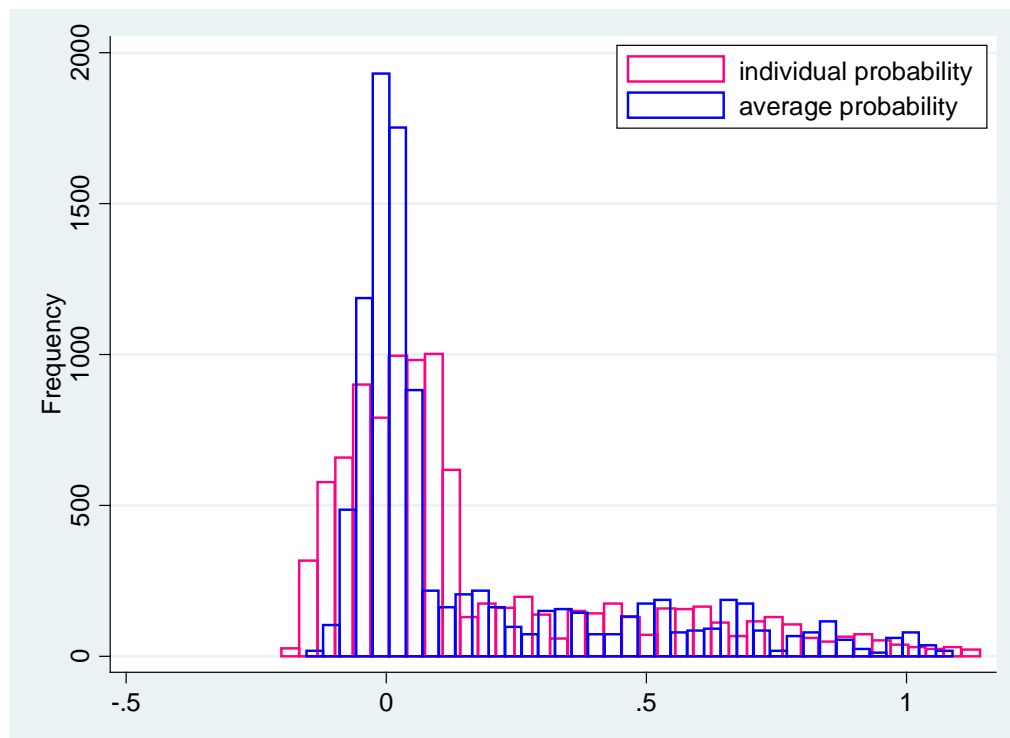**Figure 4: Histogram: Predicted Individual Fixed-effects for Obesity Equation**

Figure 5: Histogram: Average and Predicted Probability of Being Obese

emphasize that another set of events early in life, such as delivery mode, maternal pre-pregnancy BMI, and antibiotic treatment during infancy, influence obesity in childhood and later life through altered host-gut microbiota metabolic interferences. These are all arguments consistent with our findings, and suggest a potential fruitful direction for future obesity research.

The USDA's new SNAP-Ed, which attempts to help SNAP participants make healthier food choices and provide information how to prepare a diverse set of foods, could be adapted to the growing awareness of the likely human host-microbial basis of metabolic diseases such as obesity and diabetes, which would de-emphasize processed and fatty foods and emphasize raw vegetables, fruits and nuts.

Appendix I: Detailed Empirical Definitions of Variables

Body Mass Index (BMI) and Obesity

BMI is a simple index of weight-for-height and is commonly used to measure health in literature. It is defined as the individual's body weight (in kilograms) divided by the square of his or her height (in meters). According to the World Health Organization's classification, an adult's normal weight should be between 18.5 and 25. Persons with BMI<18.5 (kg/m^2) are classified as being underweight, persons with BMI>=25(kg/m^2) are classified as being overweight, and persons with BMI>=30(kg/m^2) are classified as being obese.

In NYSL79, respondents' self-reported weight was recorded in each round, but self-reported height was only available in round 1981, 1982, 1985 and 2006. We use the maximum of all available height values up to the survey year as the respondent's height to calculate his/her BMI in this year. Specifically, for the observations in 1982, we use the maximum of the available height values in 1981 and 1982 to calculate current BMI in 1982. For the observations in 1986, 1990, 1994, 1998 and 2002, we use the maximum of the available height values in 1981, 1982 and 1985 to calculate BMI in these years. However, in order to keep the most updated information, for the observations in 2006, we use the height value in 2006 to calculate current BMI when it is available and use the foresaid method when it is not available.

FSP/SNAP Participation

The survey asked the respondents about the detailed information on SNAP/FSP participation in all rounds. The questions covered the beginning date and the ending date of each period between the last interview and this interview in which the household received any food stamps, as well as the values of SNAP benefits in each month during these periods. Therefore, we can get the total amount of the food stamps the respondents received during each year. We constructed the index for current SNAP participation: if the respondent received any SNAP benefits during the reported year, the index for current FSP participation equals 1, otherwise it is 0.

ACCRA Prices of Food, Drinks, Fast Food and Health Care

The American Chamber of Commerce Researchers Association (ACCRA) collects data on prices of 63 different items in 300 U.S. cities quarterly. These data provide useful information on prices of individual food items and can also be used to construct local cost of living indexes. The ACCRA data are collected at the establishment level, and the basket of goods reflects a mid-management standard of living. The sample weight for each item is derived from expenditure shares in the U.S. Bureau of Labor Statistics' 1993 Consumer Expenditure Survey. Although one can imagine creating better prices for some commodity groups, they would need prices on a much broader range of goods. The methodology we use has been applied by Chou, Grossman, and Saffer (2004), Powell et al. (2007), Auld and Powell (2008) for the price of fast food, Keng and Huffman (2007) for the price of alcohol, and Auld and Powell (2008) for the price of fruits and vegetables. Chen (2009) also used this method.

To be consistent with the reported years of the NLSY79 data, we construct price indexes for food, drinks, fast food and health care using all price data included in the ACCRA data set in year 1985, 1989, 1993, 1997, 2001 and 2005. The following prices for commodity groups were created: price of fresh fruits and vegetables (*PR_FFruVeg*), price of processed fruits and vegetables (*PR_PFruVeg*), price of meat and fish (*PR_Meat*), price of dairy foods (*PR_Dairy*), price of alcoholic drinks (*PR_Alco*), price of non-alcoholic drinks (*PR_NAlco*), price of fast food (*PR_FF*), and price of health care (*PR_HC*). Please See Appendix II for more details on the list of items included in each component and the units priced.

To eliminate locational noise in the price data and to solve the problem of different units among purchased items, a relative price for each item was created by dividing an item's price in a particular location by its average price among all the participating locations, and this real price was used to generate weighted consumer prices for each commodity group. Suppose there are I cities in total. Let P_{ki} denote the price of consumption category k in city i, P_{kji} denote the price of consumption item j ($j = 1,2,...,J$) in category k in city i, and P_{kj} denote the average price of consumption item j in category k across all participating cities in ACCRA (i.e. $P_{kj} = \sum_i P_{kji} / I$). W_{kji} denotes the expenditure weight of consumption item j in

category k in city i where $\sum_j W_{kji} = 1$ for any k and i. Then the price of consumption category k in city i is:

$$P_{ki} = (P_{k1i}/P_{k1})W_{k1i} + (P_{k2i}/P_{k2})W_{k2i} + \ldots\ldots + (P_{kJi}/P_{kJ})W_{kJi} \qquad \textit{for any k and i}$$

where J is the total number of items belonging to consumption category k. See Appendix II for an example showing how the weighted price for a food group in a particular city is derived.[7]

Not all NLSY respondents lived in an ACCRA cost of living index (CLI) participating city, so a different strategy was developed to obtain prices for respondents who lived in these areas. First, the price index was calculated for all ACCUR CLI participating cities in the same state as the respondent's residence, and then a simple average price was created across them. This average price for a commodity group was then used for the price that respondents faced in all non-ACCRA participating cities in that state. Because most ACCRA cost of living index (CLI) participating cities are urban areas in federally designated Standard Metropolitan Statistical Areas (MSAs), this average price would be less representative for respondents in suburbs within MSAs or in non-MSAs. To correct for this problem, we will add in some variables to control for the differences in economic status between these areas, such as the dummy variables that index urban areas or MSAs. This methodology allows us to keep all observations rather than deleting ones outside of ACCRA cost of living cities. It has been applied by Keng and Huffman (2007) for the price of alcohol.

Labor Market Variables

The NLSY79 collects detailed information about an individual's employer(s) in each reported year. A series of variables provide information on (1) time spent with an employer, i.e., start and stop dates for each job, hours, tenure, type of shift worked; (2) time spent away

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[7] There are several differences in our method for constructing food and drink prices relative to the ones used in other studies. First, households purchase food and drink to produce various nutritional, social and psychological outcomes, and hence, not just for calories. Second, as in Chen (2009), I include a disaggregated but relatively comprehensive set of six food and drink prices rather than one or two prices. Third, we disaggregate fruits and vegetables into fresh and processed because the latter contain, on average, significant added sugar and less fiber, which makes them less healthy. Fourth, non-labor income and the wage are deflated using the ACCRA cost of living index, which is consistent with food, drink, and health care price data.

from an employer either on unpaid or paid leave, i.e., gaps within jobs; and (3) periods not working, i.e., gaps between jobs. Based on this information, the total hours that a respondent spent on work in the reported year were provided in each round.

All respondents were also asked about earnings received from working in each round, including military income, wages, salaries, tips, farm income, and business income. The wage income we use here is the sum of wages, salaries and tips. We then compute the hourly wage rate by dividing total wage income by total working hours in the reported year. The real wage in each cross-section is computed by dividing the hourly wage by the ACCRA cost of living index for the location where the individual resides.

Noncognitive Abilities.

Psychologists suggest that an individual's psychological traits, such as motivation and self control, affect his or her behaviors (Dunifon and Duncan 1998). Starting in the late 1990's, economists have included these noncognitive factors in the models for the labor market, and their findings confirm that noncognitive abilities seem to matter for achievement in children, as reflected in completed schooling, which in turn affects later earnings.

Cawley, Heckman, and Vytlacil (2001) used the High School and Beyond (HSB) data set and defined nine behavioral problems, as measured by social skills in the 10th grader. Their results suggested that when controlling for cognitive ability, these social skills were correlated with later earnings. They operated primarily through an individual's decisions on schooling attainment.

Groves (2005) used the National Longitudinal Survey of Young Women in U.S. and women from the National Child Development Study in the U.K. to explore the value of incorporating psychological traits into wage determination models, and found that some were statistically significant factors. Her results indicated that white women in the labor market were penalized for externality, aggression and withdrawal.

Muller and Plug (2006) also adopted the Five-Factor Model of personality structure to explore how personality affected the earnings of a large group of men and women who graduated from Wisconsin high schools in 1957, and were re-interviewed in 1992. Their results indicated that all five basic traits had statistically significant positive or negative

earning effects and the overall effects were comparable to those commonly found for cognitive abilities. They also suggested that different traits were rewarded by different magnitudes for men and women.

The noncognitive measures we use are the Rotter Internal-External Locus of Control Scale that was administered in the 1979 round, and the Rosenberg Self-Esteem Scale that was administered in the 1980 round. Groves (2005) uses the Rotter Scale in her analysis of the return to personality. Heckman, Stixrud, and Urzua (2006) use the standardized average of the person's scores on the Rotter and Rosenberg scales as a measure of noncognitive skills.

The Rotter Internal-External Locus of Control Scale is a four-item abbreviated version of a 23-item forced-choice questionnaire, adapted from the 60-item Rotter Adult I-E scale developed by Rotter (1966). The scale was designed to measure the extent to which individuals believe they have control over their lives through self-motivation or self-determination (internal control), as opposed to the extent that the environment (i.e., chance, fate, luck) controls their lives (external control). The score for each item ranges from 1 to 4 in the external direction: the higher the score, the more external the individual. Since literature has found that people usually benefit from internal control, we construct a scale for internal control by reversing the score for each item. As a result, the minimal possible total score of the internal control scale is 16, indicating highest internal control, while the minimum possible total score is 4, indicating highest external control.

The Rosenberg Self-Esteem Scale was designed to measure the self-evaluation that an individual makes and customarily maintains. It describes a degree of approval or disapproval toward oneself (Rosenberg 1965). It contains 10 statements of self-approval and disapproval with which respondents are asked to strongly agree, agree, disagree, or strongly disagree. The scale for each statement ranges from 1 to 4, and is scored in the self-approval direction: the higher the score, the higher self-esteem. The maximum possible score is 40 while the minimum possible score is 10. The scale is widely used, and has accumulated evidence of validity and reliability.

The Rosenberg Self-Esteem Scale was also administered in 1987. We do not use it because personality is also affected by its success or failure in the labor market. By using the

scales before labor market outcomes, we can treat the noncognitive skills as exogenous. See Appendix II for detailed information about questions for the Rotter Internal-External Locus of Control Scale and the Rosenberg Self-Esteem Scale.

We construct a comprehensive index for noncognitive abilities, instead of using two separate noncognitive scales. We derive this comprehensive index by dividing the internal control scale and the Rosenberg Self-Esteem Scale by their own sample standard deviations first, and then take the summation of these two standardized scales. Nyhus and Pons (2005) also use the standardized average of the person's scores on the Rotter and Rosenberg scales as a measure of noncognitive skills.

vi) Basic Demographic Information and Family Background

Round 1979 provided each respondent's basic demographic information such as gender and race-ethnicity. Each round of NYSL79 updates information on the respondent's own education and marriage status, as well as the number of all biological and non-biological children and the age of each of them.

Each round also provides detailed information on household income. Household real non-labor income in a given cross section is computed as total household income less the respondent's earnings divided by the ACCRA cost of living index for the area where the respondent resides. In the survey, only about 70% of respondents provided complete information on household income, thus missing values of non-labor income are a major problem. In order to keep as many observations as possible in the sample, we use predicted household real non-labor income instead of reported household real non-labor income, by regressing reported household real non-labor income on all available exogenous variables available on demographic information and family background.

The Temporal Price Deflator

Since the purchasing power of family non-labor income and wage rates is affected by the inter-temporal price level, the real cross-sectional income and wage rates will be adjusted for temporal price changes by using the implicit price deflator for personal consumption expenditures from the U.S. Department of Commerce's GNP accounts (GNPDEF). This deflator is marginally better than the consumer price index of the U.S. Bureau of Labor Statistics (CPI),

because the CPI is based upon a basket of goods and services while the GNPDEF incorporates all of the final goods produced by an economy. This allows the GNPDEF to more accurately capture the effects of inflation, since it is not limited to a smaller subset of goods.

Appendix 2. Food and Drink Items and Their Weight in Aggregated Food and Drink Prices

1. Food and Drink Items in Each Food Group

Category	Item	Weight	Description
PR_FFruVeg	Fresh Bananas	0.509678	Price per pound
	Fresh Potatoes	0.245161	10 lb., white or red
	Fresh Iceberg lettuce	0.245161	Head, approximately 1.25 pounds
PR_PFruVeg	Frozen corn	0.083624	16 oz. whole kernel, lowest price
	Canned Peaches	0.386760	29 oz. can, halves or slices
	Fresh Orange Juice	0.445992	64 oz. (1.89 liters) Tropicana or Florida Natural brand
	Canned Sweet peas	0.083624	15-17 oz. can, Del Monte or Green Giant
PR_Meat	T-bone steak	0.237067	Price per pound
	Ground Beef/ Hamburger	0.237067	Price per pound, lowest price
	Sausage	0.221322	Price per pound, 100% pork
	Frying Chicken	0.166892	Price per pound, whole fryer
	Chunk Light Tuna	0.137652	6.0 oz. can, Starkist or Chicken of the Sea
PR_Dairy	Whole Milk	0.369760	Half-gallon carton
	Eggs	0.067366	One dozen, Grade A, Large
	Margarine	0.281437	One pound, cubes, Blue Bonnet or Parkay
	Grated parmesan cheese	0.281437	8 oz. canister, Kraft brand
PR_Alco	Beer	0.498462	Heineken's, 6-pack, 12-oz. containers, excluding the deposit
	Wine	0.501538	Livingston Cellars or Gallo Chablis or Chenin Blanc, 1.5-liter bottle
PR_Nalco	Coffee, vacuum-packed	0.571906	11.5 oz. can, Maxwell House, Hills Brothers, or Folgers
	Coca Cola	0.428094	2 liter, excluding any deposit
PR_FF	Hamburger sandwich	0.333334	McDonald's Quarter-Pounder with cheese, where available
	Pizza	0.333333	11"-12" thin crust cheese pizza; Pizza Hut or Pizza Inn where available
	Fried chicken	0.333333	Thigh and drumstick, with or without extras, whichever is less expensive, Kentucky Fried Chicken or Church's where available

PR_HC	Office visit, doctor	0.425333	American Medical Association procedure 99213 (general)
	Office visit, dentist	0.425333	American Dental Association procedure 1110 (adult teeth cleaning)
	Ibuprofen	0.149334	200 mg, 51 tablets, Advil brand

2. **Example: Relative Price of Meat and Fish (*PR_Meat*) in San Francisco**

	T-bone Steak	Ground Beef or Hamburger	Sausage	Frying Chicken	Chunk Light Tuna
Local Price	9.32	3.14	4.78	1.55	0.99
Mean Price	8.91	2.30	3.38	1.10	0.69
Weight	0.237067	0.237067	0.221322	0.166892	0.137652

Then *PR_Meat* for San Francisco, CA is calculated as:

$$PR\_Meat = \frac{9.32}{8.91}*0.237067 + \frac{3.14}{2.30}*0.237067 + \frac{4.78}{3.38}*0.221322 + \frac{1.55}{1.10}*0.166892 + \frac{0.99}{0.69}*0.137652$$
$$= 1.316$$

which is 31.6% percent higher than the national average price.

Appendix II: Non-cognitive Ability

1. Rotter Internal-External Locus of Control Scale

Respondents were asked to select one of each of the paired statements and decide if the selected statement was much closer or slightly closer to their opinion of themselves.

Pair One:
A. (1) What happens to me is my own doing…………………………………………………..…..1
    Or
  (2) Sometimes I feel that I don't have enough control over the direction my life is taking……....…..…2
B. Is this statement much closer of slightly closer to your opinion?
    much closer…………………………...…………………………………………………………1
    slightly closer…………………...…………………………………………………………………..2

Pair Two:
A. (1) When I make plans, I am almost certain that I can make them work…………………….………....1
    Or
  (2) It is not always wise to plan too far ahead, because many things turn out to be a matter of good or
    bad fortune anyhow……….…………………………………………………….…......…..…2
B. Is this statement much closer of slightly closer to your opinion?
    much closer…………………………...…………………………………………………………1
    slightly closer…………………...…………………………………………………………………..2

Pair Three:
A. (1) In my case, getting what I want has little or nothing to do with luck…………………….………....1
    Or
  (2) Many time I might just as well decide what to do by flipping a coin………...……………...………2
B. Is this statement much closer of slightly closer to your opinion?
    much closer…………………………...…………………………………………………………1
    slightly closer…………………...…………………………………………………………………..2

Pair Four:
A. (1) Many times I feel that I have little influence over the things that happen to me…………….……..1
    Or
  (2) It is impossible for me to believe that chance or luck plays an important role in my life……...……..2
B. Is this statement much closer of slightly closer to your opinion?
    much closer…………………………...…………………………………………………………1
    slightly closer…………………...…………………………………………………………………..2

The following shows how the scale is constructed:

Internal Control Item		External Control Item	
Much closer	Slightly closer	Slightly closer	Much closer
1	2	3	4

Each of the four paired items is constructed in this manner. The values for each item are then summed. The maximum possible score is 16, indicating high external control, while the minimum possible score is 4, indicating high internal control.

2. Rosenberg Self-Esteem Scale

The questionnaire contains 10 statements of self-approval and disapproval with which respondents are asked to strongly agree (1), agree (2), disagree (3), or strongly disagree (4).

A.   I feel that I am a person of worth, at least on an equal basis with others.

B.   I feel that I have a number of good qualities.

C.   All in all, I am inclined to feel that I am a failure.

D.   I am able to do things as well as most others.

E.   I feel I do not have much to be proud of.

F.   I take a positive attitude toward myself.

G.   On the whole, I am satisfied with myself.

H.   I wish I could have more respect for myself.

I.   I certainly feel useless at times.

J.   At times I think I am no good at all.

The scale for each statement ranges from 1 to 4, and is scored in the self-approval direction: the higher the score is, the higher self-esteem. Note that Items A, B, D, F, and G need to be reversed prior to scoring in order for a higher score to designate higher self-esteem.

References

Arellano, Manuel, and Stephen Bond. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies* 58 (1991): 277-297.

Auld, Christopher M., and Lisa M. Powell. "Economics of Food Energy Density and Adolescent Body Weight." *Econometrica* 76 (2009): 719-740.

Baum II, C.L. "The Effects of Food Stamps on Obesity. Middle Tennessee State University, Department of Economics and Finance Working Paper Series, Feb. 2010.

Baum II, Charles L. and William F. Ford. "The Wage Effects of Obesity: a Longitudinal Study." *Health Economics* 13 (2004): 885-899.

Blundell, Richard, and Thomas MaCurdy. "Labor Supply: A Review of Alternative Approaches." Vol. 3. In *Handbook of Health Economics*, O. Ashenfelter and D. Card, 1559-1695. New York: Elsevier, 1999.

Capps, Oral Jr., and Randall A. Kramer. "Analysis of Food Stamp Participation Using Qualitative Choice Models." *American Journal of Agricultural Economics* 67 (1985): 49-59.

Caswell, J.A and A.L. Yaktine, eds. Supplemental Nutrition Assistance Program: Examining the Evidence to Define Benefit Adequacy. Committee on Examination of the Adequacy of Food Resources and SNAP Allotments, Food and Nutrition Board, Committee on National Statistics, Institute of Medicine and National Research Council. Washington, DC: 2013.

Cawley, John. "The Impact of Obesity on Wages." *Journal of Human Resources* 39 (2004): 451-474.

Cawley, John, James Heckman and Edward Vytlacil. "Three Observations on Wages and Measured Cognitive Ability." *Labour Economics* 8 (2001): 419-442.

Chen, Yanni. "An Economic Analysis of the Impact of Food Prices and Other Factors on Adult Lifestyles: Choices of Physical Activity and Healthy Weight." Ph.D. dissertation, Department of Economics, Iowa State University (2009).

Chen, Zhou, Steven T. Yean, and David B. Eastwood. "Effects of Food Stamp Participation on Body Weight and Obesity." *American Journal of Agricultural Economics* 87 (2005): 1167-1173.

Chou, Shin-Yi, Michael Grossman, and Henry Saffer. "An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System." *Journal of*

Health Economics 23 (2004): 565 – 87.

Currie, Jane, and Jeffrey Grogger. "Explaining Recent Declines in Food Stamp Program
Participation." in *Brookings-Wharton Papers on Urban Affairs*, William G. Gale and
Janet R. Park, 203-244. Washington DC: Brookings Institution, 2001.

Daponte, Beth O., Seth Sanders, and Lowell Taylor. "Why do Low-Income Households Not
Use Food Stamps? Evidence from an Experiment." *The Journal of Human Resources* 34
(1999): 612-628.

Dunifon, Rachel, and Greg J. Duncan. "Long-Run Effects of Motivation on Labor-Market
Success." *Social Psychology Quarterly* 60 (1998): 33-48.

Etilé, Fabrice. "Food Price Policies and the Distribution of Body Mass Index: Theory and
Empirical Evidence from France"; SSRN Working Paper (2008).

Fogel, R.G. "Health, Nutrition, and Economic Growth." *Economic Development and
Cultural Change* 52(April 2004):643-658.

Fox, Mary K., William Hamilton, and Biing-Hwan Lin. "Effects of Food Assistance and
Nutrition Programs on Nutrition and Health: Volume 4, Executive Summary of the
Literature Review." Food Assistance and Nutrition Research Report 19-4 (2004).

Gibson, Diane. "Food Stamp Program Participation is Positively Related to Obesity in Low
Income Women." *The Journal of Nutrition* 133 (2003): 2225-2231.

Gibson, Diane. "Long-Term Food Stamp Program Participation is Differentially Related to
Overweight in Young Girls and Boys." *The Journal of Nutrition* 134 (2004): 372-379.

Greene, William H.. *Econometric Analysis*. 5th Edition. Upper Saddle River, N.J.: Prentice
Hall, 2003.

Grossman, M.. "The Human Capital Model." Vol.1A. in *Handbook of Health Economics*,
D.A. Culter and J.P. Newhouse. New York: Elsevier, 2000.

Groves, Melissa Osborne. "How Important is Your Personality? Labor Market Returns to
Personality for Women in the US and UK." *Journal of Economic Psychology* 26 (2005):
827-841.

Heckman, James J.. "Sample Selection Bias as Specification Error." *Econometirca* 47
(1979): 153-161.

Heckman, J.J. and D.V. Masterov. "The Productivity Argument for Investing in Young
Children," *Review of Agricultural Economics* 29(Fall 2007):446-493.

Heckman, James J., Jora Stixrud, and Sergio Urzua. "The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behaviors." *Journal of Labor Economics* 24 (2006): 411-482.

Huffman, Wallace E.. "Human Capital: Education and Agriculture." Vol. IA in *Handbook of Agricultural Economics*, Burce L. Garden and Gordon C. Rausser, 331-381. Amsterdam, Netherlands: Elsevier Science/North-Holland, 2001.

Huffman, Wallace E., Sonya Huffman, Abebayehu Tegene, and Kyrre Rickertsen. "The Economics of Obesity-Related Mortality among High Income Countries." American Agricultural Economics Association Meeting, and the International Association of Agricultural Economics Meeting (2006).

Keng, Shao-Hsun, and Wallace E. Huffman. "Binge Drinking and Labor Market Success: A Longitudinal Study on Young People." *Journal of Population Economics* 20 (2007): 35-54.

Leung, D.W, E.L. Ding, P.J. Catalono, E. Villamor, E.B. Rimm and W.C. Willett. "Dietary Intake and Dietary Quality of Low-Income Adults in the Supplemental Nutrition Assistance Program." *American Journal of Clinical Nutrition* 96(2012):977-988.

MaCurdy, Thomas. "An Empirical Model of Labour Supply in a Life-cycle Setting." *Journal of Political Economy* 89 (1981): 1059-1085.

Meyerhoefer, Chad D. and Yuriy Pylypchuk. "Does Participation in the Food Stamp Program Increase the Prevalence of Obesity and Health Care Spending?" *American Journal of Agricultural Economics* 90 (2008): 287-305.

Moffitt, R. "An Economic Analysis of Stigma. " *American Economic Review* 73(1983):1023-1035.

Muller, Gerrit, and Erik J.S. Plug. "Estimating the Effect of Personality on Male and Female Earnings." *Industrial & Labor Relations Review* 60 (2006): 1-22.

Nicholson, J.K., E. Holmes, J. Kinross, R. Burcelin, G. Gibson, W. Jia and S. Pettersson. "Hot-Gut Microbiota Metabolic Interactions." *Science* 336(June 8, 2012):1262-1267.

Nyhus, Ellen K., and Empar Pons. "The Effects of Personality on Earnings." *Journal of Economic Psychology* 26 (2005): 363-384.

Ogden, L. Cynthia, and Margaret D. Carroll. "Prevalence of Overweight, Obesity, and Extreme Obesity among Adults: United States, Trends 1960-1962 Through 2007-2008." Division of Health and Nutrition Examination Surveys, Centers for Disease Control and Prevention (2010).

Phillips, M. "Parenting, Time Use, and Disparities in Academic Outcomes." In Duncan, G.J. and R.J. Murnane, eds., *Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances*. New York, NY: Russell Sage Foundation, 2011, pp. 207-228.

Powell L.M., Auld M.C., Chaloupka F.J., O'Malley P.M., and Johnston L.D. "Access to Fast Food and Food Prices: Relationship with Fruit and Vegetable Consumption and Overweight Status among Adolescents." *Advances in Health Economics and Health Services Research* 17 (2007): 23-48.

Rosenberg, Morris. *Society and the Adolescent Self-Image*. Princeton, N.J.: Princeton University Press, 1965.

Rosenzweig, Mark R., and T. Paul Schultz. "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and Their Effects on Birth Weight." *Journal of Political Economy* 91 (1983): 723-746.

Rotter, Julian B. "Generalized Expectancies for Internal Versus External Control of Reinforcement." *Psychological Monograph* 80 (1966): 1-28.

Schultz, Theodore W. "The Value of the Ability to Deal with Disequilibria." *Journal of Economic Literature* 13 (1975): 827-846.

Speakman, J.R., H. Walker, L. Walker, and D.M. Jackson. "Association between BMI, Social Strata and the Estimated Energy Content of Foods." *International Journal of Obesity* 29 (2005): 1281-1288.

Stock, James H., and Motohiro Yogo. "Testing for Weak Instruments in Linear IV Regression." Chapter 5 in *Identification and Inference for Econometric Models*, Donald W.K. Andrews, 80-108. New York: Cambridge University Press, 2005.

Sweeney, M.M. "Family-Structure Instability and Adolescent Educational Outcomes: A Focus on Families with Stepfathers." In Duncan, G.J. and R.J. Murnane, eds., *Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances*. New York, NY: Russell Sage Foundation, 2011, pp. 229-254.

Townsend, Marilyn S., Janet Peerson, Bradley Love, Cheryl Achterberg, and Suzanne P. Murphy. "Food Insecurity is Positively Related to Overweight in Women." *The Journal of Nutrition* 131 (2001): 1738-1745.

U.S. Census Bureau. "Families and Living Arrangement." Available at: http://www.census.gov/population/www/socdemo/hh-fam.html 2013.

Ver Ploeg, M. and K. Ralston. "Food Stamps and Obesity: What Do We Know?" USDA, Economic Research Service, *Economic Information Bulletin* No. 34, March 2008.

Wilde, Parke, Peggy Cook, Craig Gundersen, Mark Nord, and Laura Tiehen. "The Decline in Food Stamp Program Participation in the 1990's." Food Assistance and Nutrition Research Reports 33793, Economic Research Service, U.S. Department of Agriculture (2000).

Wilde, Parke, and Elizabeth Dagata. "Food Stamp Participation by Eligible Older Americans Remains Low." *Food Review* 25 (2002): 25-28.