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The Effects of Food Stamp Benefits on Weight Gained by Expectant Mothers

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Abstract

With over 66 percent of Americans overweight and subject to admonishments to lose weight, there is one segment of the population that is set apart—expectant mothers—because they are encouraged to *gain* weight while pregnant. Food Stamp benefits (FSBs) may facilitate recommended weight gain for pregnant women by providing additional resources for food and nutrition. I examine the effects of FSBs on the amount of weight gained by low-income expectant mothers using NLSY79 data. Results indicate FSBs decrease the probability of gaining an insufficient amount of weight but do not exacerbate the probability of gaining too much weight. Examining the effects of FSBs on pregnancy weight gain is important because low birth weight is more likely when expectant mothers gain an insufficient amount of weight.

JEL Codes: J1, J18, J13

The Effects of Food Stamp Benefits on Weight Gained by Expectant Mothers

I. INTRODUCTION: THE ISSUE AND HYPOTHESES

The Food Stamp Program (FSP) seems to have been successful at increasing the food consumption[1] and nutrient intake[2] of recipients. Consequently, the FSP may have also resulted in weight gain among its low-income recipients. For example, Gibson (2003) finds that FSP participation among low-income women (but not men) is significantly associated with increased obesity (see similar results in Chen, Yen, and Eastwood, 2005; Meyerhoefer and Pylypchuk, 2006; and Baum, 2007). This would be disconcerting because many Americans are already overweight or obese[3]—roughly two-thirds of Americans are overweight and 30 percent are obese (Flegal, Carroll, Ogden, and Johnson, 2002; Ogden, Carroll, Curtin, McDowell, Tabak, and Flegal, 2006)—and both are more prevalent among those with low incomes (Ogden, Flegal, Carroll, and Johnson, 2002). Thus, while the FSP aims to increase food consumption and to enhance nutrient intake, increasing weight may be a detrimental, unintended side-effect for some recipients.

The effects of Food Stamp benefits (FSBs) on weight for pregnant women are likely different. This is because weight gain is not necessarily a detrimental, unintended side-effect for them. Instead, this sub-group, perhaps unlike any other, is encouraged to *gain* at least some weight while pregnant. Specifically, the Centers for Disease Control and Prevention (CDC), using Institute of Medicine (1990) guidelines, reports that expectant mothers of normal pre-pregnancy weight should gain 25 to 35 pounds; those underweight should gain 28 to 40 pounds; those overweight should gain 15 to 25 pounds; and those

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[1]See Devaney and Fraker (1989), Fraker (1990), and Fraker, Martini, and Ohls (1995).

[2]See Basiotis, Kramer-LeBlanc, and Kennedy (1998), Rose, Habicht, and Devaney (1997), and Wilde, McNamara, and Ranney (1999).

[3]The Centers for Disease Control and Prevention (CDC) consider adults to be underweight if their Body Mass Index (BMI) is less than 18.5, normal weight if their BMI is 18.5 to 25, overweight if their BMI is 25 to 30, and obese if their BMI is 30 or more (CDC, 2006a). BMI is defined as weight in kilograms divided by height in meters squared (CDC, 2006b).

obese should gain at least 15 pounds (CDC, 2006c; Institute of Medicine, 1990).[4] Thus, expectant mothers are unique because they almost universally are encouraged by physicians to gain weight and, indeed, typically intend to consume more calories during their pregnancy than they otherwise would.

The FSP may facilitate recommended weight gain for low-income pregnant women by providing additional resources for food consumption and nutrition. A portion of these women might otherwise be unable to achieve desired pregnancy weight-gain goals due to financial constraints. Certainly it is not uncommon to fail to gain an ideal amount of weight while pregnant: an estimated 15.0 percent of expectant mothers with normal pre-pregnancy weight do not gain enough weight during their pregnancy; 22.8 percent of expectant mothers underweight pre-pregnancy do not; 4.5 percent of those overweight do not; and 12.7 percent of those obese do not (CDC, 2006c). More generally, 30 percent to 40 percent of expectant mothers do not gain an amount of weight that falls within recommended ranges (Abrams, Altman, and Pickett, 2000; Hickey, 2000).

In this project, I examine the effects of the FSP on the amount of weight gained by expectant mothers during their pregnancy using 1979-cohort National Longitudinal Survey of Youth (NLSY79) data. I focus the analysis on a relatively homogeneous sample of low-income expectant mothers[5] and control for possible omitted variable bias using a discrete factor random effects (DFRE) estimator. I also estimate a set of models examining whether expectant mothers gain an ideal amount of weight while pregnant, more weight than recommended, or less weight than recommended based on pre-pregnancy BMI. This is important because expectant mothers underweight pre-pregnancy are recommended to gain more weight while pregnant than those overweight pre-pregnancy. I estimate supplemental sets of models that *(i)* control for gestation length, *(ii)* separately examine first-time expectant mothers, *(iii)*

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[4]However, these pregnancy weight gain recommendations, derived by the Institute of Medicine in 1990, define underweight pre-pregnancy as a BMI less than 19.8, normal pre-pregnancy weight as a BMI of 19.8 to 26.0, overweight as a BMI of 26.1 to 29.0, and obese as a BMI of 29.0 or higher.

[5]Limiting the sample in this way follows much of the welfare literature (for example, see Hurst and Ziliak, 2006; Sullivan, 2006).

simultaneously examine participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), *(iv)* control for other pregnancy behaviors, *(v)* control for receipt of FSBs pre-pregnancy, and *(vi)* examine the effects of food stamp receipt from each trimester. Results provide some evidence that FSBs increase the amount of weight gained while pregnant. In addition, FSBs decrease the probability of low-income expectant mothers gaining an insufficient amount of weight; however, FSBs do not increase the probability of gaining too much weight. In particular, providing low-income women with FSBs would reduce the prevalence of insufficient pregnancy weight gain by about 4 percentage points. This project fills a gap in the literature because I know of no research examining the effects of FSBs on pregnancy weight gain.

Examining the effects of FSBs on pregnancy weight gain is important because medical researchers have found evidence that poor infant health (proxied by low birth weight, preterm delivery, and infant mortality) is more likely when an insufficient amount of weight is gained during the pregnancy (Abrams et al., 2000; Butte, Ellis, Wong, Hopkinson, and O'Brien Smith, 2003; Caulfield, Stolzfus, and Witter, 1998; Cogswell, Serdula, Hungerford, and Yip, 1995; Costa, 2004; Ehrenberg, Dierker, Millluzzi, and Mercer, 2003; Kramer et al., 1995; Marsoosi, Jamal, and Eslamian, 2004; Schieve, Cogswell, and Scanlon, 1998; Thorsdottir, Torfadottir, Birigsdottir, and Geirsson, 2002).[6] For example, the CDC reports that 13.5 percent of women whose pregnancy weight gain is less than that recommended give birth to low birth weight babies while only 6.2 percent of those whose weight gain is in the recommended range do (CDC, 2006c). Thus, FSBs, by facilitating pregnancy weight gain, could indirectly improve health outcomes for low-income pregnant women.

Certainly health at birth has been found to influence later health and development. For example, health at birth, proxied by low birth weight and preterm birth, has been found to be a significant predictor

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[6]Some disagree that pregnancy weight gain significantly affects these measures (Johnson and Yancey, 1996; Stephansson, Dickman, Johansson, and Cnattingius, 2001).

of infant mortality and morbidity, congenital abnormalities, and neurodevelopmental disorders (Institute of Medicine, 1985; Kiely and Susser, 1992; Kline and Susser, 1989; Koops, Morgan, and Battaglia, 1982; McCormick, 1985). Perhaps as a consequence, Healthy People 2010, through which the Department of Health and Human Services specifies the nation's health objectives, calls for decreasing the prevalence of low birth weight at least to 5.0 percent from a current estimate of roughly 7.5 percent (U.S. Department of Health and Human Services, 2000).

Additionally, examining the effects of FSBs on pregnancy weight gain is important because such weight gain may influence future maternal weight. Researchers have found evidence that mothers who gain too much weight while pregnant are more likely to be overweight or obese post-partum[7] (Butte et al., 2003; Gunderson and Abrams, 2000; Gunderson, Abrams, and Selvin, 2000; Rooney and Schauberger, 2002) and that the portion of women who gain too much weight while pregnant is increasing (Schieve et al., 1998). Currently, the medical literature estimates that obesity contributes to between 111,909 and 365,000 premature adult deaths in the U.S. each year (Flegal, Graubard, Williamson, and Gail, 2005; Mokdad, Marks, Stroup, and Gerberding, 2004; Mokdad, 2005).

II. DATA

I use NLSY79 data to estimate the effects of FSBs on pregnancy weight gain because it collects information on each respondent's experiences with welfare programs, including the FSP, and information about each female respondent's pregnancies, including weight gained during each. The NLSY79 began annually interviewing 12,686 individuals who were between the ages of 14 and 21 in 1979. In 1994, the NLSY79 began surveying biennially, and the survey remains in progress on that basis. The original NLSY79 sample contained 6,283 women and an oversample of blacks, Hispanics, low-income whites,

[7]Further, some have found that gaining an excessive amount of weight while pregnant has adverse effects on infant and maternal health and increases the probability of cesarean delivery (Cogswell et al., 1995; Johnson, Longmate, and Frentzen, 1992; Johnson and Yancey, 1996; Rosenberg, Garbers, Lipkind, and Chiasson, 2005; Young and Woodmansee, 2002).

and military personnel. I include the black, Hispanic, and low-income oversamples and, consequently, use sampling weights throughout the analysis. I focus my analysis on low-income expectant mothers (defined as having less than a high school education) because these are the ones most likely impacted by food stamps. Between the period covered by the initial 1979 interviews and the year-2002 survey, 10,465 children were born to female NLSY79 respondents.

The key outcome of interest is the amount of weight gained by expectant mothers during their pregnancy.[8] The NLSY79 first collected pregnancy information from female respondents in the 1983 survey retroactively for the *youngest* child in the household. Beginning with the 1984 survey and continuing through the most recently released 2002 survey, the NLSY79 collects pregnancy information for all births to female respondents *since the last interview*. Specifically, in these surveys, the NLSY79 asks each mother for each live-birth pregnancy her weight before the pregnancy and her weight at the time of delivery. Of the 10,465 children born to NLSY79 respondents between 1979 and 2002, 6,744 live-born singletons (1,477 of whom are low-income) were covered by the pregnancy questions in the 1983 or successive surveys and provide the necessary information (such as the amount of weight gained while pregnant) to be used in the analysis. Since most of the pregnancies that are not included come from pre-1983 surveys, my sample disproportionately under-represents pregnancies of relatively young NLSY79 mothers. Shown in Table 1, descriptive statistics indicate that average pregnancy weight gain is around 31 pounds and that the rate of weight gain is 0.8 pounds per week.

It is possible to identify recommended weight gain, which is based on pre-pregnancy weight, for each expectant mother because the NLSY79 also collects information on height, allowing me to calculate BMI and classify each woman pre-pregnancy as being of normal weight, underweight, overweight, or

[8]The NLSY79 measures of weight are self-reported. Unfortunately, self-reported weight potentially is measured with error. Cawley (2000), using National Health and Nutrition Examination Survey (NHANES) – NHANESIII (1988–1994) data, predicts actual weight using self-reported weight for NLSY79 respondents. I am unable to adjust my NLSY79 data for reporting inaccuracies with NHANES data because NHANES does not collect information on actual and reported pregnancy weight gain.

Table 1
Descriptive Statistics

Key Explanatory Variable		
FSBs (average monthly benefits during pregnancy, in 100s, 2004 $s)	0.407	(0.036)
Key Outcome Variables		
Pregnancy Weight Gain (in pounds)	31.240	(0.535)
Rate of Pregnancy Weight Gain (pounds per week)	0.802	(0.014)
Weight Gain - Recommended Weight Gain Ratio	1.082	(0.020)
Gained too Much Weight (%)	0.390	(0.021)
Gained too Little Weight (%)	0.303	(0.019)
Other Key Variables		
Gestation Length (in weeks)	39.012	(0.055)
Pre-Pregnancy FSBs (average monthly benefits, in 100s, 2004 $s)	0.303	(0.032)
Standard Demographic Variables		
Black Dummy Variable (=1 if black)	0.213	(0.025)
Hispanic Dummy Variable (=1 if Hispanic)	0.152	(0.023)
Mother's Marital Status (=1 if married)	0.526	(0.022)
Mother's Age (in years)	22.242	(0.174)
Mother's Highest Grade Completed	9.573	(0.066)
Health Dummy Variable (=1 if any health limitations)	0.104	(0.011)
Pre-Pregnancy BMI (= BMI prior to conception)	22.355	(0.209)
Household Income (in 10,000s, 2004 $s)	3.517	(0.121)
Household Size (number of household member)	4.156	(0.092)
Child Gender (=1 if male, 0 if female)	0.534	(0.017)
Child's Birth Order (parity)	2.174	(0.058)
Local Unemployment Rate (%)	8.292	(0.217)
Urban Dummy Variable (=1 if lives in urban area)	0.743	(0.032)
Pregnancy Behavior Variables		
Visit Month (month of first physician visit during pregnancy)	2.969	(0.066)
Alcohol Once (=1 if drank alcohol no more than once/month)	0.157	(0.017)
Alcohol More (=1 if drank alcohol more than once/month)	0.174	(0.013)
Smoked One (=1 if smoked no more than 1 pack/day)	0.330	(0.022)
Smoked More (=1 if smoked more than 1 pack/day)	0.189	(0.020)
Vitamin (=1 if took vitamin supplement during pregnancy)	0.934	(0.009)
Salt (=1 if reduced salt intake during pregnancy)	0.498	(0.018)
Diuretic (=1 if took a diuretic during pregnancy)	0.034	(0.007)
Pregnancy Employment (= portion of pregnancy weeks employed)	0.210	(0.014)

Standard errors are in parentheses. There are 1,477 pregnancy-level observations.

obese.[9] The weighted sample average ratio of pregnancy weight gain to recommended weight gain is greater than one, indicating expectant mothers tend to gain more than recommended (see Table 1). Further, in my sample when weighted, 53.4 percent of NLSY79 expectant mothers are of normal weight pre-pregnancy, 30.1 percent are underweight, 16.4 percent are overweight (the overweight category includes those obese), and 8.7 percent are obese.[10] Based on pre-pregnancy weight, 30.7 percent of the expectant mothers gain an ideal amount of weight while pregnant, 30.2 percent do not gain enough weight, and 38.9 percent gain too much weight. Of those who gain an insufficient amount of weight, about one-third gain at least 10 pounds too little. Of those who gain an excessive amount, about one-half gain at least 10 pounds too much. Expectant mothers underweight pre-pregnancy are most likely to gain an ideal amount of weight than normal weight, overweight, and obese expectant mothers, and underweight expectant mothers are also most likely to gain too little weight. Overweight and obese expectant mothers are most likely to gain too much weight.

The NLSY79 also collects extensive information on each respondent's welfare experiences. For my purposes, the NLSY79 identifies whether each respondent receives FSBs in each month covered by the survey. The NLSY79 also reports the week in which each child was born; therefore, I am able to identify whether each mother received FSBs during each month of her pregnancy. The NLSY79 also identifies the amount of FSBs received in each month. To measure FSBs, I create a variable that equals average monthly food stamp receipt during the pregnancy. As specified, the FSBs covariate identifies the effects of FSBs during the entire pregnancy. Fortunately, since the NLSY79 identifies receipt of FSBs in each month covered by the survey, it will be possible to determine the separate effects of FSBs in each

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[9] However, the CDC's method for classifying weight in those under age 21 is through age- and gender-specific BMI growth charts, which are categories not consistent with CDC's categories for recommended pregnancy weight gain. For consistency across respondents, I use the BMI cutoffs described earlier for all respondents.

[10] The sizable proportion underweight is at least partially due to these women being relatively young (with an average age of about 22). Furthermore, the definition of underweight for pregnant women is relatively liberal: recall that the CDC's definition of underweight for pregnant women is a BMI less than 19.8 instead of a BMI less than 18.5 for others.

pregnancy trimester to explore in which third of the pregnancy FSBs have the largest impact. Thus, I create an additional set of FSB variables that are equal to the portion of months during each trimester in which FSBs were received.

Each of the models contains a set of standard explanatory variables designed to control for exogenous characteristics of the expectant mother that might affect her weight gain. These variables will be exogenous in that they are either determined prior to the pregnancy or should not change as pregnancy weight gain is realized. I control for: the woman's race/ethnicity, marital status, age, education level, health, and pre-pregnancy BMI; for the household's income and size; and for the expectant child's gender and parity. I also control for the local unemployment rate, whether the woman resides in an urban or rural area, and state of residence (one dummy variable for each state). Finally, I include year dummy variables to control for the calendar year in which each pregnancy occurred. Descriptive statistics for these and other variables are presented in Table 1.

A key variable that will influence pregnancy weight gain is gestation length because pregnancy weight gain should increase with the length of the pregnancy. To explore the effects of controlling for gestation, I include a variable measuring length of gestation (in weeks) in a separate portion of the models. This shows the partial effect of FSBs because such benefits may affect pregnancy weight gain through their effects on gestation length. For example, if FSBs promote recommended pregnancy weight gain and consequently decrease the probability of preterm birth, then they potentially increase pregnancy weight gain through two channels: by increasing the *rate* of weight gain during the pregnancy and by increasing the length of the pregnancy.

III. EMPIRICAL METHODOLOGY

My goal is to identify the causal effects of FSBs on pregnancy weight gain using multivariate regression analysis. The key variables are a measure of pregnancy weight gain (W) and FSBs (FSB). Formally, I estimate

$$W_{ij} = \beta_0 + \beta_1\mathbf{X}_{ij} + \beta_2 FSB_{ij} + \varepsilon_{Wij} \quad (1)$$

for woman i during pregnancy j, where **X** is a vector of covariates and ε_W is the error term in the pregnancy weight gain equation. In this model (and in all others that use multiple observations from the same respondent), I adjust my standard errors to account for respondent-specific correlation because women potentially provide multiple pregnancy observations. Otherwise, standard errors will be understated and significance levels will be overstated.

I also estimate a pregnancy weight gain specification that jointly models the probabilities of gaining an ideal amount of weight (I), too little weight (L), and too much weight (M) while pregnant. I assume the ε_W's are jointly normally distributed, which yields the multinomial probit (MNP) functional form.[11] The advantage of using a MNP instead of a multinomial logit (MNL) is that the MNP's errors are correlated across the alternatives; conversely, the MNL assumes the outcomes' errors are independent, which seems unrealistic in this context. Formally, the covariance matrix of the MNP's errors (Σ) is

$$\Sigma = \begin{pmatrix} \sigma_I^2 & & \\ \rho_{IM}\sigma_I\sigma_M & \sigma_M^2 & \\ \rho_{IL}\sigma_I\sigma_L & \rho_{ML}\sigma_M\sigma_L & \sigma_L^2 \end{pmatrix}$$

where σt2 is the variance of εWt and ρtt′ is the correlation between the alternatives for t = I, L, and M and t′ = I, L, and M. To identify the model, I estimate the probabilities of gaining too much weight and too little weight relative to the probability of gaining an ideal amount of weight.

Even within the context of multivariate regression analysis, estimates are susceptible to various sources of bias. One potential source of bias is due to unobserved heterogeneity, where pregnant women

[11] I also estimate these probabilities using an ordered probit, whose results are similar to those from the continuous OLS specification. However, I choose instead to present MNP results because the ordered probit specification is more restrictive, constraining the effect of FSBs (and all other covariates) to be monotonic across the ordered probabilities.

who gain an ideal amount of weight systematically differ from their counterparts who do not in ways that are difficult for researchers to measure. If FSBs are correlated with any unobserved characteristic that is also correlated with pregnancy weight gain, then regression estimates will not identify the causal effects of FSBs on pregnancy weight gain, producing unobserved heterogeneity bias.

I attempt to control for potential unobserved heterogeneity bias by jointly modeling pregnancy weight gain and FSBs, allowing cross-equation correlation. Formally, suppose FSBs can be modeled as

$$FSB_{ij} = \alpha_0 + \alpha_1 \mathbf{X}_{ij} + \alpha_2 \mathbf{Z}_{ij} + \varepsilon_{FSBij} \tag{2}$$

where **Z** is a vector of covariates included in the FSBs equation but not in the pregnancy weight equation. To model this correlation, I assume that the error terms include an independently and identically distributed component (ν) and components representing the unobserved person-specific factors ($\mu_1,\ldots,\mu_M$)

$$\varepsilon_{FSBij} = \nu_1 + \sum_{m=1}^{M} \gamma_{1m}\mu_{ijm} \text{ and } \varepsilon_{Wijt} = \nu_{2t} + \sum_{m=1}^{M} \gamma_{2tm}\mu_{ijm}$$

where the γs are factor loadings, M is the number of common factors, and t = W when estimating (continuous) pregnancy weight gain and t = M and L when estimating the probabilities of gaining too much weight and too little weight. This structure assumes that the idiosyncratic disturbances (the νs) are uncorrelated with the unobserved factors (the μs), but cross-equation correlation exists because the error structure contains the same unobserved variables (the μs). This model's complete conditional likelihood (LL) function contribution for expectant mother i during pregnancy j is

$$LL_{ij}(\mu_1,..., \mu_M) = f_{FSB}(FSB_{ij}| \mu_1,..., \mu_M) \left\{ \sum_{t=1}^{2} d_{ijt}\, \lambda_{ij}^{t}\, (d_{ijt} = 1 \mid FSB_{ij}, \mu_1,..., \mu_M) \right\}$$

for t = L and M and where $f_{FSB}(.)$ is the density function for FSBs and d_{ijL} and d_{ijM} are indicator variables that equal one if mother i during pregnancy j gains too much weight and too little weight, respectively. (When estimating pregnancy weight gain, the multinomial probit is replaced with a density function for weight gain.)

To explicitly model and control for the biasing effects of unobserved heterogeneity, I use a strategy similar to the one proposed by Heckman and Singer (1984) and used by many others (Gritz, 1993; Ham and LaLonde, 1996; Blau and Hagy, 1998; Hotz, Xu, Tienda, and Ahituv, 2002; Mroz, 1999), including some recent studies that use microdata (Mroz and Savage, 2006; Tekin, 2007), where a step function approximates the distribution of the unobserved variables. In particular, I jointly estimate the discrete values of the unobserved factors and their associated probabilities with the αs and βs. Recall that the sources of bias are cross-equation correlation captured by the μs. I "integrated out" these factors by approximating the unobserved heterogeneity's distribution with a step function of mass points and probability weights jointly with the other parameters. For example, the distribution of each unobserved factor μ is $\Pr(\mu=\mu_n) = \theta_n$, with n = 1,…, N and $\sum_{n=1}^{N}\theta_n = 1$ where N is the number of mass points in the distribution of μ and θ is the probability that μ equals a particular point of support.[12] With M different factors of μ, the unconditional likelihood function is given by

$$\prod_{i=1}^{I}\prod_{j=1}^{J}\sum_{n_1=1}^{N_1}\sum_{n_2=1}^{N_2}\cdots\sum_{n_m=1}^{N_M} L_{ij}(\Theta \mid \mu_{i1}, \mu_{i2}, \ldots, \mu_{iM})\theta_{1n_1}\theta_{2n_2}\theta_{Mn_M}$$

where N, μ, and θ are as defined above and Θ are the other parameters to be estimated.

Gritz (1987) and Heckman and Walker (1990) explain that there are no well-established rules for determining the number of factors and mass points to use in these type models. Standard log-likelihood ratio tests are inappropriate in this instance since parameters that fall on the boundary space violate the chi-squared distribution conditions. In later work, Gritz (1993), referring to Akaike's Information Criterion (Akaike, 1973), suggests adding factors and points of support as long as the value of the

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[12]This routine is performed in FORTRAN using analytic first derivatives to obtain maximum likelihood estimates. Identification is achieved by setting the first mass point equal to zero and the second mass point equal to one for each factor. The additional mass points and the probability weights are restricted to lie between zero and one, but the factor loadings are allowed to take any value.

likelihood function improves by at least one point for each additional parameter. Alternatively, Blau (1994) and Mroz (1999) continue adding factors and mass points to the model as long as they improve the value of the likelihood function. In my analysis, I use one common factor with three points of support. Using Gritz's (1993) criteria, I am unable to reject the joint null hypothesis that additional factors and mass points are not warranted because the value of the likelihood function did not significantly improve with any combination of additional factors and mass points. Further, continuing to add factors and mass points left the key coefficient estimates virtually unchanged.

I achieve identification in three ways. First, identification is secured by functional form. Specifically, the index functions and discrete factors enter corresponding equations non-linearly. Second, I include instruments in the FSBs model that are not included in the pregnancy weight gain equation. Third, I use intertemporal variation in instrument values. In particular, I include lagged instrument values, when available, allowing, for example, covariate values from each trimester during the pregnancy to have a separate effect on the potentially endogenous explanatory variable.

As instruments, I use state variation in Food Stamp eligibility laws.[13] These characteristics will serve as exogenous instruments identifying FSBs if *(i)* they significantly explain food stamp receipt and *(ii)* do not significantly affect pregnancy weight gain independently of FSBs. These eligibility criteria are probably valid instruments on both counts. Certainly state food stamp eligibility criteria should affect FSBs by determining who is eligible (for empirical evidence of this, see Kabbani and Wilde, 2003). Further, it seems reasonable to assume that state food stamp eligibility criteria are unrelated to pregnancy

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[13]The NLSY79 identifies each respondent's state of residence, which enables me to link measures of state food stamp eligibility criteria with each respondent. The state food stamp eligibility laws control for: whether states provide FSBs via coupons or the Electronic Benefit Transfer (EBT) program (starting in 1989, states began switching from the coupon system to the EBT program, and by 1999, 35 states were providing benefits electronically [Ziliak, Gundersen, and Figlio, 2003]); whether only parents or non-parental adults in the household can be considered caregivers of dependents if a child is present; whether the state uses simplified periodic reporting instead of incident reporting; whether residents are categorically eligible for FSBs if they qualify for other types of welfare; whether the state's employment and training sanctions are severe; and whether the state has a FSP-approved outreach plan designed to increase program participation (Gabor and Botsko, 1998; Super and Dean, 2001; Knaus, 2003).

weight gain when controlling for FSBs. For example, state legislatures probably do not alter FSP eligibility criteria based on a state's incidence of ideal pregnancy weight gain. Ultimately, log-likelihood ratio tests indicate that these eligibility characteristics and food stamp eligibility criteria are indeed valid instruments for FSBs. That is, the value of the log-likelihood function significantly improves when these variables are added to the FSBs equation but not when they are added to the pregnancy weight gain equation. [A full set of results for the FSBs equation is available upon request.]

Results using OLS instead of the DFRE estimator are available upon request. In each case, the value of the log-likelihood function improves substantially when using the DFRE specification. If anything, FSB-related results in OLS specifications appear somewhat biased toward zero.

I later explore the sensitivity of my results to potential remaining omitted variable bias by including an unusually large number of additional covariates to control more extensively for pregnancy behaviors that may affect pregnancy weight gain. First, I control for the month of the pregnancy that the mother first visited a physician. In addition, I control for whether the woman drank alcohol and smoked cigarettes during the pregnancy. Further, I include a "vitamin" variable that equals one if the woman took a vitamin supplement, a "salt" variable that equals one if the woman reduced her salt intake, and a "diuretic" variable that equals one if the woman took a diuretic. Finally, I control for the portion of the pregnancy in which the expectant mother was employed. If these variables are correlated with other, unmeasurable individual-specific characteristics, then, when included, they reduce or eliminate omitted variable bias essentially by "soaking up" confounded effects of unobserved heterogeneity. If unobserved heterogeneity is biasing the estimates, then when these pregnancy behaviors variables are included, the food stamp receipt coefficient should substantively change.

As an additional robustness check, I include in my models controls for FSBs received prior to the pregnancy. This is another way to test for unobserved heterogeneity bias because pre-pregnancy FSBs should have no effect on pregnancy weight gain since such benefits are received, by definition, prior to the pregnancy. However, if pre-pregnancy food stamp receipt picks up remaining effects of otherwise omitted characteristics correlated with both pregnancy weight gain and food stamp receipt during the pregnancy, then the effects of pregnancy food stamp receipt will change and pre-pregnancy FSBs will have significant effects on pregnancy weight gain. This would be evidence that food stamp receipt during the pregnancy is picking up the effects of unobserved factors.

IV. RESULTS

A. Initial Results

To explore the effects of FSBs on pregnancy weight gain, I first regress the amount of weight gained while pregnant measured in pounds on average monthly FSBs (in $100s) received during the pregnancy. I report the effects of the FSBs covariate in Table 2 (a representative set of the results for other covariates is available upon request). Results, displayed as model 1, provide weak evidence that FSBs increase the amount of weight gained while pregnant. Not quite significant at the 10 percent level, increasing FSBs by $100 in each month of the pregnancy would increase pregnancy weight gain by a little over one pound (1.3 pounds), which is about 10 percent of a standard deviation (a standard deviation in pregnancy weight gain is about 12 pounds).

As specified, model 1 provides the total effect of FSBs, which potentially confounds separate effects on gestation length and the rate of weight gain. To explore whether FSBs have these separate effects, I next in model 2 add a control for gestation length. Model 2's results provide the partial effect of FSBs holding gestation, and therefore potential effects on pregnancy weight gain through pregnancy length, constant. The results in model 2 also provide weak evidence that FSBs increase pregnancy weight gain, with the magnitude of this effect being much the same as in model 1. This suggests that FSBs do not affect pregnancy weight gain through gestation length. In another attempt to identify total and partial effects of FSBs, I next re-estimate the model using only pregnancy observations of normal gestation length (defined as 37 to 42 weeks). The effects of FSBs are marginally significant at the 10 percent level, with $100 in FSBs received in each month of the pregnancy increasing weight by about one and a half pounds. Again, FSBs do not appear to operate indirectly through gestation. These conclusions are

Table 2
The Effect of FSBs on Pregnancy Weight Gain

	Model 1	Model 2	Model 3	Model 4
FSBs	1.289	1.205	1.429*	0.032*
	(0.845)	(0.849)	(0.880)	(0.020)
Predicted Outcomes				
Without FSBs	29.996	30.037	29.985	0.769
With FSBs	31.285	31.242	31.413	0.802
Log-likelihood Function Value	-6,979.3	-6,978.4	-6,371.8	-1,568.8
Gestation Length Covariate Included	No	Yes	No	No
Gestation Lengths Included	All	All	37–42 Weeks	All
Weight Gain Measure	Weight Gain	Weight Gain	Weight Gain	Rate of Gain

Standard errors are in parentheses. * indicates statistical significance at the 10 % level, ** at the 5 % level, and *** at the 1 % level. The models include 1,477 low-income pregnancy-level observations in models 1, 2, and 4, with 1,324 normal gestation-length observations in model 3. All models adjust for race, ethnicity, marital status, age, highest grade completed, health, pre-pregnancy BMI, household income, household size, child gender, child parity, the local unemployment rate, urban residence, state of residence, and year of pregnancy. In addition, model 2 controls for gestation length. Normal gestation length is defined as 37 to 42 weeks, inclusive.

essentially unchanged in model 4, where I instead model the weekly rate of weight gain (defined as pregnancy weight gain divided by gestation length), again including gestations of all lengths. This accords with the Institute of Medicine's (1990) report that implies fetal growth is more closely linked to nutrition than preterm birth.

B. Basic Results: Recommended Pregnancy Weight Gain

The models estimated thus far do not identify whether the amount of weight gained while pregnant is an ideal amount, too much, or too little. The CDC (CDC, 2006c; Institute of Medicine, 1990) recommends the ideal amount of weight for expectant mothers to gain based on pre-pregnancy BMI, where, for example, underweight women should gain more weight than those overweight. I first specify a model that estimates the ratio of pregnancy weight gain to recommended weight gain. Results, displayed as model 1 in Table 3, indicate FSBs have a statistically insignificant effect, though the corresponding FSBs coefficient is positive and is almost significant at the 10 percent level. This specification is somewhat crude in that I assume recommended pregnancy weight gain is the midpoint of the relevant CDC-recommended range. For example, I assume recommended pregnancy weight gain is 30 pounds for an expectant mother of normal pre-pregnancy BMI. However, results are virtually unchanged when I instead experiment with my own continuous scale for recommended weight gain (where, for example, an expectant mother with the lowest normal pre-pregnancy BMI would be recommended to gain 35 pounds and an expectant mother with the highest normal pre-pregnancy BMI would be recommended to gain 25 pounds).

I next estimate a multinomial probit that jointly models the probability of gaining too much weight and the probability of gaining too little weight (both relative to gaining an ideal amount of weight). Multinomial probit results, presented as model 2 in Table 3, indicate that FSBs do not significantly affect the probability of gaining too much weight, but they do significantly decrease the probability of gaining too little weight at the 5 percent level. For example, increasing FSBs from $0 to $100 during each month of the pregnancy decreases (increases) the probability of gaining too little weight

Table 3
The Effect of FSBs on Recommended Pregnancy Weight Gain

	Model 1	Model 2	Model 2
FSBs	0.045	-0.009	-0.131**
	(0.031)	(0.076)	(0.058)
Predicted Outcomes			
Without FSBs	1.045	0.373	0.331
With FSBs	1.090	0.386	0.292
Log-likelihood Function Value	-2,098.7	-1,928.7	-1,928.7
Sample	Full	Full	Full
Weight Gain Measure	Gain-Recommendation Ratio	Gained too Much	Gained too Little

Standard errors are in parentheses. * indicates statistical significance at the 10 percent level, ** at the 5 percent level, and *** at the 1 percent level. The models include 1,477 low-income pregnancy-level observations. All models adjust for race, ethnicity, marital status, age, highest grade completed, health, pre-pregnancy BMI, household income, household size, child gender, child parity, the local unemployment rate, urban residence, state of residence, and year of pregnancy. Model 1 estimates the ratio of pregnancy weight gain to recommended pregnancy weight gain. Model 2 is a multinomial probit that jointly estimates the probabilities of gaining too much weight and too little weight (relative to gaining a normal amount of weight).

(too much weight) from 33.1 percent to 29.2 percent (37.3 percent to 38.6 percent), which is a 3.9 (1.3) percentage point change. Thus, such benefits may be of assistance preventing an insufficient amount of pregnancy weight gain. That FSBs affect pregnancy weight gain non-monotonically may explain why continuous-outcome models that constrain effects to be proportional only produce marginally significant results. I also separately estimate the probability of gaining too much weight (relative to not gaining too much weight) and the probability of gaining too little weight (relative to not gaining too little weight) in separate probits. These models (results not reported) also show that FSBs do not affect the probability of gaining too much weight but do significantly reduce the prevalence of insufficient pregnancy weight gain.

C. By Pre-Pregnancy BMI

The models in Table 3 base ideal pregnancy weight gain on pre-pregnancy BMI. If pre-pregnancy BMI affects recommended pregnancy weight gain, then the effects of FSBs on pregnancy weight gain may differ by pre-pregnancy BMI. Thus, I next re-estimate the models separately for three sub-samples: underweight expectant mothers, expectant mothers of normal weight, and overweight expectant mothers. The results (not presented) are largely consistent with those presented in Tables 2 and 3, and coefficients on the FSBs covariates are typically not statistically different from one another across sub-samples. Perhaps the most notable change is that some effects that were marginally significant when using the full sample (at the 10 percent level) are no longer significant. This may be due to reduced sample sizes. For example, the sample of overweight expectant mothers contains only 250 observations.

D. First-Time Mothers

The effects of FSBs may differ for first-time expectant mothers. Perhaps first-time expectant mothers are less likely to receive FSBs, resulting in FSBs received during the pregnancy partially serving as a proxy indicating that the observation is a second or successive pregnancy, when pregnancy weight gain may be more likely. Indeed, only 16.9 percent of the first-time expectant mothers in my sample (521 observations) receive FSBs during their pregnancy but 42.3 percent of non-first-time expectant mothers receive FSBs. Therefore, I next re-estimate the models separately on sub-samples of first-time and non-first-time expectant mothers. When examined separately, the effects of FSBs on first-time expectant mothers are statistically insignificant (results not reported), but the effects on non-first-time expectant mothers are similar to those reported in Tables 2 and 3, at much the same significance levels.

In a related set of models that includes both first-time and non-first-time expectant mothers, I interact FSBs with an indicator for first-time pregnancy. Specification 1 in Table 4 presents the effect of FSBs with the FSBs-first pregnancy interaction term for select models (measuring weight gain, the rate of weight gain, and the probabilities of gaining too much weight and too little weight). In these models, the effects of FSBs are similar to those reported in Tables 2 and 3 (and to those for the sub-sample of non-first-pregnancy expectant mothers, described above), and the FSBs-first pregnancy interaction terms have statistically insignificant effects. For example, increasing monthly FSBs from $0 to $100 is predicted to significantly decrease (at the 10 percent level) the probability of gaining an insufficient amount of weight from 31.7 percent to 28.8 percent, which is a 2.9 percentage point change. These models provide no significant evidence that FSBs have a different effect on first-time mothers. Thus, I conclude that FSBs have effects on first-time expectant mothers that are not statistically different than those for other expectant mothers and that detected effects of FSBs are not the result of the FSBs covariate picking up the effects of second and successive pregnancies. The fact that the models already control for parity supports this conclusion. Alternatively, my sample of full-time mothers may be too small to gauge precisely whether effects differ by child parity.

E. Confounding Effects of WIC

The effects of FSBs may be different when expectant mothers simultaneously receive benefits from WIC because WIC benefits may substitute for FSBs. Furthermore, many pregnant WIC recipients began receiving counseling on recommended weight gain in the early 1990s. Therefore, I next simultaneously examine the effects of WIC on pregnancy weight gain. Unfortunately, the NLSY79 identifies whether expectant mothers (or their spouses or children) receive WIC benefits during the past

Table 4
The Effect of FSBs on Pregnancy Weight Gain

FSB Specification 1:	Model 1	Model 2	Model 3	Model 3
FSBs	1.157	0.029	-0.009	-0.101*
	(0.859)	(0.022)	(0.081)	(0.060)
FSBs-First Pregnancy Interaction	1.288	0.029	-0.022	-0.231
	(1.615)	(0.041)	(0.215)	(0.248)
Predicted Outcomes				
Without FSBs, First Pregnancy	31.065	0.799	0.419	0.297
With FSBs, First Pregnancy	33.511	0.858	0.448	0.208
With FSBs, Non-First Pregnancy	30.231	0.776	0.393	0.317
Without FSBs, Non-First Pregnancy	31.388	0.805	0.403	0.288
Log-likelihood Function Value	-6,979.0	-1,568.5	-1,928.1	-1,928.1
FSB Specification 2:				
FSBs	1.654*	0.405*	-0.015	-0.136**
	(0.849)	(0.218)	(0.079)	(0.063)
WIC	1.171	0.075	-0.111	0.232
	(2.227)	(0.300)	(0.190)	(0.196)
Predicted Outcomes				
Without FSBs	29.822	0.765	0.370	0.335
With FSBs	31.467	0.806	0.391	0.289
Log-likelihood Function Value	-6,976.0	-1,563.0	-1,922.7	-1,922.7
FSB Specification 3:				
FSBs	1.525*	0.036*	-0.009	-0.131**
	(0.842)	(0.021)	(0.104)	(0.066)
Predicted Outcomes				
Without FSBs	29.881	0.767	0.370	0.334
With FSBs	31.406	0.804	0.389	0.290
Log-likelihood Function Value	-6,970.5	-1,562.5	-1,912.0	-1,912.0
Weight Gain Measure	Weight Gain	Rate of Gain	Gained too Much	Gained too Little

Standard errors are in parentheses. * indicates statistical significance at the 10 % level, ** at the 5 % level, and *** at the 1 % level. The models include 1,477 low-income pregnancy-level observations. All models adjust for race, ethnicity, marital status, age, highest grade completed, health, pre-pregnancy BMI, household income, household size, child gender, child parity, the local unemployment rate, urban residence, state of residence, and year of pregnancy. In addition, specification 2 controls for the month of the first physician visit during the pregnancy, pregnancy alcohol consumption, pregnancy cigarette smoking, pregnancy vitamin intake, pregnancy salt consumption, use of diuretics, and pregnancy employment. Model 3 is a multinomial probit that jointly estimates the probabilities of gaining too much weight and too little weight.

calendar year in only the 1990 and successive surveys. Thus, WIC participation is not identified for pregnancy observations occurring prior to those covered by the 1990 survey. For the sub-sample with WIC participation information, I re-estimate my basic models including a "WIC participation" dummy variable. However, the models produce statistically insignificant WIC results (results not reported), possibly because a majority (over two-thirds) of the pregnancy observations are not used in this portion of the analysis due to missing WIC information. When using this reduced sample, the effects of FSBs are statistically insignificant regardless of whether controls for WIC are included, suggesting insignificant results are due to reduced sample size rather than to eliminating potentially confounding effects of WIC benefits.

In an effort to use the full sample, I next re-estimate the models including an individual-specific proxy measure of WIC benefits that equals WIC receipt averaged across the 1990–2002 surveys. The effects of FSBs in these models (not reported) are largely unchanged from those in Tables 2 and 3. Much the same is true when I instead use actual WIC benefits when available and average WIC benefits otherwise (for pre-1990 pregnancies). In this specification, I also include a dummy variable indicating whether WIC values are actual or averaged. Results, presented as specification 2 in Table 4, show that FSBs continue to have a marginally significant effect on the amount of weight gained and the rate of weight gained. Furthermore, FSBs continue to significantly decrease the probability of gaining an insufficient amount of weight (in the multinomial probit model) at the 5 percent level, where increasing FSBs from \$0 to \$100 in each pregnancy month is predicted to decrease this probability from 33.5 percent to 28.9 percent, which is a 4.6 percentage point change. The WIC proxy has a corresponding statistically insignificant effect in these models.

To the extent that average WIC benefits proxy for actual WIC benefits when missing, these results provide no evidence that the effects of FSBs are confounded with WIC. At a minimum, the effects of FSBs are not statistically different when controls for WIC are added. Of course, average WIC benefits may be a poor proxy for actual WIC benefits. If the effects of FSBs and WIC remain confounded, then it may be more appropriate to consider FSBs as a general measure of food assistance rather than as assistance specifically from the Food Stamp Program.

Welfare (AFDC/TANF) receipt and income from Supplemental Security Income (SSI) are collected in every survey. In a related model specification, I control for these sources of transfer payments. The effects of FSBs (not reported) are again essentially unchanged from those in Tables 2 and 3. Welfare and SSI never have significant effects on any measure of pregnancy weight gain.

F. Other Potential Controls for Unobserved Heterogeneity

To explore more generally the extent to which the effects of FSBs identified above represent causal effects, I re-estimate the models first including a supplemental set of covariates controlling for other pregnancy behaviors. These include controls for the month of the first physician visit during the pregnancy, pregnancy alcohol consumption, pregnancy cigarette smoking, pregnancy vitamin intake, pregnancy salt consumption, use of diuretics, and pregnancy employment. I do not necessarily interpret the effects of these supplemental pregnancy behaviors variables as causal; instead, these variables potentially are correlated with other, unmeasurable individual-specific characteristics. To the extent that they are, however, they "soak up" confounded effects of unobserved heterogeneity. If the FSBs coefficient does not substantively change when these variables are added, then this would suggest omitted variables have largely already been controlled for. Specification 3 in Table 4 presents the effects of FSBs with the supplement pregnancy behaviors variables included for select models. The food stamp receipt covariate does not substantively change. For example, FSBs continue to have positive effects on the amount of weight gained while pregnant and on the weekly rate of pregnancy weight gain that are significant at the 10 percent level. FSBs also continue to significantly decrease the probability of gaining an insufficient amount of weight while pregnant, with coefficients that are virtually the same size as in Table 3.

In an additional attempt to explore the extent of potential unobserved heterogeneity bias, I next re-estimate the models including a control for FSBs received in the two years prior to the pregnancy (results not reported). It is difficult to imagine food stamp receipt prior to the pregnancy having a causal effect on pregnancy weight gain. However, prior food stamp receipt may proxy for unobserved individual characteristics potentially correlated with both pregnancy FSBs and pregnancy weight gain. If so, then, as for specification 2, controlling for pre-pregnancy FSBs may "pick up" correlation with unobserved heterogeneity. As expected, results indicate that pre-pregnancy FSBs never have statistically significant effects on pregnancy weight gain in any of the models, but the contemporaneous measure of FSBs continues to decrease the probability of gaining too little weight while pregnant (though corresponding standard errors are somewhat larger) with a coefficient that is about 85 percent the size of that in Table 3. Both specifications 2 and 3 indicate that additional controls for individual characteristics have a minimal impact on the estimated effects of FSBs.

G. FSBs by Trimester

Next, I re-estimate the pregnancy weight gain models separately identifying the effects of FSBs received in the three pregnancy trimesters. It is not clear whether the effects of FSBs during the first, second, or third trimester should be greatest. One might argue that the effects of FSBs late in the pregnancy should be greatest because most fetal growth occurs in the third trimester (see Chomitz, Cheung, and Lieberman, 1995). However, effects in other trimesters may be just as significant. For example, in related studies, pregnancy weight gain in all three trimesters has been found to significantly affect birth weight (Abrams et al., 2000), with some studies finding the third trimester to be most important (Hickey, Cliver, McNeal, Hoffman, and Goldenberg, 1995) and others finding the second trimester to be most important (Abrams and Selvin, 1995; Hickey, Cliver, McNeal, Hoffman, and Goldenberg, 1996). Alternatively, Hediger, Scholl, Belsky, Ances, and Salmon (1989) find that insufficient weight gain during the first 24 weeks of the pregnancy has significant, detrimental effects on fetal growth even if weight gain during the remaining portion of the pregnancy results in sufficient total pregnancy weight gain. In another related line of research, Mucscati, Gray-Donald, and Koski (1996) have found that weight retention postpartum is significantly associated with weight gain during the first 20 weeks of the pregnancy.

Results (not reported) indicate that receipt during none of the three trimesters has an effect that is statistically different than zero. However, these results should be interpreted with caution because FSBs received across the three trimesters are quite correlated, and different effects across trimesters would likely be identified by relatively infrequent changes in food stamp receipt. For example, only 220 (about 15 percent) of my pregnancy observations receive FSBs in at least one trimester but not in at least one other trimester.

V. CONCLUSIONS

These results indicate that FSBs have a marginally significant positive effect on pregnancy weight gain and significantly decrease the likelihood that low-income expectant mothers gain an insufficient amount of weight while pregnant. Further, FSBs appear to do nothing to exacerbate excessive weight gain. This result is obtained using a DFRE estimator to explicitly model spurious correlation between pregnancy weight gain and FSBs for a sample of relatively homogeneous low-income expectant mothers. Results are broadly similar when supplemental covariates are included measuring other pregnancy behaviors, which suggests unobserved omitted factors have already largely been controlled for. Further, results remain largely unchanged when controlling for pre-pregnancy FSBs, which should have no causal effects on pregnancy weight gain but which might be correlated with the same unobserved factors as FSBs received during the pregnancy.

That FSBs help achieve an ideal amount of pregnancy weight gain for recipients is a previously-unidentified justification for the program. Specifically, providing FSBs to low-income expectant mothers during each month of their pregnancy is predicted to decrease the probability of gaining an insufficient amount of weight by an average of about 4 percentage points (across the various model specification). To put this impact in perspective, suppose the CDC's estimates for the prevalence of low birth weight are relevant for my sample of low-income expectant mothers (recall that 13.5 percent of expectant mothers who gain too little weight while pregnant have low birth weight babies while only 6.2 percent of expectant mothers who gain a sufficient amount of weight do). If roughly 32 percent of low-income women gain an insufficient amount of weight and the rest gain a sufficient amount of weight, then we would expect about 8.5 percent of my sample's births to be of low birth weight. However, if FSBs were provided to the expectant mothers in my sample, then the results presented in this paper predict that the prevalence of insufficient pregnancy weight gain would decrease to about 28 percent (and 72 percent of my sample would then gain a sufficient amount of weight). Now, a bit less than 8.25 percent of my sample's births would be predicted to be of low birth weight. Thus, FSBs could potentially decrease the prevalence of low birth weight among low-income women by about a fourth of a percent.[14] This would achieve among low-income women about 10 percent of the reduction in low birth weight called for by Healthy People 2010, whose goal, specifically, is to decrease the prevalence of low birth weight by 2.5 percent, though the prevalence of low birth weight for all expectant mothers would fall by this amount only if FSBs had the same impact on non-low-income women (U.S. Department of Health and Human Services, 2000). Correspondingly, the average cost of providing FSBs (based on average FSBs excluding non-recipients in my sample) to a pregnant woman for nine months would be roughly $1,800 (in 2004 dollars).

The FSP, by facilitating ideal pregnancy weight gain, potentially improves health outcomes. Uncovering this link is particularly important given that insufficient pregnancy weight gain is common, and it is even more prevalent in low-income sub-samples. Identifying such a justification is particularly important in today's welfare-reformed environment where entitlement benefits (such as AFDC/TANF) have been substantially reduced or eliminated, leaving the FSP as one of the largest remaining entitlement programs. Furthermore, the results provide no evidence that FSBs spur too much pregnancy weight gain.

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[14]Similarly, many studies, which are summarized by a GAO report (1992), find that WIC reduces low birth weight, though this conclusion has been challenged recently by some who contend that much of this effect appears to operate through preterm birth but that it is unlikely WIC would affect gestation length (Joyce, Gibson, and Colman, 2005). No study has examined the FSBs-birth weight link.

Consequently, it would be difficult to infer from these results that such benefits exacerbate obesity, as found in other contexts (Gibson, 2003; Chen et al., 2005; Meyerhoefer and Pylyphuck, 2006; Baum, 2007).

References

Abrams, Barbara, Sarah L. Altman, and Kate E. Pickett. 2000. "Pregnancy Weight Gain: Still Controversial." *American Journal of Clinical Nutrition* 71(5): 1233S–1241S.

Abrams, B. F., and S. Selvin. 1995. "Maternal Weight Gain Pattern and Birth Weight." *Obstetric Gynecology* 86(2): 163–169.

Akaike, Hirotugu. 1973. "Information Theory and an Extension of the Maximum Likelihood Principle." In 2nd International Symposium on Information Theory, edited by B. N. Petrov and C. Csaki. Budapest: Akademiai Kiado, pp. 267–281.

Basiotis, Peter, Carol S. Kramer-LeBlanc, and Eileen T. Kennedy. 1998. "Maintaining Nutrition Security and Diet Quality: The Role of the Food Stamp Program and WIC." *Family Economics and Nutrition Review* 11(1–2): 4–16.

Baum, Charles L. 2007. "The Effects of Food Stamps on Obesity." The United States Department of Agriculture (USDA), Economic Research Service (ERS), Washington, DC.

Blau, David M. 1994. "Labor Force Dynamics of Older Men." *Econometrica* 62(1): 117–156.

Blau, David M., and Alison Hagy. 1998. "The Demand for Quality in Child Care." *Journal of Political Economy* 106(1): 104–146.

Butte, Nancy F., Kenneth J. Ellis, William W. Wong, Judy M. Hopkinson, and E. O'Brien Smith. 2003. "Composition of Gestational Weight Gain Impacts Maternal Fact Retention and Infant Birth Weight." *American Journal of Obstetrics and Gynecology* 189(5): 1423–1432.

Caulfield, Laura E., Rebecca J. Stolzfus, and Frank R. Witter. 1998. "Implications of the Institute of Medicine Weight Gain Recommendations for Preventing Adverse Pregnancy Outcomes in Black and White Women." *American Journal of Public Health* 88(8): 1168–1174.

Cawley, John. 2000. "Body Weight and Women's Labor Market Outcomes." Unpublished Manuscript. National Bureau of Economic Research.

Centers for Disease Control and Prevention (CDC). 2006a. "Overweight and Obesity: Defining Overweight and Obesity." Centers for Disease Control and Prevention, Department of Health and Human Services. Washington, DC: http://www.cdc.gov/nccdphp/dnpa/obesity/defining.htm.

Centers for Disease Control and Prevention (CDC). 2006b. "BMI - Body Mass Index: Home." Centers for Disease Control and Prevention, Department of Health and Human Services. Washington, DC: http://www.cdc.gov/nccdphp/dnpa/bmi/index.htm.

Centers for Disease Control and Prevention (CDC). 2006c. "Birth Outcome and Risk Factor Analysis." Centers for Disease Control and Prevention, Department of Health and Human Services. Washington, DC: http://www.cdc.gov/pednss/how_to/read_a_data_table/prevalence_tables/birth_outcome.htm.

Chen, Zhuo, Steven T. Yen, and David B. Eastwood. 2005. "Effects of Food Stamp Participation on Body Weight and Obesity." *American Journal of Agricultural Economics* 87(5): 1167–1173.

Chomitz, V. R., L. W. Y. Cheung, and E. Lieberman. 1995. “The Role of Lifestyle in Preventing Low Birth Weight.” *The Future of Children* 5(1): 121–138.

Cogswell, Mary E., Mary K. Serdula, Daniel W. Hungerford, and Ray Yip. 1995. “Gestational Weight Gain among Average-Weight and Overweight Women – What is Excessive?” *American Journal of Obstetrics and Gynecology* 172(2): 705–712.

Costa, Dora L. 2004. “Race and Pregnancy Outcomes in the Twentieth Century: A Long-Term Comparison.” *Journal of Economic History* 64(4): 1056–1086.

Devaney, Barbara, and Thomas Fraker. 1989. “The Effect of Food Stamps on Food Expenditures: An Assessment of Findings From the Nationwide Food Consumption Survey.” *American Journal of Agricultural Economics* 71(1): 99–104.

Ehrenberg, Hugh M., LeRoy Dierker, Cynthia Milluzzi, and Brian M. Mercer. 2003. “Low Maternal Weight, Failure to Thrive in Pregnancy, and Adverse Pregnancy Outcomes.” *American Journal of Obstetrics and Gynecology* 189(6): 1726–1730.

Flegal, Katherine M., Margaret D. Carroll, Cynthia L. Ogden, and Clifford L. Johnson. 2002. “Prevalence and Trends in Obesity Among U.S. Adults, 1999–2000.” *Journal of the American Medical Association* 288(14): 1723–1727.

Flegal, Katherine M., Barry I. Graubard, David F. Williamson, and Mitchell H. Gail. 2005. “Excess Deaths Associated with Underweight, Overweight, and Obesity.” *Journal of the American Medical Association* 293(15): 1861–1867.

Fraker, Thomas M. 1990. *The Effects of Food Stamps on Food Consumption: A Review of the Literature*. Alexandria, VA: Food and Nutrition Service.

Fraker, Thomas M., Alberto P. Martini, and James C. Ohls. 1995. “The Effect of Food Stamp Cashout on Food Expenditures.” *Journal of Human Resources* 30(4): 633–649.

Gabor, Vivian, and Christopher Botsko. 1998. “State Food Stamp Policy Choices under Welfare Reform: Findings of 1997 50-State Survey.” United States Department of Agriculture. Washington, DC.

General Accounting Office (GAO). 1992. “Early Intervention: Federal Investments Like WIC Can Produce Savings.” Washington, DC: General Accounting Office: GAO-HRD-92-18.

Gibson, Diane. 2003. “Food Stamp Program Participation is Positively Related to Obesity in Low Income Women.” *Journal of Nutrition* 133(7): 2225–2231.

Gritz, R. Mark. 1987. “An Empirical Analysis of the Effect of Training Programs on Employment.” Dissertation, Stanford University. Stanford, CA.

Gritz, R. Mark. 1993. “The Impact of Training on the Frequency and Duration of Employment.” *Journal of Econometrics* 57 (1–3): 21–51.

Gunderson, Erica P., and Barbara Abrams. 2000. “Epidemiology of Gestational Weight Gain and Body Weight Changes after Pregnancy.” *Epidemiology Review* 22(2): 261–274.

Gunderson, E. P., B. F. Abrams, and S. Selvin. 2000. "The Relative Importance of Gestational Weight Gain and Maternal Characteristics Associated with the Risk of Becoming Overweight After Pregnancy." *International Journal of Obesity and Related Metabolic Disorders* 24 (12): 1660–1668.

Ham, John C., and Robert J. LaLonde. 1996. "The Effect of Sample Selection and Initial Conditions in Duration Models: Evidence From Experimental Data on Training." *Econometrica* 64(1): 175–205.

Heckman, James J., and Burton Singer. 1984. "A Method for Minimizing the Distributional Assumptions in Econometric Models for Duration Data." *Econometrica* 52: 271–320.

Heckman, James J., and James R. Walker. 1990. "The Relationship between Wages and Income and the Timing and Spacing of Births: Evidence from Swedish Longitudinal Data." *Econometrica* 58(6): 1411–1441.

Hediger, M. L., T. O. Scholl, D. H. Belsky, I. G. Ances, and R. W. Salmon. 1989. "Patterns of Weight Gain in Adolescent Pregnancy: Effects on Birth Weight and Pre-Term Delivery." *Obstetrics and Gynecology* 74(1): 6–12.

Hickey, Carol A. 2000. "Sociocultural and Behavioral Influences on Weight Gain during Pregnancy." *American Journal of Clinical Nutrition* 71(supplement): 1364S–1370S.

Hickey, C. A., S. P. Cliver, S. F. McNeal, H. J. Hoffman, and R. L. Goldenberg. 1995. "Prenatal Weight Gain Patterns and Spontaneous Preterm Birth Among Non-Obese Black and White Women." *Obstetric Gynecology* 85(6): 909–914.

Hickey, C. A., S. P Cliver, S. F. McNeal, H. J. Hoffman, and R. L. Goldenberg. 1996. "Prenatal Weight Gain Patterns and Birth Weight among Non-Obese Black and White Women." *Obstetrics and Gynecology* 88(4): 490–496.

Hotz, V. Joseph, Lixin C. Xu, Marta Tienda, and Avner Ahituv. 2002. "Are There Returns to the Wages of Young Men From Working While in School?" *Review of Economics and Statistics* 84(2): 221–236.

Hurst, Erik, and James P. Ziliak. 2006. "Do Welfare Asset Limits Affect Household Saving? Evidence from Welfare Reform." *Journal of Human Resources* 41(1): 46–71.

Institute of Medicine. 1985. *Preventing Low Birth Weight*. Washington, DC: National Academy Press.

Institute of Medicine. 1990. *Nutrition During Pregnancy*. Washington, DC: National Academy Press.

Johnson, J. W. C., J. A. Longmate, and B. Frentzen. 1992. "Excessive Maternal Weight and Pregnancy Outcome." *American Journal of Obstetrics and Gynecology* 167: 353–372.

Johnson, John W. C., and Michael K. Yancey. 1996. "A Critique of the New Recommendations for Weight Gain in Pregnancy." *American Journal of Obstetrics and Gynecology* 174(1): 254–258.

Joyce, Ted, Diane Gibson, and Silvie Colman. 2005. "The Changing Association between Prenatal Participation in WIC and Birth Outcomes in New York City." *Journal of Policy Analysis and Management* 24(4): 661–685.

Kabbani, Nader S., and Parke E. Wilde. 2003. "Short Recertification Periods in the U.S. Food Stamp Program." *Journal of Human Resources* 83(5): 1112–1138.

Kiely, John L., and Mervyn Susser. 1992. "Preterm Birth, Intrauterine Growth Retardation, and Perinatal Mortality." *American Journal of Public Health* 82(3): 343–345.

Kline, J., Z. Stein, and M. Susser. 1989. *Conception to Birth: Epidemiology of Prenatal Development*. New York: Oxford University Press.

Knaus, John. 2003. "Food Stamp Program State Options Report." Washington, DC: United States Department of Agriculture, Food and Nutrition Service.

Koops, B. L., L. J. Morgan, and F. C. Battaglia. 1982. "Neonatal Mortality Risk in Relation to Birth Weight and Gestational Age: Update." *Journal of Pediatrics* 101(6): 969–977.

Kramer, M. S., A. L. Coates, M. C. Michoud, S. Dagenais, E. F. Hamilton, and A. Papageorgiou. 1995. "Maternal Anthropometry and Idiopathic Preterm Labor." *Obstetric Gynecology* 86(5): 744–748.

Marsoosi, V., A. Jamal, and L. Eslamian. 2004. "Pre-Pregnancy Weight, Low Pregnancy Weight Gain, and Preterm Delivery." *International Journal of Gynecology and Obstetrics* 87(1): 36–37.

McCormick, M.C. 1985. "The Contribution of Low Birth Weight to Infant Mortality and Childhood Mortality." *New England Journal of Medicine* 312(2): 82–90.

Meyerhoefer, Chad D., and Yuriy Pylypchuk. 2006. "Does Participation in the Food Stamp Program Affect the Prevalence of Obesity and Health Care Spending?" *Unpublished Manuscript*, Center for Financing, Access and Cost Trends, Agency for Healthcare, Research, and Quality.

Mokdad, Ali H. 2005. "Correction: Actual Causes of Death in the United States, 2000." *Journal of the American Medical Association* 293(3): 293.

Mokdad, Ali H., James S. Marks, Donna F. Stroup, and Julie L. Gerberding. 2004. "Actual Causes of Death in the United States, 2000." *Journal of the American Medical Association* 291(10): 1238–1245.

Mroz, Thomas A. 1999. "Discrete Factor Approximations in Simultaneous Equation Models: Estimating the Impact of a Dummy Endogenous Variable on a Continuous Outcome." *Journal of Econometrics* 92(2): 233–274.

Mroz, Thomas A., and Timothy H. Savage. 2006. "The Long-Term Effects of Youth Unemployment." *Journal of Human Resources* 41(2): 259–293.

Mucscati, S., K. Donald-Grey, and K. Koski. 1996. "Timing of Weight Gain during Pregnancy: Promoting Fetal Growth and Minimizing Maternal Weight Retention." *International Journal of Obesity* 20: 526–532.

Ogden, Cynthia L., Margaret D. Carroll, Lester R. Curtin, Margaret A. McDowell, Carolyn J. Tabak, and Katherine M. Flegal. 2006. "Prevalence of Overweight and Obesity in the United States, 1999–2004." *Journal of the American Medical Association* 295(13): 1549–1555.

Ogden, Cynthia L., Katherine M. Flegal, Margaret D. Carroll, and Clifford L. Johnson. 2002. "Prevalence and Trends in Overweight among U.S. Children and Adolescents, 1999–2000." *Journal of the American Medical Association* 288(14): 1728–1732.

Rooney, Brenda L., and Charles W. Schauberger. 2002. "Excess Pregnancy Weight Gain and Long-Term Obesity: One Decade Later." *Obstetrics and Gynecology* 100(2): 245–253.

Rose, D., J. P. Habicht, and B. Devaney. 1997. "Household Participation in the Food Stamp and WIC Programs Increases the Nutrient Intakes of Preschool Children." *Journal of Nutrition* 128: 548–55.

Rosenberg, Terry J., Samantha Garbers, Heather Lipkind, and Mary A. Chiasson. 2005. "Maternal Obesity and Diabetes as Risk Factors for Adverse Pregnancy Outcomes: Differences among 4 Racial/Ethnic Groups." *American Journal of Public Health* 95(9): 1545–1551.

Schieve, L. A., M. E. Cogswell, and K. S. Scanlon. 1998. "An Empiric Evaluation of the Institute of Medicine's Pregnancy Weight Gain Guidelines by Race." *Obstetric Gynecology* 91(6): 878–884.

Stephansson, Olof, Paul W. Dickman, Anna Johansson, and Sven Cnattingius. 2001. "Maternal Weight, Pregnancy Weight Gain, and the Risk of Antepartum Stillbirth." *American Journal of Obstetrics and Gynecology* 184(3): 463–469.

Sullivan, James X. 2006. "Welfare Reform, Saving, and Vehicle Ownership: Do Asset Limits and Vehicle Exemptions Matter?" *Journal of Human Resources* 41(1): 72–105.

Super, David, and Stacy Dean. 2001. "New State Options to Improve the Food Stamp Vehicle Rule." Center on Budget and Policy Priorities. Washington, DC: http://www.cbpp.org/1-16-01fs.htm.

Tekin, Erdal. 2007. "Childcare Subsidies, Wages, and Employment of Single Mothers." *Journal of Human Resources* 42(2): 453–487.

Thorsdottir, Inga, Johana E. Torfadottir, Bryndis E. Birgisdottir, and Reynir T. Geirsson. 2002. "Weight Gain in Women of Normal Weight Before Pregnancy: Complications in Pregnancy or Delivery and Birth Outcome." *Obstetrics and Gynecology* 99(5): 799–807.

United States Department of Health and Human Services. 2000. *Healthy People 2010: Understanding and Improving Health*. U.S. Department of Health and Human Services. Washington, DC.

Wilde, Parke E., Paul E. McNamara, and Christine K. Ranney. 1999. "The Effect of Income and Food Programs on Dietary Quality: A Seemingly Unrelated Regression Analysis with Error Components." *American Journal of Agricultural Economics* 81(4): 959–971.

Young, Thomas K., and Barbara Woodmansee. 2002. "Factors that are Associated with Cesarean Delivery in a Large Private Practice: The Importance of Prepregnancy Body Mass Index and Weight Gain." *American Journal of Obstetrics and Gynecology* 187(2): 312–320.

Ziliak, James P., Craig Gundersen, and David N. Figlio. 2003. "Food Stamp Caseloads over the Business Cycle." *Southern Economic Journal* 69(4): 903–919.