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The Effects of Food Stamps on Weight Gained by Expectant Mothers

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Abstract

With over 66 % of Americans overweight, expectant mothers are unusual because they are encouraged to *gain* weight while pregnant. Food stamp receipt (FSR) may facilitate recommended weight gain for pregnant women by providing additional resources for food and nutrition. I examine the effects of FSR on the amount of weight gained by low-income expectant mothers using NLSY79 data. Results indicate FSR decreases the probability gaining an insufficient amount of weight but does not exacerbate the probability of gaining too much weight. Examining the effects of FSR on pregnancy weight gain is important because low birth weight is more likely when expectant mothers gain an insufficient amount of weight.

Key words: Food stamps, weight, weight gain

JEL category: J1

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I. Introduction

The Food Stamp Program (FSP) seems to have been successful increasing food consumption[1] and nutrient intake[2] for 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 Baum, 2007, Chen, Yen, and Eastwood, 2005, and Meyerhoefer and Pylyphuck, 2008). This would be concerning because many Americans are already overweight and obese[3]—roughly two-thirds of Americans are overweight and 30 % are obese (Flegal et al., 2002; Ogden et al., 2006)—and both are more prevalent among those with low incomes (Ogden et al., 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 receipt (FSR) on weight for pregnant women are likely different. This is because weight gain is not necessarily a detrimental, unintended side-effect for them. Instead, expectant mothers are almost universally encouraged by their physicians to *gain* at least some weight while pregnant. Specifically, the Centers for Disease Control and Prevention (CDC), using Institute of

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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).

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 obese should gain at least 15 pounds (CDC, 2006c; Institute of Medicine, 1990).[4]

The FSP may facilitate recommended weight gain for low-income pregnant women by providing additional resources for food consumption and nutrition. For example, Devaney and Moffitt (1991) find that receipt of average food stamp benefits increases caloric intake by 564 calories per week (which is less than two Oreo cookies per day) for adult-male equivalents, with much of the literature largely concurring (for example, see Akin et al., 1985, Basiotis et al., 1998, and Rose et al., 1997). Gaining a pound of weight requires an imbalance of 3,500 calories. Without a change in caloric expenditure, increasing caloric intake by 564 calories per week could result in weight gain of 6.28 pounds over a 39-week pregnancy (564 calories multiplied by 39 weeks and then divided by 3,500 to convert to pounds). This suggests food stamps have the potential to increase weight while pregnant by a meaningful amount. A portion of expectant mothers on food stamps 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 % of expectant mothers with normal pre-pregnancy weight do not gain enough weight during their pregnancy, 22.8 % of expectant mothers underweight

[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.

pre-pregnancy do not, 4.5 % of those overweight do not, and 12.7 % of those obese do not (CDC, 2006c).[5]

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[6] 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)* simultaneously examine participation in The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), *(iv)* control for other pregnancy behaviors, and *(v)* examine the effects of FSR from each trimester. Results provide some evidence that FSR increases the amount of weight gained while pregnant by a pound or two and the amount of weight gained relative to the recommended amount of weight to gain. In addition, FSR decreases the probability of low-income expectant mothers gaining an insufficient amount of weight; however, FSR does not increase the probability of gaining too much weight. In particular, providing low-income women with food stamps would reduce the prevalence of insufficient pregnancy weight gain by about 6 percentage points. This

[5] Relatedly, 30 % to 40 % of expectant mothers do not gain an amount of weight that falls within recommended ranges, gaining either an insufficient amount of weight or too much weight (Abrams, Altman, and Pickett, 2000; Hickey, 2000).

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

project fills a gap in the literature because I know of no research examining the effects of FSR on pregnancy weight gain.

Examining the effects of FSR 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 et al., 2003; Caulfield, Stolzfus, and Witter, 1998; Cogswell et al., 1995; Costa, 2004; Ehrenberg et al., 2003; Kramer et al., 1995; Marsoosi, Jamal, and Eslamian, 2004; Schieve, Cogswell, and Scanlon, 1998; Thorsdottir et al., 2002).[7] For example, the CDC reports that 13.5 % of women whose pregnancy weight gain is less than that recommended give birth to low birth weight babies while only 6.2 % of those whose weight gain is in the recommended range do (CDC, 2006c).[8]

Many concur that gaining a recommended amount of weight while pregnant instead of an amount below the recommended range reduces the probability of low birth weight; however, some even find that the probability of low birth weight decreases incrementally with continued maternal weight gain, even for weight gain beyond the minimum threshold recommended by the Institute of Medicine (Abrams et al., 2000; Caulfield et al., 1998; Cogswell et al., 1995; Schieve et al., 1998). For example,

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[7] Some disagree that pregnancy weight gain significantly affects these measures (Johnson and Yancey, 1996; Stephansson et al., 2001).

[8] Almond, Hoynes, and Schanzenbach (2008) examine the effects of the FSP on birth weight and the probability of low birth weight. They conclude that food stamps significantly increase birth weight (and decrease the prevalence of low birth weight) but do not significantly affect neonatal mortality. Somewhat differently, Currie and Cole (1991) find no significant effects of the FSP on birth weight, and Currie and Moretti (2008) find that food stamps reduce birth weight.

Schieve et al. (1998) conclude that the relationship between pregnancy weight gain and low birth weight is "strong, near-linear." Similarly, Caulfield et al. (1998) find that the probability of low birth weight decreases incrementally by about 0.09 probability points for each pound gained while pregnant. In a final example, Cogswell et al. (1995) show that even pregnancy weight gain within recommended ranges reduces the probability of low birth weight: mothers of normal weight who gain 30 to 35 pounds instead of 20 to 25 pounds have a one percentage point lower probability of having a low birth weight baby. If so, then recommended ranges for pregnancy weight gain do not necessarily minimize the probability of low birth weight; rather, recommended ranges identify an acceptably low risk level. In sum, FSR, 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 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 % from a current estimate of roughly 7.5 % (U.S. Department of Health and Human Services, 2000).

Additionally, examining the effects of food stamps 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[9] (Butte et al., 2003; Gunderson and Abrams, 2000; Gunderson, Abrams, and Selvin, 2000;

[9] 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.,

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 et al., 2005; Mokdad et al., 2004; Mokdad 2005).

II. Data

I use NLSY79 data to estimate the effects of food stamps 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, 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 gross income at or below 130 % of the national household size-specific poverty line, because these are the ones most likely impacted by food stamps.[10] Between the period covered by the initial 1979 interviews and the year-2002 survey, 10,465 children were born to female NLSY79 respondents.

1995; Johnson, Longmate, and Frentzen, 1992; Johnson and Yancey, 1996; Rosenberg et al., 2005; Young and Woodmansee, 2002).

[10] Results are broadly similar when I instead define low-income as being at or below either 100 %, 150 %, or 200 % of the poverty line.

The key outcome of interest is the amount of weight gained by expectant mothers during their pregnancy.[11] 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 liveborn singletons (709 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 30 pounds and that the rate of weight gain is 0.775 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 obese.[12] The weighted sample average ratio of pregnancy weight gain to recommended

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[11] 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.

[12] 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

weight gain is greater than one (1.048), indicting expectant mothers tend to gain more than recommended (see table 1). Further, 55.4 % of NLSY79 expectant mothers are of normal weight pre-pregnancy, 27.9 % are underweight, 16.6 % are overweight (the overweight category includes those obese), and 8.6 % are obese.[13] Based on pre-pregnancy weight, 32.4 % of the expectant mothers gain an ideal amount of weight while pregnant, 31.4 % do not gain enough weight, and 36.1 % gain too much weight. Of those who gain an insufficient amount of weight, almost 40 % gain at least 10 pounds too little. Of those who gain an excessive amount, 38.8 % gain at least 10 pounds too much. Expectant mothers underweight pre-pregnancy are more likely to gain an ideal amount of weight than normal weight, overweight, and obese expectant mothers. 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 food stamps 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 food stamps during each month of her pregnancy. The NLSY79 also identifies the amount of food stamps received in each month. To measure FSR, I create a

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recommended pregnancy weight gain. For consistency across respondents, I use the BMI cutoffs described earlier for all respondents.

[13] The sizable proportion underweight is at least partially due to these women being relatively young (with an average age of 21.6). For example, 33.9 % of expectant mothers in my sample who give birth in 1979, 1980, 1981, or 1982 are underweight compared to 6.8 % of expectant mothers in my sample who give birth in 1993 through 2002. 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.

dummy variable that equals one if the expectant mother received food stamps during her pregnancy. As specified, the FSR covariate identifies the effect of receiving food stamps at any point during the pregnancy. Fortunately, since the NLSY79 identifies receipt of food stamps in each month covered by the survey, it will be possible to determine the separate effects of FSR in each pregnancy trimester to explore in which third of the pregnancy food stamps have the largest impact. Thus, I create an additional set of food stamp variables that measure whether food stamps were received in each trimester.

Figure 1 shows the amount of pregnancy weight gained by pre-pregnancy weight status for food stamp recipients (those who received food stamps at any time while pregnant) and for non-recipients. Pregnancy weight gain seems to be inversely related to pre-pregnancy weight. In addition, underweight food stamp recipients gain more weight while pregnant than underweight non-recipients. The opposite is true for recipients and non-recipients of normal weight and for those who are overweight or obese pre-pregnancy. Figure 2 presents the proportion of food stamp recipients and the proportion of non-recipients who while pregnant gain an insufficient amount of weight, an amount of weight within the recommended range, and an excessive amount of weight. A smaller portion of mothers on food stamps gain an insufficient amount of weight than mothers without food stamps. The same is true for mothers who gain an excessive amount of weight while pregnant. Therefore, food stamp recipients are more likely to gain a recommended amount of weight than non-recipients.

These correlations do not necessarily represent causal effects. To control for exogenous characteristics of the expectant mother that might affect her weight gain, each of the regression models contains a set of standard explanatory variables. In particular, I control for: the woman's race/ethnicity, marital status, age, education level, and health; 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. Table 2 presents these statistics separately for sub-samples of non-recipients and recipients. Indicated in table 2, low-income food stamp recipients are significantly more likely to be black and significantly less likely to be married. Food stamp recipients have significantly more children (indicated by child parity), but non-recipients have larger households.

A key variable that potentially influences pregnancy weight gain is gestation length because pregnancy weight gain should increase with the length of the pregnancy. Therefore, I include a variable measuring length of gestation (in weeks) in a separate portion of the models. This shows the partial effect of FSR because such food stamps may affect pregnancy weight gain through their effects on gestation length. For example, if food stamps 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

I use multivariate regression analysis to estimate the relationship between FSR and pregnancy weight gain. The key variables are a measure of pregnancy weight gain (W) and FSR (FSR). Formally, I estimate

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

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. I use OLS for continuous pregnancy weight gain measures. 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.[14] 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 σ_t^2 is the variance of ε_{Wt} and $\rho_{tt'}$ 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. In all models, I adjust my standard errors to account for respondent-specific correlation because NLSY79 mothers potentially provide multiple pregnancy observations. Otherwise, standard errors will be understated and significance levels will be overstated.

Within the context of multivariate regression analysis, estimates are susceptible to various sources of bias.[15] One potential source of bias is due to unobserved heterogeneity, where pregnant women 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 FSR is correlated with any unobserved

[14] 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 FSR (and all other covariates) to be monotonic across the ordered probabilities.

[15] See Hamilton and Rossi (2002) and Burstein et al. (2005) for more on potential bias in food assistance research.

characteristic that is also correlated with pregnancy weight gain, then regression estimates will not identify the causal effects of FSR on pregnancy weight gain, producing unobserved heterogeneity bias.

I attempt to control for potential unobserved heterogeneity bias by jointly modeling pregnancy weight gain and FSR, allowing cross-equation correlation. Formally, suppose FSR can be modeled using the probit functional form such that

$$\Pr(FSR_{ij} \mid \varepsilon_{FSRij}) = \Phi(\{FSR_{ij} - [\alpha_0 + \alpha_1 \mathbf{X}_{ij} + \alpha_2 \mathbf{Z}_{ij} + \varepsilon_{FSRij}]\} / \sigma_{FSR}) \quad (2)$$

where Φ is the normal cumulative distribution function and **Z** is a vector of covariates included in the FSR 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 ($\mu_1,\ldots,\mu_M$)

$$\varepsilon_{FSBij} = \nu_1 + \sum_{m=1}^{M} \gamma_{1m}\mu_{ijm} \text{ and } \varepsilon_{Wijt} = \nu_{2t} + \sum_{m=1}^{M} \gamma_{2tm}\mu_{ijm} \quad (3)$$

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

$$LL_{ij}(\mu_1,\ldots, \mu_M) = f_{FSR}(FSR_{ij}| \mu_1,\ldots, \mu_M) \{\sum_{t=1}^{2} d_{ijt}\, \lambda_{ij}^{t} (d_{ijt} = 1 \mid FSR_{ij}, \mu_1,\ldots, \mu_M) \} \quad (4)$$

for t = L and M and where $f_{FSR}(.)$ is the density function for FSRs 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.[16] With M different factors of μ, the unconditional likelihood function is given by

$$\prod_{i=1}^{I}\prod_{j=1}^{J}\sum_{n_1=1}^{N_1}\sum_{n_2=1}^{N_2}\cdots\sum_{n_m=1}^{N_M}L_{ij}(\Theta\,|\,\mu_{i1},\mu_{i2},\ldots,\mu_{iM})\theta_{1n_1}\theta_{2n_2}\theta_{Mn_M} \qquad (5)$$

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

[16] 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.

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 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 FSR 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. 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 food stamps 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 et al., 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 food stamps 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).

These characteristics will serve as exogenous instruments identifying FSR if *(i)* they significantly explain FSR and *(ii)* they do not significantly affect pregnancy weight gain independently of FSR. These eligibility criteria are probably valid instruments on both counts. Certainly state food stamp eligibility criteria should affect FSR 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 weight gain when controlling for FSR. 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 FSR. That is, the value of the log-likelihood function significantly improves when these variables are added to the FSR equation but not when they are added to the pregnancy weight gain equation. [A full set of results for the FSR 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, FSR-related results in OLS specifications appear somewhat biased toward zero.

I later explore the sensitivity of my results to potentially 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. Descriptive statistics presented in table 2 indicate food stamp recipients are significantly more likely to consume alcohol and, as expected, are less likely to be employed. If these variables are correlated with other, unmeasurable individual-specific characteristics, then, when included, they may reduce or eliminate omitted variable bias essentially by "soaking up" confounded effects of unobserved heterogeneity. If unobserved heterogeneity correlated with pregnancy behaviors is biasing the estimates, then when these pregnancy behaviors variables are included, the FSR coefficient should substantively change. Of course, it still could be that other unobserved characteristics not correlated with pregnancy behaviors are affecting the results.

IV. Results

A. Initial Results

To explore the effects of food stamps on pregnancy weight gain, I first regress the amount of weight gained while pregnant measured in pounds on FSR during the pregnancy. I report the effects of the FSR covariate in table 3 (a representative set of results for other covariates is presented in the appendix table). Results, displayed as model 1, provide statistically significant evidence that FSR increases the amount of weight gained while pregnant. For example, switching from no food stamp receipt to receiving food stamps during the pregnancy is predicted to increase pregnancy weight gain by 1.78 pounds, which is about 14 % of a standard deviation (a standard deviation in pregnancy weight gain is 12.6 pounds).

As specified, model 1 provides the total effect of FSR, which potentially confounds separate effects on gestation length and the rate of weight gain. To explore whether FSR has these separate effects, I next in model 2 add a control for gestation length. Model 2's results provide the partial effect of FSR holding gestation, and therefore potential effects on pregnancy weight gain through pregnancy length, constant. The results in model 2 also provide evidence that FSR increases pregnancy weight gain, with the magnitude of this effect being about 80 % the size of that effect in model 1 (and the effects are not statistically different from one another). This suggests that FSR does not primarily affect pregnancy weight gain through gestation length. In another attempt to identify total and partial effects of FSR, I next re-estimate the model using only pregnancy observations of normal gestation length (defined as 37 to 42 weeks). The effects of FSR are statistically significant at the 5 % level, with receiving food stamps while pregnancy again increasing weight by about 1.7 pounds. This suggests FSR does not operate indirectly through gestation. These conclusions are 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. (A representative set of results for other covariates from model 4 is presented in the appendix table.) This accords with the Institute of Medicine's (1990) report that implies fetal growth is more closely linked to nutrition that preterm birth.[17]

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 4, indicate FSR has a statistically significant positive effect, with receiving food stamps increasing the gain-recommendation ratio from 0.937 to 1.157. This specification is somewhat crude in that I assume recommended pregnancy weight gain is the midpoint of the relevant

[17] Kramer (1987a, 1987b) suggests that fetal growth is easier to manipulate than gestational length.

CDC-recommended range. For example, I assume recommended pregnancy weight gain is 30 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 points 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 4, indicate that FSR does not significantly affect the probability of gaining too much weight, but FSP participation does significantly decrease the probability of gaining too little weight at the 5 % level. (A representative set of probit results for other covariates is presented in the appendix table.) For example, switching from no food stamp receipt to receiving food stamps during the pregnancy decreases (decreases) the probability of gaining too little weight (too much weight) from 33.4 % to 27.1 % (36.3 % to 34.3 %), which is a 6.3 (2.0) percentage point change. Thus, such benefits may be of assistance preventing an insufficient amount of pregnancy weight gain. That FSR affects pregnancy weight gain non-monotonically may limit the ability of continuous-outcome models that constrain effects to be proportional to produce statistically significant positive effects of FSR. 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 FSR does not affect the probability of gaining too much weight but does significantly reduce the prevalence of insufficient pregnancy weight gain.

C. By Pre-Pregnancy BMI

The models in table 4 base ideal pregnancy weight gain on pre-pregnancy BMI. If pre-pregnancy BMI affects recommended pregnancy weight gain, then the effects of FSR 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 3 and 4, and coefficients on the FSR covariates are typically not statistically different from one another across sub-samples. Perhaps the most notable change is that some effects that were statistically significant when using the full sample are no longer significant. This may be due to reduced sample sizes. For example, the sample of overweight expectant mothers contains only 118 observations.

D. First-Time Mothers

The effects of FSR may differ for first-time expectant mothers. Perhaps first-time expectant mothers are less likely to receive food stamps, resulting in FSR 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 25.9 % of the first-time expectant mothers in my sample (278 first-time mothers) receive food stamps during their pregnancy but 62.4 % of non-first-time expectant mothers receive food stamps. 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 FSR 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 3 and 4, 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 FSR with an indicator for first-time pregnancy. Specification 1 in table 5 presents the effect of FSR with the FSR-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 FSR for non-first-time mothers are similar to those reported in tables 3 and 4 (and to those for the sub-sample of non-first-pregnancy expectant mothers, described above). However, the FSR-first pregnancy interaction terms tend to have countervailing effects. For example, FSR is predicted to significantly increase pregnancy weight gain by 2.3 pounds for non-first-time expectant mothers but to have virtually no effect on first-time expectant mothers. Similarly, FSR significantly increases pregnancy weight gain by 0.252 pounds per week of gestation for non-first-time expectant mothers, but this positive effect for first-time mothers is only half as large. If anything, these models suggest that positive effects of FSR on pregnancy weight gain (and negative effects on the probability of gaining an insufficient amount of weight) are smaller (in absolute value) for first-time mothers. Alternatively, my sample of full-time mothers may be too small to gauge reliably whether effects differ by child parity. Of the 278 first-time mothers, only 72 receive food stamps while pregnant. For example, the FSR results from the multinomial probit model (model 3 in table 5) are quite mixed, but only 24 (21) first-time expectant mothers in my sample who receive food stamps while pregnant gain too much (too little) weight. I conclude that effects for first-time mothers may be different, and I continue to control for parity in successive models.

E. <u>Confounding Effects of WIC</u>

About 47 % of the expectant mothers in my sample with valid WIC information receive benefits from both WIC and the FSP. The effects of FSR may be different when expectant mothers simultaneously receive benefits from WIC because WIC benefits may substitute for FSR. 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 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 FSR 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 FSR in these models (not reported) are largely unchanged from those in tables 3 and 4. 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 5, show that FSR continues to have a statistically significant positive effect on the amount of weight gained and the rate of weight gained that are largely the same as (about 90 % the size of) corresponding FSR effects in tables 3 and 4 when the WIC covariates are not included. Furthermore, FSR continues to significantly decrease the probability of gaining an insufficient amount of weight (in the multinomial probit model) at the 5 % level, where switching from no food stamp receipt to receiving food stamps is predicted to decrease this probability from 34.3 % to 27.7 %, which is a 6.6 percentage point change. The WIC proxy has corresponding statistically insignificant effects 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 FSR are confounded with WIC. At a minimum, the effects of FSR 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 FSR and WIC remain confounded, then it may be more appropriate to consider FSR as a general measure of food assistance rather than as assistance specifically from the FSP.

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 FSR (not reported) are again essentially unchanged from those in tables 3 and 4. 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 FSR 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 FSR 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 5 presents the effects of FSR with the supplement pregnancy behaviors variables included for select models. Compared to the FSR coefficients in tables 3 and 4, in specification 3 the positive coefficient on the FSR covariate is about 50 % the size in pregnancy weight gain model 1 and is about 75 % the size in rate of gain model 2. However, the effects of FSR on the probability of gaining an insufficient amount of weight (and on the probability of gaining too much weight) are virtually unchanged. For example, FSR continues to decrease the probability of gaining too little weight while pregnant by about 6 percentage points.

G. FSR by Trimester

Next, I re-estimate the pregnancy weight gain models separately identifying the effects of FSR in the three pregnancy trimesters. It is not clear whether the effects of FSR during the first, second, or third trimester should be greatest. One might argue that the effects of FSR late in the pregnancy should be greatest because most fetal growth occurs in the third trimester (see Chomitz et al., 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 et al., 1995) and others finding the second trimester to be most important (Abrams and Selvin, 1995; Hickey et al., 1996).[18] Alternatively, Hediger et al. (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 FSR across the three trimesters is quite correlated, and different effects across trimesters would likely be identified by relatively infrequent changes in FSR. For example, only 134 (about 19 %) of my pregnancy observations receive FSR in at least one trimester but not in at least one other trimester.

V. Conclusions

These results indicate that FSR has a significantly significant positive effect on the amount of weight gained while pregnant and significantly decreases the likelihood that low-income expectant mothers gain an insufficient amount of weight while pregnant. Further, FSR appears to do nothing to

[18] A literature review by Rush et al. (1980) suggests nutrition during the third trimester is most important.

exacerbate excessive weight gain. This result is obtained using a DFRE estimator to explicitly model spurious correlation between pregnancy weight gain and FSR for a sample of relatively homogeneous expectant mothers with gross income at or below 130 % of the poverty line. Results are broadly similar when supplemental covariates are included measuring other pregnancy behaviors, which suggests the omission of those particular factors is not primarily driving the results.

That FSR helps achieve an ideal amount of pregnancy weight gain for recipients is a previously unidentified justification for the program. Specifically, providing FSR 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 6 percentage points (across the various model specifications). 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 % of expectant mothers who gain too little weight while pregnant have low birth weight babies while only 6.2 % of expectant mothers who gain a sufficient amount of weight do). If roughly 32 % 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 % of my sample's births to be of low birth weight. However, if providing food stamps to expectant mothers in my sample reduces the probability of gaining an insufficient amount of weight by 6 percentage points, then the results presented in this paper predict that the prevalence of insufficient pregnancy weight gain would decrease to about 26 % (and 74 % of my sample would then gain a sufficient amount of weight).[19] Now, a bit less than 8.125 % of my sample's births would be predicted

[19] Actually, providing food stamps to expectant mothers in my sample would only decrease the probability of gaining an insufficient amount of weight by 6 percentage points if none of the low-income expectant mothers were receiving food stamps initially. Since about 48 % receive food stamps, providing such benefits to the 52 % who were not receiving food stamps initially would decrease the probability of gaining an insufficient amount of weight in my sample by about half of 6 percentage

to be of low birth weight. Thus, providing food stamps to low-income expectant mothers who are not already receiving such benefits could potentially decrease the prevalence of low birth weight by about three-eighths of a % (0.375).[20] This would achieve among low-income women about 15 % of the reduction in low birth weight called for by Health People 2010, whose goal, specifically, is to decrease the prevalence of low birth weight by 2.5 %, though the prevalence of low birth weight for all expectant mothers would fall by this amount only if FSR had the same impact on non-low-income women (U.S. Department of Health and Human Services, 2000). Correspondingly, the average cost of providing food stamps to a pregnant woman for nine months would be $1,800 (in 2004 dollars).[21]

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 FSR spurs too much pregnancy weight gain. Consequently, it would be difficult to infer from these results that such benefits exacerbate

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points. However, to determine the marginal effect of providing food stamps to every expectant mother in my sample (versus no food stamp receipt), my calculations assume the probability of gaining an insufficient amount of weight decreases by the full 6 percentage points.

[20] 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).

[21] Food stamp recipients in my sample receive roughly $200.00 a month on average in food stamp benefits.

obesity, as found in other contexts (Baum, 2007; Chen et al., 2005; Gibson, 2003; Meyerhoefer and Pylyphuck, 2008).

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Table 1: Descriptive Statistics, Full Sample

Key Explanatory Variable		
FSR (=1 if received food stamps while pregnant)	0.481	(0.500)
Key Outcome Variables		
Pregnancy Weight Gain (in pounds)	30.178	(12.595)
Rate of Pregnancy Weight Gain (pounds per week)	0.775	(0.324)
Weight Gain - Recommended Weight Gain Ratio	1.048	(0.468)
Gained too Much Weight (%)	0.361	(0.481)
Gained too Little Weight (%)	0.315	(0.465)
Other Key Variables		
Gestation Length (in weeks)	39.007	(1.682)
Standard Demographic Variables		
Black Dummy Variable (=1 if black)	0.362	(0.481)
Hispanic Dummy Variable (=1 if Hispanic)	0.254	(0.436)
Mother's Marital Status (=1 if married)	0.286	(0.452)
Mother's Age (in years)	21.646	(4.511)
Mother's Highest Grade Completed	9.317	(1.707)
Health Dummy Variable (=1 if any health limitations)	0.106	(0.308)
Household Income (in 10,000s, 2004 $s)	1.794	(1.502)
Household Size (number of household member)	4.575	(2.474)
Child Gender (=1 if male, 0 if female)	0.519	(0.500)
Child's Birth Order (parity)	2.151	(1.264)
Local Unemployment Rate (%)	8.385	(3.438)
Urban Dummy Variable (=1 if lives in urban area)	0.729	(0.445)
Pregnancy Behavior Variables		
Visit Month (month of first physician visit during pregnancy)	3.182	(1.939)
Alcohol Once (=1 if drank alcohol no more than once/month)	0.087	(0.283)
Alcohol More (=1 if drank alcohol more than once/month)	0.169	(0.375)
Smoked One (=1 if smoked no more than 1 pack/day)	0.320	(0.467)
Smoked More (=1 if smoked more than 1 pack/day)	0.134	(0.341)
Vitamin (=1 if took vitamin supplement during pregnancy)	0.925	(0.263)
Salt (=1 if reduced salt intake during pregnancy)	0.504	(0.500)
Diuretic (=1 if took a diuretic during pregnancy)	0.027	(0.162)
Pregnancy Employment (= portion of pregnancy weeks employed)	0.128	(0.262)

Standard deviations are in parentheses. There are 709 pregnancy-level observations.

Table 2: Descriptive Statistics, Sub-Samples of Non-Recipients and Recipients

Key Explanatory Variable	**Non-Recipients**	**Recipients**
FSR	0.000	1.000
Key Outcome Variables		
Pregnancy Weight Gain	30.633	29.686
Rate of Pregnancy Weight Gain	0.789	0.759
Weight Gain - Recommended Weight Gain Ratio	1.049	1.046
Gained too Much Weight	0.359	0.364
Gained too Little Weight	0.334	0.293
Other Key Variables		
Gestation Length	38.902*	39.120
Standard Demographic Variables		
Black Dummy Variable	0.313***	0.416
Hispanic Dummy Variable	0.269	0.238
Mother's Marital Status	0.334***	0.235
Mother’s Age	20.693***	22.674
Mother's Highest Grade Completed	9.302	9.334
Health Dummy Variable	0.098	0.114
Household Income	1.846	1.737
Household Size	4.861***	4.267
Child Gender	0.511	0.528
Child’s Birth Order	1.712***	2.625
Local Unemployment Rate	8.204	8.580
Urban Dummy Variable	0.726	0.733
Pregnancy Behavior Variables		
Visit Month	3.364***	2.985
Alcohol Once	0.076	0.100
Alcohol More	0.130***	0.211
Smoked One	0.293	0.349
Smoked More	0.128	0.141
Vitamin	0.935	0.915
Salt	0.560***	0.443
Diuretic	0.027	0.026
Pregnancy Employment	0.186***	0.066

Standard deviations are in parentheses. There are 368 non-recipient pregnancy-level observations and 341 recipient pregnancy-level observations. * indicates the means between non-recipients and recipients are statistically different at the 10 % level, ** at the 5 % level, and *** at the 1 % level.

Table 3: The Effect of FSR on Pregnancy Weight Gain

	Model 1	Model 2	Model 3	Model 4
FSR	1.782**	1.392*	1.786**	0.159**
	(0.869)	(0.868)	(0.881)	(0.069)
Predicted Outcomes				
FSR = 0	29.351	29.509	29.360	0.693
FSR = 1	31.134	30.902	31.146	0.852
Log-likelihood Function Value	-3042.4	-3040.8	-2742.3	-480.5
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 709 low-income pregnancy-level observations in models 1, 2, and 4, with 630 normal gestation-length observations in model 3. All models adjust for race, ethnicity, marital status, age, highest grade completed, health, 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.

Table 4: The Effect of FSR on Recommended Pregnancy Weight Gain

	Model 1	Model 2	Model 2
FSR	0.220**	-0.159	-0.288**
	(0.087)	(0.145)	(0.147)
Predicted Outcomes			
FSR = 0	0.937	0.363	0.334
FSR = 1	1.157	0.343	0.271
Log-likelihood Function Value	-741.4	-1005.4	-1005.4
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 % level, ** at the 5 % level, and *** at the 1 % level. The models include 709 low-income pregnancy-level observations. All models adjust for race, ethnicity, marital status, age, highest grade completed, health, 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).

Table 5: The Effect of FSR on Pregnancy Weight Gain

FSR Specification 1:	Model 1	Model 2	Model 3	Model 3
FSR	2.316**	0.252***	-0.038	-0.224
	(1.016)	(0.040)	(0.166)	(0.166)
FSR-First Pregnancy Interaction	-2.521*	-0.123***	-0.664***	-0.188
	(1.401)	(0.044)	(0.242)	(0.306)
Predicted Outcomes				
FSR = 0, First Pregnancy	29.797	0.739	0.400	0.309
FSR = 1, First Pregnancy	29.592	0.868	0.252	0.252
FSR = 0, Non-First Pregnancy	29.427	0.671	0.366	0.339
FSR = 1, Non-First Pregnancy	31.743	0.924	0.401	0.274
Log-likelihood Function Value	-3042.2	-475.7	-1002.0	-1002.0
FSR Specification 2:				
FSR	1.955**	0.204***	-0.154	-0.295**
	(0.869)	(0.060)	(0.153)	(0.147)
WIC	-1.645	-0.058	0.008	0.228
	(1.233)	(0.044)	(0.241)	(0.249)
Predicted Outcomes				
FSR = 0	29.262	0.669	0.368	0.343
FSR = 1	31.217	0.874	0.351	0.277
Log-likelihood Function Value	-3041.1	-478.8	-1001.1	-1001.1
FSR Specification 3:				
FSR	1.036	0.154***	-0.238	-0.282*
	(0.942)	(0.043)	(0.149)	(0.158)
Predicted Outcomes				
FSR = 0	29.676	0.691	0.376	0.331
FSR = 1	31.712	0.848	0.333	0.277
Log-likelihood Function Value	-3030.3	-463.9	-985.4	-985.4
Weight Gain Measure	Weight Gain	Rate of Gain	Gained too Much	Gained too Little

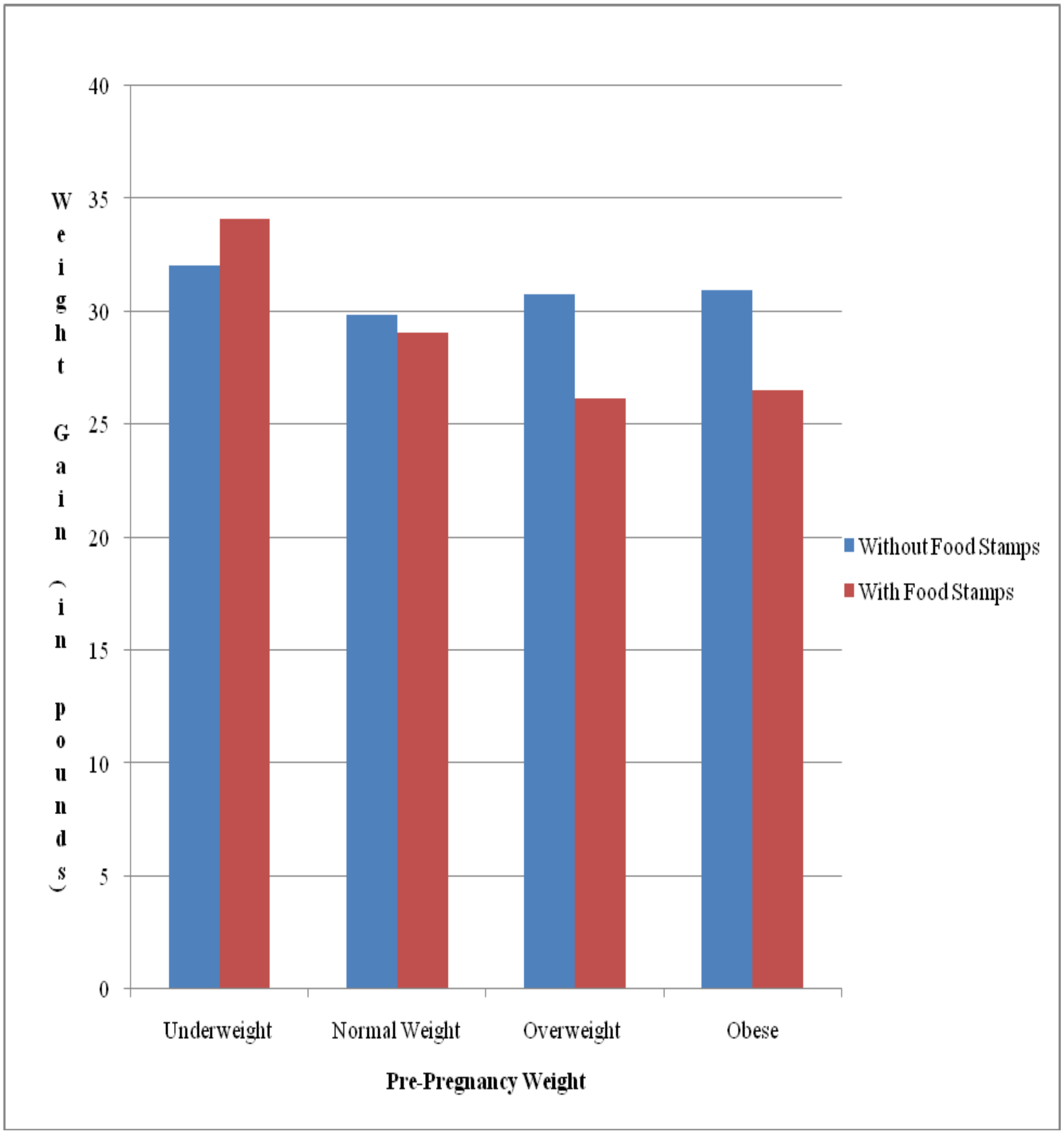
Standard errors are in parentheses. * indicates statistical significance at the 10 % level, ** at the 5 % level, and *** at the 1 % level. The models include 709 low-income pregnancy-level observations. All models adjust for race, ethnicity, marital status, age, highest grade completed, health, household income, household size, child gender, child parity, the local unemployment rate, urban residence, state of residence, and year of pregnancy. In addition, specification 3 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.

Appendix Table: The Effects of Selected Other Covariates

	Model 1		Model 2		Model 3		Model 3	
Constant	23.732***	(4.310)	0.649***	(0.140)	-0.208	(0.750)	0.012	(0.569)
Black Dummy Variable	-4.548***	(1.013)	-0.199***	(0.034)	-0.252	(0.248)	0.682***	(0.242)
Hispanic Dummy Variable	-2.607**	(1.246)	-0.081**	(0.039)	-0.137	(0.213)	0.329	(0.243)
Mother's Marital Status	-0.279	(0.843)	0.015	(0.028)	0.011	(0.147)	0.189	(0.156)
Mother's Age	0.188*	(0.111)	0.007*	(0.004)	0.011	(0.021)	-0.053**	(0.023)
Mother's Highest Grade Completed	0.215	(0.326)	0.004	(0.008)	-0.024	(0.041)	-0.009	(0.041)
Health Dummy Variable	1.600	(1.167)	-0.017	(0.038)	0.213	(0.196)	0.144	(0.214)
Household Income	0.533***	(0.206)	0.019***	(0.007)	0.067*	(0.039)	-0.065	(0.054)
Household Size	-0.445**	(0.182)	-0.011**	(0.005)	-0.033	(0.034)	0.066**	(0.033)
Child Gender	0.968	(0.755)	0.016	(0.022)	-0.046	(0.119)	-0.148	(0.129)
Child's Birth Order	-0.194	(0.397)	-0.042***	(0.012)	0.001	(0.067)	0.109	(0.071)
Local Unemployment Rate	-0.421***	(0.153)	-0.005	(0.005)	0.055**	(0.027)	0.033	(0.029)
Urban Dummy Variable	1.215	(1.011)	0.068**	(0.031)	0.086	(0.168)	-0.127	(0.183)
Visit Month	-0.079	(0.189)	-0.003	(0.006)	-0.026	(0.035)	-0.038	(0.033)
Alcohol Once	1.889	(1.231)	0.031	(0.039)	0.171	(0.208)	0.229	(0.215)
Alcohol More	3.084***	(0.924)	0.129***	(0.031)	0.595***	(0.173)	-0.119	(0.259)
Smoked One	-0.990	(0.815)	-0.011	(0.027)	0.003	(0.138)	0.009	(0.153)
Smoked More	-3.454**	(1.412)	-0.112***	(0.037)	-0.264	(0.222)	0.305	(0.245)
Vitamin	1.912	(1.399)	-0.023	(0.045)	-0.378	(0.249)	-0.208	(0.255)
Salt	0.757	(0.813)	0.033	(0.023)	0.386***	(0.121)	0.049	(0.159)
Diuretic	-9.669***	(2.065)	-0.163**	(0.066)	-0.558	(0.401)	0.260	(0.363)
Pregnancy Employment	0.101	(1.247)	-0.030	(0.047)	-0.300	(0.245)	0.100	(0.284)
Weight Gain Measure	Weight Gain		Rate of Gain		Gained too Much		Gained too Little	

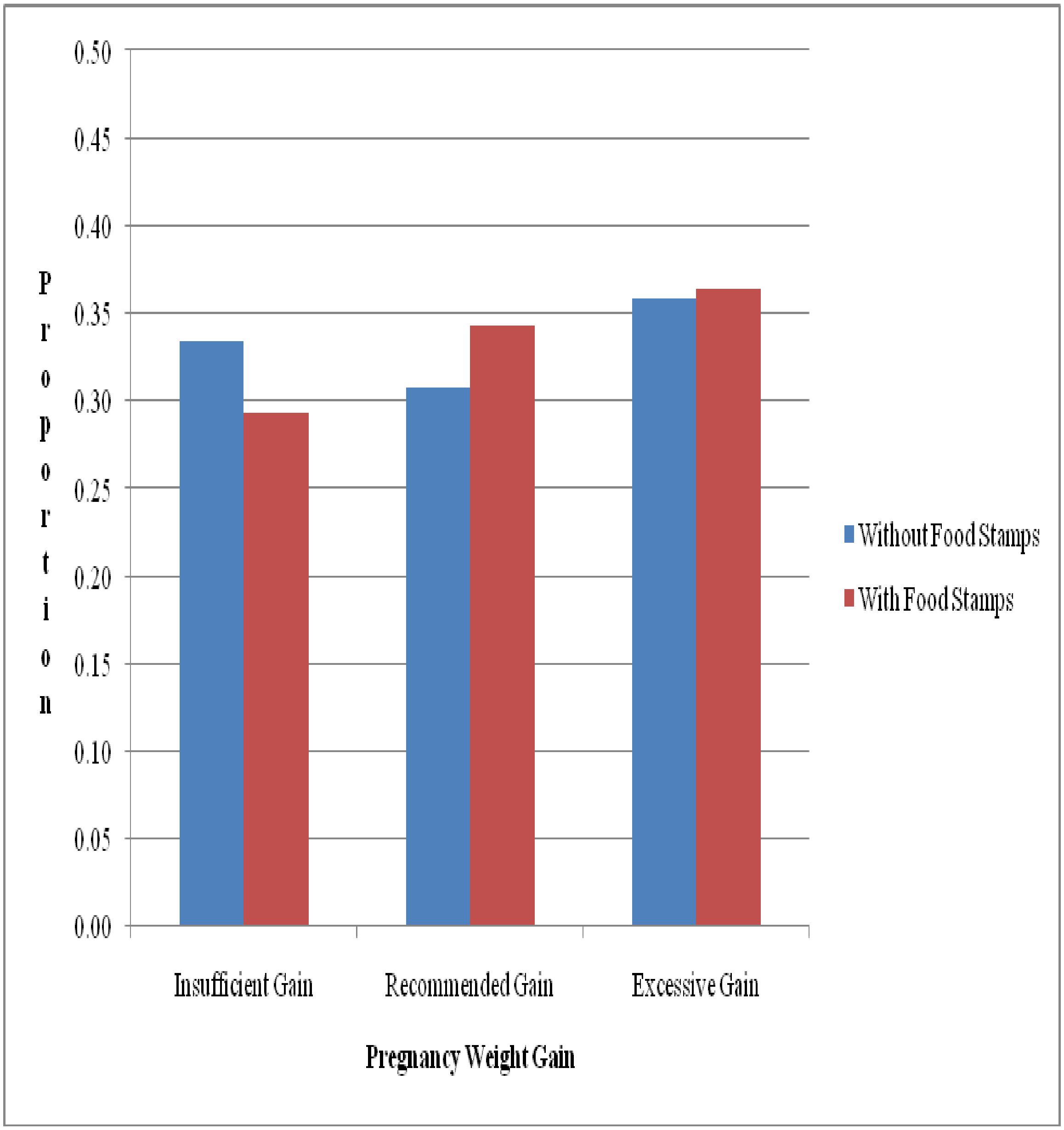
Standard errors are in parentheses. * indicates statistical significance at the 10 % level, ** at the 5 % level, and *** at the 1 % level. The models include 709 low-income pregnancy-level observations. In addition to the covariates shown, all models adjust for state of residence and year of pregnancy (coefficients not presented). The discrete factor unobserved heterogeneity distribution's parameters are also not presented. Model 3 is a multinomial probit that jointly estimates the probabilities of gaining too much weight and too little weight.

Figure 1



40
35
30
25
20
15
10
5
0
Weight Gain (in pounds)
Without Food Stamps
With Food Stamps
Underweight
Normal Weight
Overweight
Obese
Pre-Pregnancy Weight

Figure 2



0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Proportion
Insufficient Gain
Recommended Gain
Excessive Gain
Pregnancy Weight Gain
Without Food Stamps
With Food Stamps