Prenatal WIC Participation and Infant Health: Selection and Maternal Fixed Effects*

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Abstract

This paper examines the effect of participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on birth outcomes. We consider the effect of prenatal WIC participation by pregnant women on birth weight, probability of low birth weight, gestational length, probability of pre-term birth, infant mortality, and neonatal mortality using data from the 1988 National Maternal and Infant Health Survey. Estimation of the birth outcome equations is complicated by the potential endogeneity of the WIC participation decision, and we employ two alternative approaches to circumvent this issue. First, we use an instrumental variables approach in which we model the decision to enter the program. We use data on state-to-state variation in WIC program rules, the availability of WIC clinics, and the generosity of other welfare programs as instruments in this estimation. Second, we estimate a fixed-effect model to control for unobserved person-specific differences across women in the sample. We find evidence that the program has a beneficial impact on the health of black children but little evidence of an effect for whites. Our results suggest, for example, that prenatal WIC participation increases birth weights for black infants by between 5 percent and 13 percent depending on the model and estimation technique.

I. INTRODUCTION

Relative to many other industrialized countries, the United States has surprisingly high rates of low-weight births, pre-term births, and infant mortality. Within the United States, racial differences are particularly glaring with African American women experiencing much higher rates of each of these outcomes than white women (Paneth 1995). These negative birth outcomes are often associated with the socioeconomic status of the mother and her behavior during pregnancy. For example, poor women and women who smoke, use drugs, and receive inadequate prenatal care are at higher risk for poor birth outcomes than other women.[1]

The costs of caring for children born prematurely or with a low birth weight can be tremendous. Lewit et al. (1995) estimate that the cost of caring for an infant weighing less than 2,500 grams at birth averages $15,000 (1988 dollars) in the first year, almost eight times more than the cost of caring for an infant weighing more than 2,500 grams. Additionally, children born with low birth weight face greater risks of many diseases and disabilities later in life (Paneth, 1995; Hack et al. 1995).[2] Because many mothers who have poor birth outcomes also have low income and no private health insurance, government programs such as Medicaid frequently pay the significant cost of caring for premature or low birth weight infants (Devaney et al. 1992). In order to improve the nutritional health and birth outcomes of low-income woman, the U.S. government introduced the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in 1974.[3]

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[1] See the extensive review in Hughes and Simpson (1995).

[2] Paneth (1995) suggests that low birth weight babies are at a higher risk for cerebral palsy, deafness, blindness, epilepsy, chronic lung disease, learning disabilities, and attention deficit disorder.

[3] Prior to 1994 and the passage of the Healthy Meals for Healthy Americans Act, the program was entitled the Special Supplemental *Food* Program for Women, Infants, and Children. It has, however, always used the acronym WIC.

The WIC program provides food vouchers, nutritional education, and health screening and referrals to low income women, infants, and children who are “nutritionally needy.” It is a federally funded program that, in fiscal year 1999, served approximately 7.3 million women, infants, and children at a total cost to the federal government of about $3.9 billion (USDA 2001). To the extent that poor birth outcomes occur because of poor nutrition, a lack of knowledge about nutrition, or a lack of understanding of how the mother’s behavior while pregnant affects the birth outcome, there is hope that a program that provides targeted benefits (e.g., healthy food and nutritional and behavioral counseling) to this high-risk group will have significant positive effects on birth outcomes and the health of children.

A thorough examination of the WIC program is particularly important in the current climate of welfare devolution and an increased focus on in-kind benefits. Even in this climate, where there is strong political will to reduce the generosity of welfare programs and to restrict eligibility for benefits, the WIC program remains politically popular.[4] This popularity may be due to the fact that the program is more limited in scope than other means tested transfer programs such as AFDC.[5] Also, the eligibility requirements are more restrictive than Food Stamps or AFDC and are specifically focused on nutritional needs, a concern that legislators may have difficulty arguing against.

This paper examines the impact of WIC participation by pregnant women on birth weight, low birth weight, gestational length, pre-term birth, infant mortality, and neonatal mortality. The data for this project come from the 1988 National Maternal and Infant Health

[4] In May of 1995 the Senate passed a resolution to acknowledge the success of this program. Ninety-nine Senators voted in favor the resolution.

[5] In 1995 the AFDC program cost just over $22 billion and the WIC program cost just over $3.4 billion.

Survey (NMIHS), a nationally representative sample of women who experienced a live birth or fetal death in 1988, or whose infant born in 1988 subsequently died. This research is in the spirit of other work on the economic analysis of infant health such as Rosenzweig and Schultz (1982) and Currie and Cole (1993). As has been widely recognized, an evaluation of this type is complicated by the selection of women into these programs. There could be adverse selection where women most in need of services choose to participate, or there could be favorable selection of health-concerned women choosing to seek additional assistance.[6] Although a number of studies have evaluated the WIC program, they generally have been limited in scope and have not satisfactorily addressed the selection of women into the program.

We employ two approaches to circumvent the selection problem. First, we use an instrumental variables approach in which we model the woman's decision to enter the program. For this approach to identify the causal effect of the program, we require data that influence the WIC participation decision but not the birth outcome itself. For this task, we use contemporaneous data on state-to-state differences in WIC program rules, the availability of WIC clinics, and the generosity of other related transfer programs. The data on state-level WIC program rules come from a 1988 survey of local WIC agencies conducted by the United States Department of Agriculture, the federal agency that operates the program. The survey was designed to gain a better understanding of how the program is administered below the federal level, and we believe this is the first time these data have been used to explain individual level

[6] Although not discussed in this paper, it has also been recognized that because of the availability of these types of programs there may exist self-selection into who chooses to become pregnant or who decides to carry a child to term. The availability of these programs may lower the cost of child bearing and make women who would otherwise have not chosen to become pregnant, or make pregnant women who would have chosen to have an abortion, have a child. If these women are more likely to have children in the lower tail of the birth weight distribution this condition could cause the program to appear to have a negative impact on birth outcomes. See Grossman and Joyce (1990) and Joyce and Kaestner (1996).

decisions to participate in WIC. Our analysis of these data reveals that some program rules, such as the ease with which applicants can declare their income, play a statistically significant role in explaining the WIC participation decision. As a second approach we take advantage of the pregnancy and WIC participation histories available in the NMIHS and estimate a fixed effect model to control for unobserved person-specific differences across women in the sample. We find consistent evidence that participation in the program leads to improved birth outcomes for blacks. Our results suggest, for example, that prenatal WIC participation increases birth weights for black infants by between 5 and 13 percent depending on the model and estimation technique.

II. THE WIC PROGRAM

WIC is a clinic-based program designed to provide a variety of nutritional and health related goods and services to pregnant, postpartum, and breast-feeding women, infants, and children under the age of five. The WIC program began as a pilot in 1972 and received permanent funding in 1974. By the end of fiscal year 1974, 236 clinics across the U.S. were serving about 88,000 women, infants, and children at a total cost of approximately $10 million. By the end of 1993, the program had grown to 8,989 clinics serving almost 6 million participants at a total cost of just under $3 billion. The program is currently available in all 50 states, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam. For the early 1990's it has been estimated that WIC served about 50 percent of income-eligible women (Ku et al. 1994).

Eligibility

Four main criteria determine eligibility for the program. The first three are relatively straightforward and comparable to other welfare programs. First, the applicant must be a resident of the state in which she is applying for benefits. Second, the applicant must be categorically eligible for the program (e.g., pregnant). Third, the applicant must have a household income below 185 percent of the federal poverty guideline. States have some flexibility regarding the income threshold and can set a lower income limit if it is tied to the income level used for free or reduced-price health services and if the cutoff is not below 100 percent of the poverty guideline. In general if a woman is income eligible for a state's AFDC, Medicaid, or Food Stamps program, she is income eligible for WIC.

The eligibility criterion that sets WIC apart from other welfare programs is that the applicant must be at "nutritional risk." Because the level of risk varies by category, eligibility is determined at an initial screening that takes place on the applicant's first visit to a WIC clinic. While the definitions of some risk factors have changed over the course of the program, overall they have been fairly stable. For pregnant women the current risk factors are the following:[7]

- Anemia
- Age at conception less than 19 years of age or greater than or equal to 35 years of age
- Poor past pregnancy outcome (e.g., past still birth)
- Frequent conception (e.g., interval less than 24 months)
- Current high-risk pregnancy (e.g., gestational diabetes)
- Smoke cigarettes while pregnant
- Regular use of alcohol while pregnant
- Drug use/abuse while pregnant
- Inadequate weight gain
- Low pre-pregnancy weight (10% or more below standard weight for height)
- Obese (20% or more above standard weight for height)
- Inadequate/inappropriate diet (e.g., excessive fat)
- Pica (i.e., consumption of non-food items)
- Poor dentition
- Other current documented nutrition-related medical condition.

A pregnant woman who has any of these risk factors is categorized as being at "nutritional risk," and these risk factors are used to help determine the woman's food package.

The WIC program also differs from other major transfer programs in that it is not an

[7] This list is based on the risk factors used at the Jefferson WIC Clinic in Charlottesville, VA.

entitlement. Periodically the caseload exceeds the resources state agencies have been allocated by the federal government.[8] In such cases the state agencies are required to prioritize their disbursements in a predetermined order. Pregnant women, the focus of this paper, are at the top of the list and thus unlikely to be denied benefits.[9]

Benefits

WIC provides a variety of benefits to participants, most notably food. These benefits are allocated in the form of vouchers that can be redeemed at participating grocery stores. Assuming that women do not completely substitute away their own purchases of food, this program will supplement and strengthen their diet.[10] The specific items received depends on both her category and her level of nutritional risk. The foods must be high in protein, calcium, iron and Vitamins A and C. For pregnant women, the food packages may include milk or cheese, hot or cold cereal that is fortified with iron, fruit or vegetable juice, eggs, and peanut butter or beans. All participants are allocated specific quantities of each item, and many of the items must be chosen from a specific list of brand names. The WIC program is required to spend 80 percent of its budget on food benefits. The value of the food voucher varies depending on the items for which the woman is eligible. In 1988 the average food benefit per month per recipient was $33.29.

The program also provides nutritional and behavioral counseling. This advice may take

[8] Local agencies are allocated resources according to a formula based on the potential number of eligible cases in their area. Some states do contribute their own funds to the operation of WIC. For example, in 1996, 10 states appropriated a total of $51 million for WIC, ranging from $21 million in the state of New York to $24,985 in Nebraska.

[9] Discussions with the staff at the Jefferson WIC Clinic in Charlottesville, VA also suggest that pregnant woman are rarely--if ever--turned away because the clinic lacks sufficient resources.

[10] There is some evidence that WIC participants do not increase their total expenditure on food but rather shift toward more nutritious foods. See Arcia et al. (1990) for an examination of this issue.

the form of literature distributed at the time of a woman's visit to the clinic or an individual consultation with a nutritional expert. Pregnant women receive advice about which foods promote the development of a healthy baby and which behaviors they should avoid.

The third benefit is referrals to health care providers or to other social services. For example, during the screening process to determine "nutritional risk," certain health problems may be detected. In such cases, participants are referred to a variety of health services to address those problems. Women also are told of additional assistance programs for which they may be eligible (e.g., Food Stamps, Medicaid, AFDC).

III. PREVIOUS LITERATURE

Most existing studies of the effect of the WIC program on birth outcomes either focus on a local area or state and are not nationally representative or ignore selection into the program.[11] Kennedy et al. (1982) compared WIC participants from six sites in Massachusetts to non-participants and found significant increases in birth weight and a significant reduction in low birth weight births. Kotelchuck et al. (1984) also used a sample of all WIC births in Massachusetts and matched the WIC sample to a group of non-WIC births using observed characteristics of mothers available on birth certificates. The results showed positive but statistically insignificant increases in birth weight. Metcoff et al. (1985) found a statistically insignificant increase in birth weight for women in Oklahoma. Stockbauer (1987) matched a sample of WIC recipients from Missouri to non-participants using birth certificate data and found significant effects on several outcomes for blacks. Using aggregate level data, Corman et

[11] See Currie (1995) for a more complete list of studies. Schramm (1985, 1986) and Devaney et al. (1992) focus on the effect of WIC participation on Medicaid costs. Endozien et al. (1979) and Rush (1988) use data from the 1970's.

al. (1987) found that counties with higher WIC participation rates were associated with lower neonatal mortality rates. None of these studies examines WIC using nationally representative data, and many of them match WIC participants to non-participants on a limited number of observed characteristics ignoring potential selection into the program.

We are aware of only two analyses that use nationally representative data to examine the effect of WIC participation on birth outcomes. As part of the National WIC Evaluation (Rush 1988), data were gathered for a nationally representative sample of 5,025 WIC recipients and 1,358 controls. The study found weak effects of WIC compared to many of the other evaluations. The authors attribute the weak results in part to potential unobserved differences between the WIC sample and the control group. Using Ordinary Least Squares (OLS) regressions and data from the NMIHS, Gordon and Nelson (1995) concluded that WIC participation increased birth weights for whites by 59 grams (significant at the ten percent level) and for blacks by 79 grams (significant at the five percent level). They also found a significant increase in gestational age of 0.47 weeks, but no effect on infant mortality or neonatal mortality. However, limited attention is given to the issue of selection. The authors report that attempts to correct for selection resulted in implausible estimates of the effect of participation on birth weight and gestational length and that their results appeared to be sensitive to the choice of instruments (state-level WIC food expenditures per capita, an indicator for whether the family had income from wages, and an indicator for WIC participation during previous pregnancies) and model. These problems are not unusual in this literature and have been reported by others such as Devaney et al. (1992). Using the same data, we control for selection and find plausible results. In addition, Gordon and Nelson (1995) do not control for maternal fixed effects, an important contribution of our paper.

In summary, the existing literature finds mostly consistent evidence that the WIC program has a small positive effect on birth outcomes. Effects for whites are smaller and less likely to be statistically significant than results for blacks. Additionally, significant results are found much more frequently for the probability of a low-weight birth and gestational length than for birth weight itself.

IV. MODEL

In this section we outline a simple model of a health production function and discuss the estimation techniques used in the paper.[12] The theoretical basis for this analysis stems from economic models of household decision making in which the mother's utility depends on the health of her children. Choices are limited by income, time, and technology constraints. The health of a child (e.g., birth weight) is assumed to be produced via a health production function. This framework generates reduced-form demand functions for infant health.

Let h_{ij} denote the health outcome of interest where i indexes children and j indexes mothers. Let X_{ij} be a vector of exogenous determinants of outcome h_{ij} for child i in family j, let WIC_{ij} be a policy variable, and assume for simplicity that there are no other potentially endogenous determinants of the outcome of interest. The relationship generating health outcomes is given by

$$(1) \qquad h_{ij} = \alpha X_{ij} + \beta WIC_{ij} + v_{ij}$$

where α is a conformable vector of parameters, β is a scalar parameter, and v_{ij} is an idiosyncratic shock to the health outcome. Components of X_{ij} include characteristics such as

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[12] See Corman and Grossman (1985) for a discussion of this methodology. Also see Rosenzweig and Schultz (1982), Rosenzweig (1986), Rosenzweig and Wolpin (1995), and Grossman and Joyce (1990) for similar models.

mother's height and the sex of the child.

Under the assumption that WIC participation is exogenous, the ordinary least squares estimate of β is a consistent estimate of the effect of WIC participation on the health outcome. However, previous researchers (e.g., Gordon and Nelson 1995) have expressed concern about whether WIC participation is exogenous and thus about whether OLS is appropriate. Statistically, the problem is that one of the assumptions of OLS (the assumption that the expected value of the error term conditional on the regressors is equal to zero) may be violated. To gain a sense of why this might be the case, assume that women choose to participate in WIC, $WIC_{ij} = 1$, if $WIC_{ij}^{*} > 0$ where

(2) $$WIC_{ij}^{*} = \gamma W_{ij} + \omega_{ij}$$

is the latent value of WIC participation. The vector W_{ij} includes the components of X_{ij} and some additional variables (instruments) Z_{ij} that affect the WIC participation decision but not the health outcome; γ is a conformable vector of parameters that measures the effect of the observed characteristics on the value of WIC participation, and ω_{ij} is a stochastic disturbance. Now suppose that the error terms in equations (1) and (2) are correlated. If these error terms are negatively correlated, women who are at risk for a poor birth outcome after controlling for observed characteristics are more likely to participate in WIC. This negative association between birth outcomes and WIC participation leads to a downward biased OLS estimate of β .

We use two approaches to deal with the possible endogeneity problem. The first is Two Stage Least Squares (2SLS). For this procedure we estimate a first-stage WIC participation equation (equation (2)). Predicted values from this equation are then used in the estimation of equation (1). The well-known problem with this approach is finding appropriate instruments. We follow the literature that utilizes state-to-state variation in program generosity. Specifically, we use state-to-state variation in WIC and other transfer programs to identify the effect of WIC participation. The idea is that specific state rules governing WIC participation and state-level welfare generosity and availability are correlated with WIC participation but not with the unobserved health variables. The program characteristics used to identify this model are described in the data section.

As part of this analysis, we perform two types of tests. First, we perform Hausman specification tests (Hausman 1978). In the present context the Hausman test can be thought of as a test of the endogeneity of WIC participation.[13] Second, because we utilize several instruments while focusing only on the endogeneity of WIC, the model is "overidentified". Consequently, we perform tests of the overidentifying restrictions (Basmann 1960).

The validity of the 2SLS estimates depends in large part on the instruments employed in the first stage equation.[14] Other researchers (Devaney et al. 1992; Gordon and Nelson 1995) report that their results are sensitive to the choice of instruments and are sometimes implausible. Although, as discussed below, our instruments frequently have the anticipated signs and, particularly for blacks, are significant predictors of WIC participation, it is difficult to predict WIC participation using state-to-state variation in program characteristics. Fortunately, our data allow for an alternative way of addressing the endogeneity of program participation.

As a second approach, we employ a first differences estimator where we relate differences in birth outcomes across births for each woman who has more than one birth to differences in WIC participation across her pregnancies. If the endogeneity of WIC participation

[13] In fact, it is a test of whether the OLS estimates are consistent in the presence of possible endogeneity (Davidson and MacKinnon 1993).

[14] There is a line of research examining the problems with weak instruments in 2SLS regression analysis. See, for example, Staiger and Stock (1997) and the references therein.

is the result of a "maternal fixed effect" that is constant across the woman's life, then taking first differences of health outcomes for each woman will net out this effect.[15] The generalizability of the results to the larger population relies on the assumption that women who have two or more births are not different in ways that are unobserved to us from women who have only one birth.

V. THE DATA

The primary data for this analysis come from the NMIHS. Compiled by the National Center for Health Statistics, these data were collected to examine the determinants of adverse pregnancy outcomes and are based on a sample of birth and death certificates in 48 states and the District of Columbia. The data set has three main components: a live birth sample (9,953 women), a fetal death sample (3,309 women), and an infant death sample (5,332 women).[16] Given the relatively rare nature of the events that these data describe, certain populations were over sampled. The live birth file contains higher proportions of blacks and babies born with a low birth weight than found in the general population, and black infants were over sampled in the infant and fetal death files. Sample weights are provided to make the data representative of all births in 1988, and these weights are used in all the analyses in this paper.

Women who were selected for the sample were sent a detailed questionnaire regarding their behavior during and after the 1988 pregnancy outcome.[17] The data files contain information from these questionnaires as well as the data on the original birth and death

[15] See Rosenzweig and Wolpin (1995) for a more general model and a discussion of the assumptions implicit in each of these models.

[16] The respondents range in age from 15 to 49 years old and are representative of 3,898,922 births, 15,259 fetal deaths, and 38,917 infant deaths in 1988 (NCHS 1991). In addition, there are supplementary samples of urban, American Indian women and Hispanic women in Texas. These samples are not used in this paper.

[17] The median interval between the pregnancy outcome and the survey was 16 months. The response rate for the questionnaire was 74 percent for the live birth mothers, 65 percent for the infant death mothers, and 69 percent for fetal death mothers.

certificates. In many cases, information about the pregnancy outcome can be obtained from both sources. The questionnaire data include detailed demographic and anthropometric information (e.g., age, race, education, marital history, height, and weight), information on the mother's behavior and living arrangements during and after the pregnancy (e.g., prenatal care, drug and alcohol use, and the number of persons in household), household income, information about the child's father (e.g., height, and weight), and information regarding WIC participation during the pregnancy. In addition, the NMIHS collected a complete pregnancy history for each mother. For each prior pregnancy, the mother was asked the outcome and duration of the pregnancy, whether she smoked during the pregnancy, and the number of months, if any, that she received WIC food. If the pregnancy resulted in a live birth, she was asked the birth weight, the sex of the child, whether the child was still alive, and, if not, how long the child lived.

1988 Birth Outcomes

The first part of our analysis examines the 1988 live birth outcomes. We have data on 11,742 mothers from the Live Birth and Infant Death samples who provided valid information for the live birth component of the survey.[18] The variable definitions and means for this analysis are presented in Table 1. The descriptive statistics are presented separately for WIC participants, income eligible non-participants, and women who are income ineligible. A mother is determined to be income eligible if she is a member of a family that has an income in the twelve months prior to her pregnancy outcome less than 250 percent of the federal poverty guidelines (adjusted for family size), if she reports receiving AFDC or Food Stamps in the twelve months prior to the

[18] We only use women who reported their race as non-Hispanic white and non-Hispanic black. We excluded observations with missing birth weights, gestations, and maternal age. We also excluded observations that appeared to have unreasonable birth weights and gestations (≤ 20 weeks and ≥ 1,500 grams, ≤ 25 weeks and ≥ 2,500 grams, and > 50 weeks).

outcome, or if Medicaid paid for her prenatal care or delivery.[19]

As noted above we examine six birth outcomes: birth weight, the probability of a low-weight birth (< 2500 grams), gestational length, the probability of being pre-term (< 36 weeks), the probability of neo-natal mortality (infant death at < 1 month), and the probability of infant mortality (infant death at < 1 year). Descriptive statistics for these outcomes are presented in Table 1.[20] For either whites or blacks, income ineligible women have "better" birth outcomes on average than income eligible women. However, for women who are income eligible, white recipients tend to have poorer birth outcomes than white non-participants while black participants tend to have better birth outcomes than black non-participants.

In our analysis we will focus on two policy variables: an indicator equal to one if the mother received any assistance from WIC while pregnant and an indicator variable equal to one if the mother received assistance in the first trimester. The second variable is meant to capture the intensity of participation. A second measure of intensity, the number of months of WIC receipt, is reported in the table for illustration. We use the indicator of participation during the first trimester to measure intensity rather than the number of months because the number of months is potentially endogenous (if WIC affects gestational length) while participation in the first trimester increases potential exposure to the program regardless of gestational length.

[19] We use 250 percent of the poverty threshold as a cut-off rather than 185 percent since the NMIHS has a relatively crude measure of income. The crudeness of this measure can in part be seen in Table 1 by the number of respondents who we categorize as income-ineligible but who still report participating in WIC.

[20] The data permit the analysis of a large number of birth outcomes other than the six examined here. We also considered such outcomes as birth weight normalized for gestational age, whether the child was small for his or her gestation, and Apgar Score. For brevity we only discuss the more widely researched outcomes. It is also possible to combine all three components of this survey and analyze the effect of WIC on the probability of experiencing a fetal death. It may be the case that the program saves pregnancies that would have resulted in a fetal death. The birth outcomes (e.g., birth weight) associated with those pregnancies may be worse on average and, therefore, make it appear as if the program has detrimental affects. A preliminary analysis of this issue did not reveal any significant relationship between WIC participation and the incidence of fetal deaths. However, more research on this point is clearly needed.

About 41 percent of income eligible whites and 60 percent of eligible blacks participate in WIC. There are only very small differences between whites and blacks in the number of months of WIC received and in the likelihood that WIC is received in the first trimester.

To model the program participation decision we use a variety of variables that characterize the availability and generosity of WIC and other welfare programs. Appendix Table A1 contains a brief description, the source of the data, and descriptive statistics for each instrument. The sample means for the cross-sectional analysis of 1988 birth outcomes is listed at the end of Table 1. Our primary instruments are a variety of state-level characteristics of the WIC program that were reported on a national survey of state and local WIC agencies.[21] In 1986 the U.S. Congress mandated biennial reports on the characteristics of the WIC program and its participants. The intent of this mandate was to provide information on how state agencies administer the program, local agency practices, and the income and nutritional risks of the individuals who participate in WIC. The first survey was conducted in 1988 by the Research Triangle Institute. The survey provides detailed information on how each state applies the WIC federal guidelines and how local agencies administer the program. A description of the survey methodology and instruments can be found in Research Triangle Institute (1990), and a thorough analysis of these data can be found in Williams et al. (1990). From these data we construct a number of variables that may influence a potential recipient's probability of participation. These variables include an indicator equal to one when women live in states that make it relatively easy to self-declare income, an indicator equal to one when women live in states that have income allowances or exemptions, an indicator equal to one when women live in states that impose

[21] The state of residence is the only geographic identifier available on the NMIHS. Therefore, it is not possible to take advantage of any within state variation in the WIC program.

brand restrictions on the food that may be purchased, an indicator equal to one when women live in states that explicitly link WIC income eligibility to AFDC, and the first trimester hemoglobin cutoff used to determine whether a woman is nutritionally at risk.

From other sources we construct the number of WIC clinics per 1,000 poor persons and the number of WIC clinics per 1,000 square miles in the state for each state and year.[22] To capture the generosity of other welfare programs we also use the state's maximum AFDC benefit level for a family of four and the average Medicaid expenditure for a family of four.

Sibling Differences in Birth Outcomes

For the analysis focusing on differences between a mother's children, our sample is limited to mothers represented in the 1988 Live Birth and Infant Death samples who experienced at least one live birth prior to the 1988 birth. Since we do not have income information for the prior births, we do not impose an income restriction for this analysis. After imposing sample restrictions on birth weight and gestational length similar to those described above, the total sample consists of 6,254 pairs of births for white and black women.

Descriptive statistics of the variables used in the analysis of differences are reported in Table 2. We report means by race for the samples of women who entered the WIC program, exited WIC, did not use WIC for either birth, and used WIC during both births. The outcome variables analyzed are the differences in each of the birth outcomes discussed above (current minus past). We again see a marked difference between whites who enter the program and then exit as compared to blacks. Whites who did not use WIC for the first birth but did for the second

[22] An analysis of the later variable revealed that, given its physical size, the District of Columbia was an extreme outlier. To minimize the impact of this special case, we top-coded the value of this variable for the District of Columbia to the next highest state.

experience lower birth weights for the second birth on average while blacks who switch to WIC participation experience increases in birth weight on average.

The policy variable for this analysis is an indicator that equals one if the mother switches from non-participation to participation, minus one if she switches from participation to non-participation, and zero otherwise. We also create first differences in the control variables. These variables include changes in smoking behavior, the sex of the child, and an indicator for whether the woman has had a first marriage between the pregnancies. Finally, we control for the length of time between births and whether the prior birth was a woman's first pregnancy.

VI. RESULTS

We present the results in two subsections. The first subsection focuses on the birth weight related outcomes. We focus on these results for the following reasons. First, birth weight outcomes are widely accepted and frequently studied infant health outcomes (Paneth 1995). Second, birth weight is more precisely measured than gestational length outcomes (Hakim et al 1992). Finally, it is well established that low birth weight is a common precursor to infant or neonatal death (Paneth 1995). The last subsection presents results for the birth outcomes related to gestational length and the outcomes neonatal and infant mortality.

A. Birth Weight Outcomes

1. Basic OLS Results

We begin by examining the effect of WIC participation on the birth weight outcomes using OLS regressions. Our basic model includes a set of biological variables, indicators for the age and education level of the mother, and indicators for geographic region. We will compare this specification to richer specifications below. These results are presented in Table 3. The first two columns examine log birth weight. WIC participation is found to increase birth weight for whites by a statistically insignificant 1 percent. In contrast, we see that WIC participation is estimated to increase birth weight for blacks by a statistically significant 5.6 percent.

The remainder of the results in the columns 1 and 2 are consistent with the previous literature. We find that boys on average weigh about 3.5 percent more than girls; women who have more children have heavier children; birthweights increase about one percent for each additional inch of mother's height; and heavier and taller fathers have slightly heavier children. We also find that more educated mothers have heavier children.

The last two columns of the table present the results when the health outcome variable is an indicator for low-birth weight. WIC participation does not significantly affect the probability of a low-weight birth for whites. For blacks, however, we estimate that the probability of a low-weight birth will fall by about 0.05 if the mother participates in WIC prenatally.

Thus, our basic model suggests that WIC is beneficial for blacks but not for whites. This basic conclusion is reached in other studies of the WIC program such as Rush (1988). However, we have only examined one specification of our model and have not controlled for the potential endogeneity of WIC. We next examine whether this result is robust to other specifications of our OLS equation.

2. Alternative Specifications

One potential criticism of the above results is that there are many determinants of birth weight that we have not included in the basic model. In particular, birth weight also depends on prenatal care decisions, whether the mother smokes or drinks during the pregnancy, and family income. We have not included these variables in our basic specification because they are potentially endogenous. For example, women who are more likely to smoke during the pregnancy may also be more likely to make other decisions that lead to a low-weight birth.

However, it is important to understand whether our basic estimates are significantly affected by the exclusion of these observed variables. To examine this possibility, we ignore the potential endogeneity of the variables and estimate two additional OLS regressions where we expand the variable list to include these additional regressors. We first add a set of variables that describe the mother's socioeconomic and demographic environment. These include her family income and indicator variables to capture whether she lived with her parents or with the child's father at the time of the birth. The results for this specification on birth weight outcomes are presented in the columns labeled model 1 in Table 4. For whites, the addition of these variables increases the estimated effect of WIC participation from a statistically insignificant 0.008 to a statistically significant 0.020. This result implies that WIC participation proxies for demographic characteristics that result in lower birth weights. We see a similar effect for blacks, although the magnitude of the change is smaller. In this case, the coefficient on WIC increases from 0.056 to 0.060. The addition of these variables does not significantly alter our conclusions about the effect of WIC participation on the probability of a low-weight birth.

We next add variables that describe the mother's behavior during the pregnancy. These variables are clearly endogenous and may have a direct effect on birth outcomes. They include measures of whether the mother received inadequate or intermediate prenatal care using the Kessner index; indicators for whether she was a light, medium, or heavy smoker; indicators for whether she was a light, medium, or heavy drinker; and indicators for whether she used marijuana or cocaine while pregnant. The results are labeled model 2 in Table 4. Overall, the basic conclusions are not changed when moving from model 1 to 2. For whites, there is a small change in the coefficient on WIC participation as it increases from 0.020 to 0.024 in the log birth weight equations. Interestingly, for blacks the effect of adding these additional variables is to reduce the size of the WIC coefficient from 0.060 to 0.047. Comparable movements are also seen for the indicator for low birth weight.

In summary, for whites the effect of WIC participation is somewhat sensitive to the list of included variables in the sense that the effect of WIC approximately doubles and becomes statistically significant. For blacks, there appears to be less of an effect. Because we are focusing our attention on the WIC program and because we are concerned about the potential endogeneity of these other variables, we restrict our attention to the short variable list for the remainder of the cross-section results.[23]

3. Endogeneity of WIC Participation

There is a great deal of concern in the WIC evaluation literature about the potential endogeneity of WIC participation itself. To deal with this endogeneity, we use 2SLS and fixed effect models. We begin with a discussion of the 2SLS results.

Table 5 presents OLS estimates of the first stage WIC participation equation. We find lower educated women and younger women are significantly more likely to participate in WIC. The instruments are also significant predictors of program participation. Both white and black women who live in states where it is relatively easy to declare income are more likely to participate in WIC. Overall it appears that the instruments are stronger predictors of WIC participation for black women. For blacks only we find women who live in states where eligibility for WIC is automatically linked to eligibility for the AFDC program and in states with higher cutoffs for the hemoglobin risk factor for anemia are more likely to participate in WIC.

[23] Although we do not report the results in the paper, results for each of the models discussed below using 2SLS have been estimated with the expanded specifications. The general conclusions of the paper do not change, although in some cases the WIC coefficient is smaller in absolute value or statistically insignificant when the longer variable lists are used.

We also note that some of the instruments have a statistically significant effect on participation but that this effect is not in the hypothesized direction. For example, living in a state with a higher AFDC guarantee slightly reduces the likelihood of WIC participation.

The first stage parameters are of interest in their own right, but they are also of interest because they tell us about the ability of our instruments to predict WIC participation. The F-statistic for the hypothesis that the instruments are jointly equal to zero is 5.44 for whites and 11.60 for blacks. Each of these statistics is statistically significant at conventional significance levels although the instruments are clearly stronger for blacks than whites.

The 2SLS parameter estimates are presented in Table 6.[24] For whites, there are no statistically significant effects of WIC participation on log birth weight or low birth weight. For blacks the estimated effects of WIC participation become larger once we instrument for participation. WIC participation is estimated to increase birth weight by 13 percent as compared to 5.6 percent for the OLS results shown in Table 3. This result suggests that black women who participate in WIC are less likely to undertake other activities that improve birth weight. The effect of WIC participation on the probability of having a low-weight birth is larger (-0.08) than in the OLS model (-0.05), but the effect is statistically insignificant. The list of significant predictors of log birth weight in the 2SLS model is very similar to the list for the OLS model, and it is similar across race.

As discussed earlier, we conduct two specification tests. The results of these tests for the basic model are presented at the bottom of Table 6. The results of the overidentification tests

[24] Tests for the over-identifying restrictions were conducted for each of the 2SLS models. Table 6 reports the F-statistic for this test. In other tables, models that fail this test at the 5 percent level of significance are marked with an asterisk.

show that the instruments are valid in the sense that they may be properly excluded from the second stage regression. The Hausman test is conducted by including predicted WIC participation in the second stage equation and testing whether the coefficient on this variable is statistically different from zero. The t-statistics reported in Table 6 show that this variable is not statistically significantly different from zero. This result suggests that OLS may be an appropriate estimation technique in this application.

One possible explanation for the Hausman test results as well as the 2SLS results is that the instruments are not strong predictors of WIC participation even though they are jointly different from zero. This may particularly be the case for whites. Consequently, we use a second method to control for the endogeneity of WIC participation. As noted above, we assume that the correlation between WIC participation and birth weight outcomes results from a mother-specific effect that does not change over time and use a fixed effects estimator and the sample of women who have two or more births to purge the estimates of the endogeneity. We examine whether changes in WIC participation status (participating in WIC for the previous birth but not the current birth or vice versa) are related to changes in the birth weight of the mother's children or the change in the outcome that one of the children is low birth weight. We note at the outset that, given the data limitations of the pregnancy histories, this model is not intended to be the differenced version of the OLS model presented above.[25]

The results of this estimation, which are presented in Table 8, substantiate many of the conclusions reached using 2SLS. For whites, we again see no effect of the program on birth

[25] These data limitations include not knowing the income of the respondent at the time of the prior births. Consequently, some of the changes in birth outcomes that we attribute to changes in WIC participation may be attributable to changes in eligibility.

outcomes. Our results for blacks are also consistent with the OLS and 2SLS results discussed above. We find that participating in the WIC program is associated with a statistically significant 4.8 percent increase in birth weight and a reduction in the probability of a low-weight birth of 4.5. Combined with our earlier results, the results of the fixed-effects estimation provide further evidence of the effectiveness of WIC participation in improving births outcomes for black women.

4. Alternative Definition of WIC Participation

To this point, we have assumed that simply receiving WIC food at one point during pregnancy constitutes participation in the WIC program. It may be the case that there is a dose-response effect where the benefit one receives is positively related to the length of time that one participates in the program. To explore this possibility, we use an indicator variable equal to one if the woman participated in WIC in the first trimester of her pregnancy and equal to zero otherwise as the policy variable and reestimate the models described above.

The results of this exercise are presented in Table 8. As might be expected given the results presented above, we find no significant effects for white women. Perhaps surprisingly, we also find no significant effects for blacks when we use OLS. There are positive estimated effects for WIC participation, but they are smaller than our earlier results and are never statistically significant. This suggests that, at least for blacks, participation during the second and third trimesters is important—at least before we control for the endogeneity of WIC participation. Once we control for the endogeneity using 2SLS, we do find a larger effect for participation during the first trimester. For example, we find that WIC participation increases birth weight by 17 percent for blacks.

B. Other Birth Outcomes

To help gauge the robustness of our birth weight results we also considered a variety of other birth outcomes. We examine two outcomes that relate to gestational length: log gestational length and an indicator for a pre-term birth. We also consider indicators for neonatal and infant mortality. We estimate the same set of models for these outcomes that we estimated for the birth weight related outcomes discussed above. However, for the sake of brevity, we present only the coefficients on the WIC policy variable in Table 9.

1. Basic OLS Model and Sensitivity to Alternative Specifications

The first three columns of Table 9 consider various OLS models presented above in Tables 3 and 4. First consider the log of gestation. For whites, we find that WIC participation results in an increase in gestational length of approximately one percent. This result is robust to the specification of the model. For blacks there is a two percent increase in gestational length when WIC participation is defined by any participation during the pregnancy. WIC participation is found to reduce the probability of a pre-term birth by between 1.4 and 2.7 for whites. This result is sensitive to the set of regressors. For blacks, WIC participation has much stronger effects. The probability of a pre-term birth is estimated to be between 0.053 and 0.065 lower for women who participate in WIC depending on the model specification.

We conclude by examining the effect of WIC on infant and neonatal mortality. For whites, our OLS results show that WIC participation has a negative but statistically insignificant effect on each of these outcomes. For blacks, participation is estimated to significantly decrease the likelihood of a neonatal or infant death by between 0.012 and 0.016. The size of the result varies very little with the specification of the model.

2. Controlling for the Endogeneity of WIC Participation

As above, we are concerned that WIC participation is endogenous. We use the same two strategies to control for this endogeneity as we did for the birth weight related outcomes. These results are shown in columns 4 and 5 of Table 9. The 2SLS results for whites show that WIC participation does not influence birth outcomes except for infant mortality where it has an unexpected, positive effect. For blacks, the 2SLS estimates of the effect of WIC are generally larger than our OLS estimates. For example, we estimate that WIC participation will increase gestational length by 4.1 percent. We note, however, that our estimated reduction in the likelihood of a pre-term birth is perhaps unreasonably large.

Finally, in the last column, we present the results of the differenced model for these outcomes. For whites we find no effect of the program on gestational length, but there is evidence that participation in the program leads to small but statistically significant decreases in neonatal mortality. For blacks, we find a statistically significant increase in gestational length of 1.4 percent, a reduction in the likelihood of a pre-term birth of 5 percent, and significant reductions in the likelihood of a neonatal and infant death. These results, particularly for blacks, confirm the findings above on birth weight.

VII. DISCUSSION AND CONCLUSIONS

One justification for the WIC program is that it is a cost-effective way to improve child health. Since the Medicaid program pays for many of the costs of pre-term and low-weight births to low income women, it may be cost-effective to spend money to *prevent* the poor birth outcomes. Several studies focus specifically on this question. For example, Devaney et. al. (1992) matched Medicaid and WIC program administrative records for five states and found that spending one dollar on WIC benefits reduced Medicaid costs by more than one dollar. We do not have sufficient data to make such a detailed comparison. However, we can say something about the cost effectiveness of the program.

To address this issue we compare the expected benefit of preventing a low-weight birth to the cost of serving an additional WIC participant. If the expected benefit is greater than the expected cost, the program is cost effective. In 1988, the average total cost per WIC recipient was $41.64 per month and the average WIC recipient in the NMIHS participated in WIC for about 5.6 months resulting in an expected cost of serving an additional pregnant woman of $233.18. The expected benefit is the cost of a low-weight birth multiplied by the reduction in the probability of a low-weight birth attributable to WIC participation. Lewit et al. (1995) estimated that the incremental cost of caring for such a child is approximately $15,000 in the first year, and our estimates indicate that WIC participation leads to a reduction in the probability of a low-weight birth of at most 0.01 for whites and between 0.04 and 0.08 for blacks.

Table 11 presents the expected benefit of WIC participation for a range of estimates of the effectiveness of WIC in reducing low-weight births and costs of low-weight births. [26] Given our estimates from above and a cost of a low-weight birth of $15,000, the program is not cost effective for whites. The expected benefit of the program, $150 (=0.01*$15,000), is less than the cost of the additional recipient, $233.18. The reduction in the probability would have to be 0.02 for the program to be cost effective. For blacks, however, the program results in an expected savings of between $366 and $967 in the first year of the child's life when the estimate of the cost of the low-weight birth is $15,000. Since Medicaid may not pay the full cost of the low-

[26] These estimates should be considered a lower bound since they only consider the incremental costs in the first year of a child being born with a low birth weight. This analysis also ignores the distortions caused by raising money to finance WIC and any interactions with other programs.

weight birth, we include a range of potential estimates. Regardless of the cost estimate, the program is cost effective if it reduces the likelihood of a low-weight birth by at least 0.02.

This analysis highlights a finding that is pervasive throughout this paper: there are racial differences in the impact of the program. Consistent with previous work in this area, WIC appears to be beneficial primarily for black infants. There are a number of possible explanations for this result. First, racial differences in the effectiveness of WIC may be related to participation in other welfare programs. The descriptive statistics in Table 1 show that 70 percent of black WIC participants and 54 percent of white WIC participants also participated in Medicaid. There are also fairly substantial differences between whites and blacks in AFDC and Food Stamp usage. It is possible that what appear to be beneficial effects of WIC participation for blacks are really beneficial effects of multiple program participation. However, Currie and Cole (1991) and Kaestner et al. (1997) find small or no effects of AFDC and Medicaid on birth outcomes, and Brien and Swann (2001) find that WIC remains effective after controlling for other welfare participation for a sample of low-income, single women.[27]

It also may be the case that prior to any WIC intervention, white mothers are, in unobserved ways, healthier at the time of their pregnancy. The marginal impact of WIC may therefore be smaller for this group. In a separate, unreported analysis of birth outcomes, we restricted the sample to respondents with fewer than 12 years of education. These results also failed to show consistent significant positive effects of the program for whites.

A related explanation for the racial differences may lie in racial differences in the risk factors that result in WIC eligibility. There is evidence to suggest that black and white women

[27]We do not examine the effect of other programs on birth outcomes in this paper because the eligible group varies across programs, and we want to focus on all women who are eligible for the WIC program.

differ in the risk factors that make them eligible for the program. While the NMIHS does not contain information about the actual risk factor that resulted in eligibility for WIC, our descriptive statistics in Table 1 show racial differences in smoking, drinking, and drug use while pregnant. This racial difference is corroborated by data from a different source. Starting in the early 1990's the USDA began requiring local agencies to report detailed information about their WIC participants, including the participant's race and nutritional risk factor(s). Randall et al. (1995) show that there are racial differences in the fraction of women who were eligible because of "substance abuse" and other risk factors The administrative data reveal that 20.3 percent of white non-Hispanic women and 7.4 percent of black women had substance abuse as a risk factor. Additionally, 35 percent of black pregnant women on WIC were eligible because their hematocrit or hemoglobin level was below the state criteria while only 15.6 percent of white non-Hispanic pregnant women reported this same risk factor.

The way in which the differences in risk factors translate into differences in the effectiveness of WIC for white and black participants is an open question. It may be the case that the program is effective in reducing the incidence of nutritional deficiencies such as anemia among recipients but not the incidence of smoking or drug use. If this is true and if black women are more likely to suffer from nutritional deficiencies and white women are more likely to be eligible because of substance abuse, then the program will have a larger effect for black women than white women.

REFERENCES

Arcia, G. J., L. A. Crouch, R.A. Kulka. "Impact of the WIC program on Food Expenditures," *American Journal of Agricultural Economics*, 72, February 1990, 218-226.

Basmann, R. L. "On the Finite Sample Distributions of Generalized Classical Linear Identifiability Test Statistics," *Journal of the American Statistical Association*, December 1960, 650-659.

Brien, M. J. and C. A. Swann. "Does Participation in Multiple Welfare Programs Improve Birth Outcomes?" Joint Center for Poverty Research Working Paper #212, 2001.

Corman, H. and M. Grossman. "Determinants of Neonatal Mortality Rates in the U.S.: a Reduced Form Model," *Journal of Health Economics*, 4, 1985, 213-36.

Corman, H., T. Joyce, and M. Grossman. "Birth Outcome Production Function in the United States," *Journal of Human Resources*, 22, 1987, 339-60.

Currie, J. *Welfare and the Well-Being of Children*, Harwood Academic Publishers: Chur, Switzerland, 1995.

Currie, J. and N. Cole. "Welfare and Child Health: The Link Between AFDC and Participation and Birth Weight," *American Economic Review*, 83 #3, 1993, 971-985.

Davidson, R. and J. G. MacKinnon. *Estimation and Inference in Econometrics*, Oxford University Press, 1993.

Devaney, B., L. Bilheimer, and J. Schore. "Medicaid Costs and Birth Outcomes: The Effects of Prenatal WIC Participation and the Use of Prenatal Care," *Journal of Policy Analysis and Management*, 11 #4, 1992, 573-592.

Edozien, J., B. Switzer, and R. Bryan. "Medical Evaluation of the Special Supplemental Food Program for Women Infants and Children," *The American Journal of Clinical Nutrition*, 32, 1979, 677-92.

Gordon, A and L. Nelson. "Characteristics and Outcomes of WIC Participants and Nonparticipants: Analysis of the 1988 National Maternal and Infant Health Survey," U.S. Department of Agriculture, March 1995.

Grossman, M. and Joyce, T. J. "Unobservables, Pregnancy Resolutions, and Birth Weight Production Functions in New York City," *Journal of Political Economy*, 98 #5, 1990, 983-1007.

Hack, M., N. K. Klein, and H. G. Taylor. "Long-Term Developmental Outcomes of Low Birth Weight Babies," *The Future of Children*, 5 #1, Spring 1995, 176-196.

Hakim, R. B., J. M. Tielsch, and L. C. See. “Agreement between Maternal Interview- and Medical Record- based Gestational Age,” *American Journal of Epidemiology*, 136 #5, 1992, 566-573.

Hausman, J. A.. “Specification Tests in Econometrics,” *Econometrica*, 46(6), 1251-1271.

Hughes, D. and L. Simpson. “The Role of Social Change in Preventing Low Birth Weight,” *The Future of Children*, 5 #1, Spring 1995, 87-102.

Joyce, Theodore and Robert Kaestner. “The Effect of Expansions in Medicaid Eligibility on Abortion,” *Demography*, 33, 1996, 181-192.

Kaestner, R., E. Yazici, and T. Joyce. “Does Medicaid Improve Infant and Child Health?” unpublished manuscript, 1997.

Kennedy, E., S. Gershoff, R. Reed, and J. Austin. “Evaluation of the Effect of WIC Supplemental Feeding on Birth Weight,” *Journal of the American Dietetic Association*, 80, 1982, 220-7.

Kessner, D. M. , J. Singer, C. E. Falk, and E. R. Schlesinger. *Infant Death: An Analysis of Maternal Risk and Health Care*, Washington DC: Institute of Medicine, National Academy of Sciences, 1973.

Kotelchuck, M., J. Schwartz, M. Anderka, and K. Finison. “WIC Participation and Pregnancy Outcomes: Massachusetts Statewide Evaluation Project,” *American Journal of Public Health*, 74, 1984,

Ku, L., B. Cohen, and N. Pindus. *Full Funding for WIC: A Policy Review*, Washington DC: Urban Institute, 1994.

Lewit, E. M., L. S. Baker, H. Corman, and P. H. Shiono. “The Direct Cost of Low Birth Weight,” ,” *The Future of Children*, 5 #1, Spring 1995, 35-56.

Metcoff, J., P. Costiloe, W. Crosby, S. Dutta, H. Sandstead, D. Milne, C. E. Bodwell, and S. Majors. “Effect of Food Supplementation (WIC) During Pregnancy on Birth Weight,” *The American Journal of Clinical Nutrition*, 41, 1985, 933-47.

National Center for Health Statistics, “National Maternal and Infant Health Survey: Technical Documentation,” Washington D.C., 1991.

Paneth, N. S. “The Problem of Low Birth Weight,” *The Future of Children*, 5 #1, Spring 1995, 19-34.

Randall, B., L. Boast, and L. Holst. “Study of WIC Participant and Program Characteristics, 1994, Final Report”, Washington DC: USDA Food and Nutrition Service, December 1995.

Research Triangle Institute. “Study of WIC Participant and Program Characteristics, 1988, Documentation Report, Volume 3: Data Codebooks”, Washington DC: USDA Food and Nutrition Service, July 1990.

Rosenzweig, M. R. “Birth Spacing and Sibling Inequality: Asymmetric Information with the Household,” *International Economic Review*, 27, 1986, 55-76.

Rosenzweig, M. R. and T. P. Schultz. "The Behavior of Mothers as Inputs to Child Health: The Determinants of Birth Weight, Gestation, and Rate of Fetal Growth", in *Economic Aspects of Health*, V. R. Fuchs (ed.) The University of Chicago Press: Chicago, 1982.

Rosenzweig, M.R. and K. I. Wolpin. “Sisters, Siblings, and Mothers: The Effect of Teen-age Childbearing on Birth Outcomes in a Dynamic Family Context,” *Econometrica*, 63, 1995, 303-326.

Rush, D. “The National WIC Evaluation: Evaluation of the Special Supplemental Food Program for Women, Infants, and Children,” *American Journal of Clinical Nutrition*, 48, 1988, 389-519.

Schramm, W. “WIC Prenatal Participation and its Relationship to Newborn Medicaid Costs in Missouri: a Cost/Benefit Analysis,” *American Journal of Public Health*, 75, 1985.

____________. “Prenatal Participation in WIC Related to Medicaid Costs for Newborns: 1982 Update,” *Public Health Reports*, 101, 1986.

Staiger, D. and J. H. Stock. “Instrumental Variables Regression with Weak Instruments,” *Econometrica*, 65, 1997, 557-586.

Stockbauer, J. “WIC Prenatal Participation and its Relation to Pregnancy Outcomes in Missouri: a Second Look, *American Journal of Public Health*, 77, 1987, 813-18.

U.S. Department of Agriculture. http://www.fns.usda.gov/pd/wisummary.htm. April 27, 2001.

Williams, R. L., J. T. Lessler, and S. C. Wheeless. “Study of WIC Participant and Program Characteristics, 1988, Final Report”, Washington DC: USDA Food and Nutrition Service, April 1990.

Table 1: Descriptive Statistics, 1988 Births

	Whites			Blacks		
	Participants	Eligible Non-Part.	Ineligible	Participants	Eligible Non-Part.	Ineligible
Birth Outcomes						
Birth Weight (grams)	3,367.72	3,416.98	3,456.78	3,134.49	3,044.98	3,224.16
Low Birth Weight (< 2500 g.)	0.07	0.06	0.04	0.12	0.16	0.10
Gestation (weeks)	39.70	39.40	39.56	38.60	37.98	38.72
Pre-term Delivery (<36Weeks)	0.07	0.07	0.06	0.18	0.23	0.13
Neonatal Mortality	0.01	0.01	0.01	0.01	0.02	0.01
Infant Mortality	0.02	0.02	0.01	0.02	0.04	0.02
WIC Policy Variables						
Used WIC While Pregnant	1.00	0.00	0.03	1.00	0.00	0.16
Number of Mo. Used WIC	5.78	0.00	0.15	5.53	0.00	0.81
Used WIC in 1st trimester	0.54	0.00	0.01	0.53	0.00	0.07
Other Program Participation						
AFDC in 12 Months Prior to Outcome	0.30	0.08	0.01	0.50	0.37	0.02
Food Stamps in 12 Months Prior to Outcome	0.34	0.09	0.01	0.52	0.33	0.02
Medicaid Paid for Prenatal Care/Delivery	0.54	0.14	0.01	0.70	0.43	0.03
Behavior During Pregnancy						
Adequacy of Prenatal Care[a]						
Inadequate	0.05	0.04	0.01	0.08	0.18	0.04
Intermediate	0.26	0.18	0.09	0.31	0.30	0.16
Adequate	0.68	0.78	0.90	0.61	0.53	0.80
Smoking While Pregnant						
None	0.53	0.70	0.83	0.78	0.75	0.89
Light	0.05	0.04	0.03	0.06	0.06	0.04
Moderate	0.28	0.17	0.10	0.11	0.13	0.05
Heavy	0.15	0.09	0.04	0.04	0.06	0.02
Drinking While Pregnant						
None	0.79	0.80	0.70	0.88	0.85	0.88
Light	0.10	0.11	0.16	0.04	0.04	0.07
Moderate	0.10	0.08	0.13	0.07	0.09	0.04
Heavy	0.01	0.00	0.00	0.01	0.02	0.00
Drug Use While Pregnant						
Marijuana	0.05	0.03	0.02	0.03	0.03	0.00
Cocaine	0.01	0.00	0.00	0.01	0.04	0.00
Other Maternal Characteristics						
Worked While Pregnant	0.48	0.62	0.76	0.42	0.50	0.84
Mother < 18 Years of Age	0.18	0.05	0.02	0.20	0.14	0.07
Mother > 35 Years of Age	0.02	0.06	0.11	0.04	0.05	0.10
Income $0-5,000	0.23	0.09	0.00	0.34	0.25	0.00
Income $5,000-10,000	0.27	0.12	0.00	0.30	0.24	0.00
Income $10,000-20,000	0.37	0.46	0.01	0.25	0.34	0.05
Income > $20,000	0.13	0.32	0.99	0.11	0.17	0.95

[a] The variable categorizing the adequacy of prenatal care was developed by Kessner et al. (1973). This index divides prenatal care into three categories (inadequate, intermediate, and adequate) based on the frequency and timing of prenatal care visits.

(*Continued*)

Table 1: Descriptive Statistics, 1988 Births (*Continued*)

	Whites			Blacks		
	Participants	**Eligible Non-Part.**	**Ineligible**	**Participants**	**Eligible Non-Part.**	**Ineligible**
Married at Birth of Child	0.57	0.84	0.94	0.25	0.34	0.69
Lived with Father of Child while Pregnant	0.71	0.87	0.96	0.35	0.46	0.79
Lived with either of Mother's Parents	0.20	0.10	0.05	0.42	0.35	0.21
Child						
Baby was a Boy	0.55	0.52	0.52	0.50	0.52	0.50
Baby was Mother's First Preg.	0.67	0.67	0.77	0.56	0.54	0.61
Number of Past Live Births	0.93	1.03	0.68	1.00	1.12	0.66
Mother's Height and Weight						
Under-wgt. (10% under BMI)	0.34	0.26	0.26	0.24	0.25	0.23
Obese (20% over BMI)	0.11	0.09	0.06	0.12	0.11	0.10
Wgt. Prior to Preg. (lbs)	134.63	136.60	134.59	139.09	139.58	139.84
Height at Survey (ins)	64.68	64.73	64.95	64.58	64.68	64.86
Mother's Education						
0 – 11 years	0.36	0.15	0.04	0.35	0.28	0.07
12 years	0.47	0.50	0.34	0.46	0.45	0.29
13-15 years	0.15	0.24	0.31	0.17	0.22	0.37
16+ years	0.02	0.11	0.31	0.03	0.05	0.27
Father's Height and Weight						
Weight (lbs)	172.31	177.19	180.98	171.73	172.26	181.04
Height (ins)	69.95	70.24	70.80	69.77	69.85	70.64
Urban Residence						
Lived in Metro Area	0.55	0.70	0.82	0.75	0.85	0.89
Region						
Northeast	0.16	0.18	0.22	0.14	0.14	0.20
North Central	0.33	0.32	0.29	0.22	0.22	0.18
West	0.13	0.18	0.18	0.06	0.10	0.11
South	0.39	0.33	0.31	0.58	0.53	0.51
State Welfare Programs (Instruments)						
Easy Income Determination	0.49	0.41	0.45	0.50	0.45	0.48
Few Income Allowances	0.44	0.38	0.35	0.47	0.40	0.37
Brand Restrictions	0.56	0.59	0.58	0.57	0.63	0.59
Link to AFDC	0.46	0.45	0.46	0.48	0.46	0.53
1st Trimester Hemoglobin	11.73	11.78	11.78	11.59	11.64	11.66
AFDC Guarantee	409.48	438.71	452.95	364.07	394.10	419.10
Medicaid Expenditure	261.26	267.29	260.44	235.53	242.26	255.93
Clinics/ 1,000 Poor Persons	0.28	0.29	0.27	0.22	0.22	0.23
Clinics/ 1,000 Square Miles	4.82	4.81	5.96	5.28	5.86	7.04
Number of Observations	967	1,402	2,732	3,188	2,221	1,232

Table 2: Descriptive Statistics, First Differences

	Whites				Blacks			
	Entered	**Exited**	**Neither**	**Both**	**Entered**	**Exited**	**Neither**	**Both**
Difference in Birth Outcomes								
Birth Weight (grams)	-20.15	7.85	71.23	21.77	123.35	-86.23	45.79	14.98
Low Birth Weight (< 2500 g.)	0.03	0.05	0.02	0.04	0.03	0.12	0.05	0.06
Log Gestation (weeks)	-0.32	-0.38	-0.16	-0.02	-0.06	-1.07	-0.29	-0.60
Pre-term Delivery (< 36 Weeks)	0.04	0.06	0.00	0.00	0.01	0.12	0.03	0.08
Neonatal Mortality	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Infant Mortality	0.01	0.01	0.00	0.00	0.00	0.03	0.00	0.00
Difference in Background Variables								
Number of Cigarette	0.07	0.07	0.00	0.01	0.04	0.08	0.06	0.06
Age	3.93	3.14	3.49	2.37	5.00	3.38	3.75	2.71
Married between births	0.08	0.15	0.06	0.11	0.14	0.18	0.12	0.09
Boy	-0.08	-0.01	-0.02	0.00	-0.03	0.00	0.01	0.01
First Pregnancy	-0.44	-0.70	-0.56	-0.45	-0.45	-0.56	-0.51	-0.50
Number of Observations	139	101	1,261	343	485	439	1,618	1,868

Table 3: OLS Results for "Any WIC" Policy Variable

	Log Birth Weight		Low Birth Weight	
Variable	**Whites**	**Blacks**	**Whites**	**Blacks**
Any WIC	0.008	0.056	0.005	-0.053
	(0.82)	(6.55)	(0.46)	(-5.49)
Boy	0.035	0.033	-0.012	-0.015
	(3.85)	(4.01)	(-1.20)	(-1.63)
First Pregnancy	-0.002	0.018	0.000	-0.018
	(-0.21)	(1.85)	(0.01)	(-1.65)
Number of Past Live Births	0.017	0.006	-0.015	-0.006
	(3.87)	(1.59)	(-3.23)	(-1.34)
Mother' s Education < 12 Years	-0.101	-0.063	0.066	0.076
	(-4.97)	(-2.72)	(2.94)	(2.89)
Mother's Education = 12 Years	-0.049	-0.042	0.025	0.049
	(-2.64)	(-1.86)	(1.22)	(1.90)
Mother's Education 13 – 15 Years	-0.021	-0.023	0.017	0.037
	(-1.05)	(-0.98)	(0.79)	(1.39)
Mother's Age 0-18	0.018	-0.007	-0.016	-0.015
	(1.09)	(-0.64)	(-0.89)	(-1.17)
Mother's Age > 34	-0.044	0.004	0.054	0.022
	(-1.97)	(0.21)	(2.18)	(0.94)
Mother's Height	0.011	0.007	-0.005	-0.007
	(6.53)	(4.94)	(-2.74)	(-4.34)
Father's Weight	0.001	0.000	0.000	0.000
	(3.76)	(2.49)	(-0.52)	(-1.57)
Father's Height	0.001	0.002	0.001	0.000
	(0.76)	(1.39)	(0.69)	(0.31)
Northeast	0.014	-0.008	-0.005	0.027
	(1.02)	(-0.63)	(-0.35)	(1.99)
North Central	0.001	-0.014	0.003	0.010
	(0.10)	(-1.34)	(0.25)	(0.88)
West	0.009	0.015	0.007	-0.027
	(0.66)	(0.93)	(0.45)	(-1.52)
Constant	7.241	7.381	0.299	0.587
	(52.59)	(66.80)	(1.98)	(4.69)
R^2	0.06	0.02	0.02	0.01
Whole Regression F-Statistic	10.32	8.52	2.48	5.40
Number of Observations	2,369	5,409	2,369	5,409

Notes: t-statistics in parenthesis.

Table 4: Sensitivity of OLS Results to Model Specification

	Log Birth Weight				Low Birth Weight			
	Whites		Blacks		Whites		Blacks	
Variable	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Any WIC	0.020	0.024	0.060	0.047	-0.002	-0.004	-0.056	-0.039
	(1.97)	(2.41)	(6.96)	(5.39)	(-0.15)	(-0.32)	(-5.76)	(-3.94)
Boy	0.036	0.039	0.032	0.030	-0.013	-0.014	-0.015	-0.013
	(3.96)	(4.38)	(3.91)	(3.79)	(-1.28)	(-1.41)	(-1.60)	(-1.43)
First Pregnancy	-0.003	-0.009	0.018	0.013	-0.001	0.004	-0.020	-0.016
	(-0.25)	(-0.92)	(1.91)	(1.41)	(-0.05)	(0.37)	(-1.86)	(-1.44)
Number of Past Live Births	0.013	0.013	0.004	0.007	-0.013	-0.014	-0.003	-0.008
	(2.87)	(2.80)	(1.02)	(1.96)	(-2.54)	(-2.77)	(-0.61)	(-1.76)
Mother’s Education < 12 Years	-0.089	-0.056	-0.047	-0.022	0.061	0.039	0.064	0.035
	(-4.28)	(-2.67)	(-2.01)	(-0.96)	(2.65)	(1.69)	(2.39)	(1.34)
Mother’s Education = 12 Years	-0.044	-0.031	-0.031	-0.017	0.022	0.015	0.038	0.023
	(-2.38)	(-1.70)	(-1.37)	(-0.75)	(1.09)	(0.72)	(1.49)	(0.92)
Mother’s Education 13-15 Years	-0.018	-0.011	-0.018	-0.008	0.016	0.011	0.031	0.024
	(-0.90)	(-0.55)	(-0.76)	(-0.33)	(0.72)	(0.50)	(1.18)	(0.90)
Mother’s Age 0-18	0.025	0.026	0.003	-0.005	-0.022	-0.018	-0.028	-0.017
	(1.50)	(1.59)	(0.23)	(-0.42)	(-1.18)	(-0.95)	(-2.07)	(-1.22)
Mother’s Age > 34	-0.043	-0.042	-0.005	-0.016	0.052	0.051	0.029	0.041
	(-1.92)	(-1.90)	(-0.25)	(-0.79)	(2.10)	(2.08)	(1.25)	(1.78)
Mother’s Height	0.011	0.012	0.007	0.006	-0.005	-0.005	-0.007	-0.006
	(6.49)	(5.80)	(4.98)	(3.61)	(-2.77)	(-2.13)	(-4.41)	(-3.08)
Father’s Weight	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(3.51)	(2.66)	(2.12)	(0.88)	(-0.32)	(0.06)	(-1.22)	(-0.22)
Father’s Height	0.001	0.001	0.001	0.002	0.001	0.001	0.000	0.000
	(0.68)	(0.83)	(1.36)	(1.99)	(0.78)	(0.73)	(0.31)	(-0.21)
Northeast	0.018	0.007	-0.007	0.005	-0.007	0.002	0.028	0.012
	(1.35)	(0.52)	(-0.58)	(0.42)	(-0.45)	(0.10)	(2.01)	(0.88)
North Central	0.005	-0.002	-0.010	-0.002	0.002	0.005	0.009	-0.001
	(0.44)	(-0.16)	(-1.00)	(-0.21)	(0.18)	(0.44)	(0.74)	(-0.09)
West	0.014	0.006	0.012	0.021	0.004	0.011	-0.023	-0.033
	(1.03)	(0.45)	(0.78)	(1.33)	(0.23)	(0.72)	(-1.25)	(-1.86)
Mother Worked During Pregnancy	0.009	0.008	0.004	0.000	0.000	0.002	0.005	0.011
	(0.95)	(0.88)	(0.48)	(0.02)	(0.01)	(0.19)	(0.51)	(1.15)
Income 0-5,000	-0.022	-0.013	-0.032	-0.029	0.009	-0.002	0.027	0.025
	(-1.36)	(-0.82)	(-2.27)	(-2.11)	(0.51)	(-0.08)	(1.73)	(1.58)
Income 5-10,000	-0.017	-0.011	-0.018	-0.015	-0.003	-0.008	0.008	0.005
	(-1.13)	(-0.77)	(-1.29)	(-1.07)	(-0.16)	(-0.51)	(0.50)	(0.31)
Income 10-20,000	-0.009	-0.005	-0.029	-0.029	0.000	-0.002	0.022	0.024
	(-0.72)	(-0.43)	(-2.10)	(-2.14)	(0.02)	(-0.13)	(1.43)	(1.55)
Married	0.047	0.021	0.044	0.029	-0.016	0.001	-0.036	-0.018
	(3.55)	(1.54)	(3.95)	(2.60)	(-1.06)	(0.06)	(-2.87)	(-1.47)
Living With Child’s Father	-0.024	-0.026	0.005	0.000	-0.014	-0.013	-0.002	0.005
	(-1.65)	(-1.83)	(0.48)	(-0.04)	(-0.86)	(-0.82)	(-0.21)	(0.41)
Living with Mother’s Parents	-0.010	-0.011	-0.002	-0.004	0.010	0.009	0.021	0.023
	(-0.65)	(-0.72)	(-0.25)	(-0.43)	(0.63)	(0.54)	(1.88)	(2.14)
Mother Underweight		-0.058		-0.035		0.026		0.036
		(-4.33)		(-2.82)		(1.74)		(2.54)

(*Continued*)

Table 4: Sensitivity of OLS Results to Model Specification (*Continued*)

	Log Birth Weight				Low Birth Weight			
	Whites		Blacks		Whites		Blacks	
Variable	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Mother Obese		0.019		0.003		0.002		0.016
		(0.79)		(0.17)		(0.08)		(0.69)
Mother's Weight Before Pregnancy		0.000		0.001		0.000		-0.001
		(-0.11)		(2.37)		(-0.27)		(-2.21)
Inadequate Prenatal Care		-0.050		-0.054		0.058		0.075
		(-2.32)		(-3.96)		(2.41)		(4.90)
Intermediate Prenatal Care		-0.033		-0.005		0.019		0.020
		(-2.94)		(-0.51)		(1.50)		(2.00)
Light Smoker		-0.053		-0.056		0.025		0.046
		(-2.42)		(-3.33)		(1.04)		(2.38)
Moderate Smoker		-0.077		-0.072		0.039		0.093
		(-6.61)		(-5.36)		(3.01)		(6.13)
Heavy Smoker		-0.063		-0.083		0.070		0.084
		(-4.16)		(-4.05)		(4.10)		(3.63)
Light Drinker		0.009		-0.007		0.006		-0.008
		(0.64)		(-0.33)		(0.35)		(-0.32)
Moderate Drinker		-0.008		-0.030		0.010		0.063
		(-0.51)		(-1.86)		(0.57)		(3.42)
Heavy Drinker		-0.020		-0.078		0.048		0.156
		(-0.36)		(-2.14)		(0.75)		(3.78)
Marijuana		0.012		-0.014		-0.005		-0.004
		(0.46)		(-0.50)		(-0.18)		(-0.12)
Cocaine		-0.091		-0.070		0.023		0.104
		(-1.43)		(-2.35)		(0.32)		(3.06)
Constant	7.240	7.252	7.384	7.364	0.311	0.264	0.580	0.572
	(52.31)	(51.71)	(66.53)	(64.80)	(2.04)	(1.69)	(4.61)	(4.45)
R^2	0.07	0.11	0.03	0.06	0.02	0.03	0.02	0.06
Whole Regression F-Statistic	7.92	8.32	7.38	9.03	2.00	2.40	4.82	9.10
Number of Observations	2,369		5,409		2,369		5,409	

Notes: t-statistic in parentheses.

Table 5: Determinants of WIC Participation - First Stage Results

Variable	Whites	Blacks
Boy	0.027	-0.009
	(1.38)	(-0.71)
First Pregnancy	0.014	-0.014
	(0.64)	(-0.92)
Number of Past Live Births	0.000	-0.015
	(-0.04)	(-2.46)
Mother's Education < 12 Years	0.422	0.186
	(9.84)	(5.08)
Mother's Education = 12 Years	0.236	0.159
	(6.02)	(4.49)
Mother's Education 13 - 15 Years	0.170	0.093
	(4.02)	(2.51)
Mother's Age 0-18	0.197	0.057
	(5.69)	(3.11)
Mother's Age > 34	-0.141	-0.017
	(-2.94)	(-0.53)
Mother's Height	0.003	-0.002
	(0.94)	(-0.87)
Father's Weight	-0.001	0.000
	(-1.58)	(1.28)
Father's Height	-0.001	0.000
	(-0.37)	(0.01)
Northeast	0.013	0.045
	(0.25)	(1.34)
North Central	0.075	0.028
	(2.11)	(1.22)
West	0.033	-0.093
	(0.78)	(-2.03)
Easy Income Determination	0.119	0.084
	(5.52)	(5.21)
Few Income Allowances	0.042	0.050
	(1.70)	(2.57)
Brand Restrictions	-0.036	-0.015
	(-1.57)	(-0.81)
Link to AFDC	0.038	0.056
	(1.64)	(3.48)
1st Trimester Hemoglobin	0.016	0.055
	(0.63)	(2.66)
AFDC Guarantee	-0.000	-0.000
	(-3.54)	(-2.35)
Medicaid Expenditure	-0.000	-0.001
	(-2.40)	(-3.60)
Clinics per 1,000 Poor Persons	0.053	0.060
	(1.01)	(0.96)
Clinics per 1,000 Square Miles	0.006	-0.001
	(1.63)	(-3.36)
Constant	0.032	0.083
	(0.08)	(0.28)
R^2	0.12	0.04
Instruments F-Statistic	5.44	11.60

Notes: t-statistic in parentheses. The critical value for the F-test for the instruments is $F(9, \infty)=1.88$.

Table 6: 2SLS Results for "Any WIC" Policy Variable

	Log Birth Weight		Low Birth Weight	
Variable	**Whites**	**Blacks**	**Whites**	**Blacks**
Any WIC	-0.073	0.130	0.117	-0.082
	(-1.08)	(2.09)	(1.55)	(-1.16)
Boy	0.037	0.033	-0.015	-0.015
	(3.96)	(4.08)	(-1.45)	(-1.66)
First Pregnancy	-0.001	0.018	-0.001	-0.018
	(-0.14)	(1.89)	(-0.07)	(-1.67)
Number of Past Live Births	0.016	0.007	-0.015	-0.006
	(3.76)	(1.80)	(-3.09)	(-1.40)
Mother's Education < 12 Years	-0.066	-0.078	0.018	0.082
	(-1.86)	(-2.95)	(0.45)	(2.75)
Mother's Education = 12 Years	-0.029	-0.054	-0.003	0.053
	(-1.15)	(-2.18)	(-0.10)	(1.90)
Mother's Education 13-15 Years	-0.007	-0.031	-0.002	0.040
	(-0.31)	(-1.25)	(-0.06)	(1.45)
Mother's Age 0-18	0.033	-0.012	-0.037	-0.014
	(1.59)	(-0.96)	(-1.61)	(-0.99)
Mother's Age > 34	-0.056	0.005	0.070	0.022
	(-2.25)	(0.24)	(2.55)	(0.93)
Mother's Height	0.011	0.007	-0.005	-0.007
	(6.54)	(4.98)	(-2.89)	(-4.35)
Father's Weight	0.001	0.000	0.000	0.000
	(3.36)	(2.36)	(-0.18)	(-1.53)
Father's Height	0.001	0.001	0.001	0.000
	(0.66)	(1.37)	(0.78)	(0.32)
Northeast	0.011	-0.006	-0.001	0.027
	(0.78)	(-0.48)	(-0.08)	(1.93)
North Central	0.000	-0.012	0.004	0.010
	(0.01)	(-1.20)	(0.35)	(0.83)
West	0.003	0.026	0.015	-0.032
	(0.20)	(1.41)	(0.92)	(-1.52)
Constant	7.249	7.338	0.289	0.603
	(51.80)	(62.85)	(1.86)	(4.59)
F-statistic for Over ID test	0.60	0.98	0.62	1.26
t-statistic for Hausman test	-1.23	1.21	1.80	-0.41
Number of Observations	2,369	5,409	2,369	5,409

Notes: t-statistic in parentheses. The critical value for the F-statistic for the overidentification test is $F(8, \infty) = 1.94$.

Table 7: Results of the First Differences Model

	Log Birth Weight		Low Birth Weight	
Variable	**Whites**	**Blacks**	**Whites**	**Blacks**
Change in WIC Participation	-0.003	0.048	-0.009	-0.045
	(-0.27)	(5.49)	(-0.76)	(-4.72)
Change in Number of Cigarettes	-0.023	-0.021	0.020	0.023
	(-1.42)	(-1.68)	(1.31)	(1.70)
Change in Age	-0.001	0.001	0.004	0.006
	(-0.67)	(0.60)	(2.44)	(3.87)
Married between births	0.017	0.003	0.010	-0.003
	(1.07)	(0.21)	(0.67)	(-0.22)
Boy	0.033	0.028	-0.004	0.003
	(5.54)	(5.18)	(-0.71)	(0.47)
First Pregnancy	-0.020	-0.023	0.009	0.023
	(-2.35)	(-2.97)	(1.10)	(2.70)
Constant	0.008	-0.008	0.014	0.047
	(0.99)	(-1.21)	(1.90)	(6.22)
R^2	0.02	0.02	0.01	0.01
Whole Regression F-Statistic	6.94	11.41	1.73	6.78
Number of Observations	1,844	4,410	1,844	4,410

Notes: t-statistic in parentheses.

Table 8: Summary Estimates for "First Trimester" Policy Variable

	Log Birth Weight		Low Birth Weight	
Model	**Whites**	**Blacks**	**Whites**	**Blacks**
OLS	-0.008	0.012	0.012	-0.010
	(-0.06)	(1.44)	(1.04)	(-1.03)
2SLS	-0.065	0.170	-0.026	-0.117
	(-0.85)	(2.13)	(-0.32)	(-1.32)

Notes: t-statistic in parentheses.

Table 9: Effect of WIC Participation on Birth Outcomes

Panel A: Whites

	1	2	3	4	5
Dependent Variable	**OLS**	**OLS**	**OLS**	**2SLS**	**Differences**
Log Gestation	0.009	0.011	0.011	-0.008*	0.006
	(2.62)	(3.06)	(3.12)	(-0.36)	(0.40)
Early Gestation	-0.014	-0.027	-0.027	0.030	-0.004
	(-1.28)	(-2.24)	(-2.24)	(0.37)	(-0.18)
Neonatal Mortality	-0.003	-0.004	-0.004	0.008	-0.002
	(-0.68)	(-0.93)	(-0.89)	(0.31)	(-0.38)
Infant Mortality	-0.004	-0.003	-0.003	0.076	0.002
	(-0.59)	(-0.51)	(-0.49)	(2.11)	(0.28)

Panel B: Blacks

	1	2	3	4	5
Dependent Variable	**OLS**	**OLS**	**OLS**	**2SLS**	**Differences**
Log Gestation	0.021	0.022	0.018	0.041	0.014
	(6.66)	(6.84)	(5.69)	(1.81)	(3.88)
Early Gestation	-0.062	-0.065	-0.053	-0.149	-0.052
	(-5.46)	(-5.70)	(-4.60)	(-1.81)	(-3.83)
Neonatal Mortality	-0.012	-0.013	-0.012	-0.003	-0.008
	(-3.57)	(-3.78)	(-3.38)	(-0.11)	(-2.12)
Infant Mortality	-0.016	-0.016	-0.014	-0.005*	-0.015
	(-3.01)	(-3.16)	(-2.69)	(-0.12)	(-2.86)

Notes: t-statistic in parentheses. Models: 1) OLS with only exogenous variables, 2) Model 1 + income, family composition, and mother's employment variables, 3) Model 2 + maternal weight, prenatal care, smoking, drinking, and drug use variables, 4) 2SLS with only exogenous variables, 5) first differences in outcomes. * Indicates that the model fails the test of the over-identifying restrictions at the 5 % level.

Table 10: Cost-Benefit Analysis of the Effectiveness of WIC in Reducing the Probability of Low Weight Births

	Societal Cost of Low Weight Birth		
Change in Probability	**$12,000**	**$15,000**	**$18,000**
0.00	-233.18	-233.18	-233.18
0.01	-113.18	-83.18	-53.18
0.02	6.82	66.82	126.82
0.03	126.82	216.82	306.82
0.04	246.82	366.82	486.82
0.05	366.82	516.82	666.82
0.06	486.82	666.82	846.82
0.07	606.82	816.82	1,026.82
0.08	726.82	966.82	1,206.82

Notes: Each cell denotes the difference between the expected benefits of preventing a low weight birth (change in probability * societal cost) and the expected cost of having a pregnant woman participate in the program ($233.18). All monetary values are denoted in 1988 dollars.

Table A1: Descriptive Statistics for the 2SLS Instruments

Variable	Description	Source	Mean	Std. Dev.	Min	Max
Easy Income Determination	Indicator for whether it is easy to be certified as income eligible (e.g. allows self-reported income).	Study of WIC Participant and Program Characteristics - 1988	0.43	0.50	0	1
Few Income Allowances	Indicator for whether the state has limited income allowances and special exemptions.	Study of WIC Participant and Program Characteristics - 1988	0.45	0.50	0	1
Brand Restrictions	Indicator for whether the state specifies specific food brands must be purchased with WIC coupons.	Study of WIC Participant and Program Characteristics - 1988	0.63	0.49	0	1
Link to AFDC	Indicator for whether the WIC incomes eligibility in state linked to AFDC.	Study of WIC Participant and Program Characteristics - 1988	0.49	0.50	0	1
1^{st} Trimester Hemoglobin	1^{st} Trimester hemoglobin cutoff to be considered medically needy.	Study of WIC Participant and Program Characteristics - 1988	11.70	0.50	10.9	13.9
Clinics / 1,000 Poor Persons	Number of WIC clinics per 1,000 poor persons in state.	Unpublished USDA Documents	0.41	0.36	0.09	1.87
Clinics / 1,000 Square Miles	Number of WIC clinics per 1,000 square miles in state.	Unpublished USDA Documents	5.33	7.01	0.17	31.54
AFDC Guarantee	AFDC guarantee for a family of four.	Green Book	430.57	152.21	144.0	823.0
Medicaid Expenditure	Medicaid expenditure for a family of four.	U.S. Health and Human Services, "State Medicaid Tables"	273.66	81.78	0	467.77

Notes: 51 observations.