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Are People Born Equal? The Effect of WIC on Birth Outcomes

by

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Abstract

This study investigates the relationship between the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and newborn's birth weight. The WIC program provides food packages and nutritional counseling to low income pregnant, breastfeeding, and postpartum women, and their children up to age five. This study focuses on the support the program provides to low income pregnant women at nutritional risk. Recognizing that these mothers have a high probability of delivering low birth weight infants, the WIC program aims to improve their birth outcomes. We make use of a novel dataset to show that the WIC program is fulfilling its goals by increasing weight at birth and resulting in possible substantial cost savings. We also observe that the impact of the program is not uniform but is affected by the characteristics of the recipients.

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Chapter 1

Introduction

Although the infant mortality rate in the United States has declined by about 45% over the past thirty years, the rate of premature and low birth weight deliveries has doubled for the same period (Besharov and Germanis, 2001). Low birth weight babies are at a higher risk of serious lifelong health problems including learning disabilities, cerebral palsy, blindness, and hearing loss. According to the March of Dimes, a leading nonprofit organization for pregnancy and baby health, even infants born just a few weeks premature are at a greater risk of breathing problems and feeding difficulties.

According to the Federal government's Healthy People 2010 Plan[1], it is a national objective to lower premature deliveries to 7.6% of live births by 2010. With a reported average of 12.7% in 2005 and a rate as high as 18.8% in Mississippi, and 19.7% in Puerto Rico, the national objective seems almost impossible

[1]United States Department of Health and Human Services, Healthy People 2010 Plan

to achieve[2].

In 1969, to address the problem of fetal, newborn and child malnourishment, the United States government established the Special Supplemental Nutrition Program for Women, Infants, and Children, or WIC. Today, the program benefits almost nine million recipients and costs more than six billion dollars per year. With children's health and lives at risk, it is crucial that the program is fulfilling its goals.

This study focuses on one of the most important parts of the WIC program, namely the support it provides to low income pregnant women at nutritional risk. These mothers are at a high risk of delivering low birth weight babies that may suffer long-term disabilities. The WIC program, therefore, aims to give the infants of low income high risk mothers an equal start at birth by reducing their probability of being born too small or too soon.

This thesis contains this introduction and six more chapters, structured as follows:

- Chapter 2 outlines the definition of low birth weight and the risks associated with the condition;
- Chapter 3 provides background information on the WIC program and reviews the benefits it distributes;
- Chapter 4 considers the current literature to select a model for the present study;

[2]Premature delivery rates obtained from the March of Dimes 2008 Premature Report Card.

- Chapter 5 introduces the model and data set of choice for this analysis;
- Chapter 6 presents the results of this study;
- Chapter 7 concludes and offers directions for future analysis.

All tables that this study refers to are located in Appendix A and B.

Chapter 2

The Implications of Low Birth Weight

Prior to analyzing the causes of low birth weight, I provide a brief summary of recent literature on its implications. In particular, this chapter reviews the definitions, the recent trends, and the impact of low birth weight. The chapter is structured as follows: Section 1 summarizes the prevailing definitions of low birth weight and the rates at which the condition occurs. Section 2 presents the risks and healthcare costs associated with low birth weight.

2.1 Definition of Low Birth Weight

According to the March of Dimes, infants born at less than 1,000 grams (2 lbs, 3 oz) are defined as extremely low birth weight (ELBW). Most of these infants are

born at 27 weeks of gestation or less. Birth weight of less than 1,500 grams (3 lbs, 5 oz) is defined as very low birth weight (VLBW), a condition noted in 1.48% of all live births in the United States in 2006[1]. The term low birth weight (LBW) can either refer to all births below 2,500 grams or only to births between 1,500 grams and 2,500 grams. For the purpose of this study, the term low birth weight will be used to refer to any baby born at less than 2,500 grams.

The two main causes of low birth weight are prematurity and intrauterine growth retardation (IUR) (Alderman and Behrman, 2006). The first one, prematurity, is defined as birth at less than 37 weeks of gestation and according to the March of Dimes, 67% of low birth weight infants are premature. In general, a shorter gestational age corresponds to a lower birth weight and a greater risk of health problems. Mothers with previous multiple births, a high blood pressure or those exposed to stress, hard physical work or acute infections are at a higher risk of delivering a premature or a low birth weight infant (Kramer, 1998).

The second cause of low birth weight, intrauterine growth retardation, is caused by a blocked or abnormally small placenta that limits the nutrient and oxygen supply to the fetus. IUR can be due to smoking, maternal undernourishment, anemia, and acute and chronic infections (Allen and Gillespie, 2001; Verhoeff et al., 2001).

[1]March of Dimes 2008 Premature Births Report Card.

2.2 Health Risks and Economic Costs of Low Birth Weight

The health risks and economic costs of low birth weight differ throughout the stages of the life span. The risks and costs for infants differ from those for older children, which in turn differ from those for adults.

Health risks and economic costs in infancy

In most developed countries the majority of births occur in a medical setting. Other than the usual costs associated with delivering a baby, there are additional costs to cover the special medical requirements of low birth weight infants. Lewitt (1995) estimated that in 1998 75% of the excess $5.5-6 billion spent on low birth weight infants is used for care shortly after their birth and in infancy. The March of Dimes calculates that in 2007 the total average healthcare costs for a healthy normal birth weight baby were approximately $4,500 for the first year of life. For low birth weight babies, however, the cost was about $50,000.

Alderman and Behrman (2006) show that if low birth weight is caused by prematurity, the infants tend to catch up with their peers in terms of growth. If the condition is caused by IUR, however, low birth weight infants tend to remain smaller than their peers.

In countries where a large percentage of the births occur at home, the extra costs of low birth weight might be smaller, but these home births may also be characterized by higher mortality rates and worse outcomes for the surviving babies.

Health risks and economic costs in childhood

Children malnourished before birth are at a greater risk of suffering from complications typical for children malnourished in infancy (Alderman and Behrman, 2006). Low birth weight children tend to start school later than normal birth weight children. Matte et al. (2001) looked at 7 year olds to conclude that those born with a low birth weight have deficits in intelligence test scores in school. The deficit increases with a decrease in birth weight for both verbal and performance tests. One analysis of same-sex sibling pairs reveals that differences in birth weight are directly associated with differences in IQ in boys but not in girls. Fetal growth rates appear to differ for boys and girls, which leads to a different impact of fetal malnourishment (Forsen et al., 1999).

A correlation between low birth weight and autism has also been observed. Studying children born at least three months premature suggests that 21% of them receive positive scores on autism screening tests early in life. It is still unclear what the direction of the causality is and it is possible that a third factor causes both conditions (Kuban et al., 2009).

The primary expenses for low birth weight babies in childhood are related to additional outpatient care and hospitalization (Victora et al., 1999), including medical bills and time lost by caregivers. Special education and services for children suffering from the long-term effects of low birth weight result in extra costs (Petrou et al., 2001).

Health risks and economic costs in adulthood

According to Alderman and Behrman (2006), there are at least three main

possible effects of low birth weight on adults: lower cognitive abilities, metabolic changes and long-term consequences on future generations. As they age, low birth weight adults tend to have lower cognitive abilities and, therefore, a decreased productivity and income. Adults who were malnourished early in life or at birth also have a higher risk of long-term metabolic changes. Finally, low birth weight mothers are more likely to give birth to low birth birth weight babies, thus propagating the complications of low birth weight (Alderman and Behrman, 2006).

This chapter has summarized the definition of low birth weight that will be used in this analysis. It has also described some of the consequences and costs of low birth weight. The next chapter outlines the most important aspects of WIC, one of the ways the United States government has to battle pre-natal and child malnourishment.

Chapter 3

Overview and History of WIC

The Special Supplemental Nutrition for Women, Infants, and Children (WIC) started as a small program in 1969 and since then its eligibility criteria has changed to allow more individuals to participate. The program has expanded by making the recipients of SNAP[1], Medicaid and Temporary Assistance for Needy Families (TANF) automatically eligible for WIC. This has likely led to the inclusion of higher income families.

Close to nine million people participated in the program in 2008, receiving an average of $43.41 per month, resulting in a total program cost of $6.221 billion[2]. This chapter considers the goals of the program, the benefits it provides and the typical profile of its recipients. With that information, one can proceed to speculate about the effects of WIC on different groups of participants. This

[1] After October 1, 2008 *Supplemental Nutrition Assistance Program (SNAP)* is the new name of the Federal Food Stamp program. The term *food stamps* is common and still in use, so *SNAP* and *food stamps* will be used interchangeably in this study.

[2] United States Department of Agriculture, FY 2008 Report.

chapter is organized as follows: Section 1 states the goals of the program and provides a brief history of it. Section 2 reviews the benefits that WIC offers and the eligibility requirements that participants must meet.

3.1 Goal and History of WIC

In 1969, the White House Conference on Food, Nutrition, and Health drew the nation's attention to the importance of nutrition in the life and well-being of the individual. The conference led to significant policy changes, including an expansion of the Food Stamp program, improved food labeling, a broadened school lunch program, and the launching of a two-year pilot program - the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). The conference concluded that nutritional deficiencies among low income women and children threaten their health and increase their medical bills. The purpose of the program, as stated in the amended Section 17 of the Child Nutrition Act of 1966, is to provide more adequate nutrition to low income pregnant, breastfeeding and post-partum women, as well as children up to age 5. For this purpose, the program provides supplemental foods, nutritional education, and referrals to health and other social services through payments of cash grants to state agencies[3].

Today, WIC is available in all 50 States, 34 Indian Tribal Organizations, American Samoa, the District of Columbia, Guam, the Commonwealth Islands of the Northern Marianas, Puerto Rico, and the Virgin Islands. A total of 90 WIC state agencies administer the program through 2,200 local agencies and 9,000

[3]White House Conference on Food, Nutrition, and Health Executive Summary Report 1969.

clinic sites[4].

It is important to note that WIC is not an entitlement program. The United States Congress treats WIC as a Federal grant program, authorizing a specific amount of funding each year, which is then passed to the WIC State agencies.

3.2 Eligibility and WIC Benefits

The WIC program was permanently authorized in 1974 with a funding of $20.6 million and 88,000 people participating. By 1980, participation in all groups was close to two million people and its funding was $750 million. In 2008 almost 9 million people received WIC benefits each month sharing $6.209 billion provided by Congress[5].

Children have always been the largest category of WIC participants. Of the 7.9 million individuals who received WIC benefits each month in FY 2004, approximately 4 million were children, 2 million were infants, and 1.9 million were women, about half of whom were pregnant (Besharov and Germanis, 2001).

Take-up rates of WIC appear difficult to estimate because data recording the nutritional risk of individuals is scarce. The USDA Food and Nutrition Service estimates that in 1997 the take-up rate was about 87%. Participation for pregnant women in 1999 was about 69% (estimated by Besharov and Germanis, 2001), a

[4]National Nutritional Summit of the National Institute of Health 1996

[5]United States Department of Agriculture, Food and Nutritional Services, WIC FactSheet and Program Data

number that might be artificially suppressed because it is estimated by using all eligible pregnant women from the first week of their pregnancy as a base. Eligible pregnant women may join the program later and therefore the take-up rate for pregnant women may be higher than the stated 69%.

Eligibility for WIC is determined based on two main characteristics: income level and nutritional risk. To be eligible based on income, a family must have an income at or below 185 percent of the U.S. Poverty Income Guidelines[6]. For a family of four, the 2008 poverty line was $21,834 (US Census Bureau), which means that pregnant and postpartum women with an annual income of $40,392 ($21,834x1.85) or less are eligible for WIC. Moreover, recipients of TANF, SNAP and Medicaid are automatically income eligible[7].

Applicants who meet the income requirement also have their nutritional status evaluated. WIC guidelines recognize two major types of nutritional risks: medically based and dietary risks. Medically based risks include anemia, obesity, malnourishment, and a history of pregnancy complications or poor pregnancy outcomes. Dietary risks include poor nutritional practices and a failure to meet dietary guidelines[8]. Each applicant's nutritional status is determined by a physician, a nutritionist or a nurse, and recertified every six months.

Once eligible for the program, participants receive three kinds of benefits: food packages, nutritional and health counseling, and referrals to health care and

[6]Poverty thresholds are obtained from the U.S. Census Bureau, 2008

[7]United States Department of Agriculture, Food and Nutritional Services, WIC Income Eligibility Guidelines.

[8]United States Department of Agriculture, Food and Nutritional Services, WIC Eligibility Requirements.

social service providers.

Food packages

The foods that are part of the WIC package are high in nutrients often lacking in the diets of the program's target population. These include protein, calcium, iron, and vitamins A and C. Participants receive checks or vouchers, which are reissued every one to three months. Similar to food stamps, vouchers are accepted at participating food stores. With WIC vouchers, participants are limited to purchases of foods specified in their food package. A few WIC State agencies distribute the WIC foods through warehouses or deliver the foods to the participants' homes[9].

Counseling and referrals

With each periodic certification documenting their nutritional risks, participants must be offered at least two nutritional education sessions. These sessions last about 15 minutes and educate the participants about their health risks and the health risks of their children that can be avoided with better nutrition. The USDA limits the amount states can spend on providing counseling services, which leads states to prefer group rather than individual counseling (Besharov and Germanis, 2001). To cut down on their administrative costs even further, states also prefer to administer standard food packages rather than adjusting them to the needs of each participant. Also, receipt of food packages is not conditioned on attendance of the education sessions. Unfortunately, the USDA concludes that WIC participants still appear to have a limited knowledge of appropriate dietary

[9]Details about the distribution of benefits are provided by the United States Department of Agriculture, Food and Nutrition Services.

practices.

Given WIC's history of expansion and its worthy goals, evaluations of its effectiveness are naturally of interest. I will now proceed to review the existing literature on the effects of the WIC program on pregnant women and their birth outcomes.

Chapter 4

The Debate About WIC

This study focuses on only one aspect of the WIC program, namely its efficacy in increasing the birth weight of newborns. Since its inception, WIC has been subject to numerous studies and debates. On one hand, the General Accounting Office in 1992 concluded that WIC helped save $1 billion in federal, state and private spending over an 18-year period. On the other hand, some recent studies, including Joyce et al. (2007), conclude that the impact of WIC on both savings and health outcomes is much smaller than previously thought.

This chapter is structured as follows: Section 1 outlines two major concerns that need to be taken into account when studying the impact of WIC. Section 2 reviews previous studies that found a significant positive impact of WIC on birth outcomes. Section 3 reviews the opposite side: studies that concluded that the effect of WIC on birth outcomes is limited.

4.1 Selection and Simultaneity Bias

Two main weaknesses are cited when studying the effect of WIC: selection bias and simultaneity bias. The selection bias stems from the fact that women who are more concerned about their health and the health of their babies are more likely to enroll in WIC. Their better birth outcomes may then be due to their overall better care for themselves and their unborn children during pregnancy. If this is the case, and the selection bias is not controlled for, the effect of WIC will be overestimated. On the contrary, if WIC mothers are negatively selected and at a greater nutritional risk than non-participants, then the effect of WIC will appear smaller than it truly is. Controlling for a large number of maternal characteristics in a multiple regression or using a two-stage least squares model to first predict WIC participation are some of the ways to control for the selection bias. This study will use a similar approach.

Simultaneity bias might result from the fact that the longer a woman is pregnant, the more time she has available to learn about WIC and the more likely she is to enroll. On the other hand, the longer a woman is pregnant, the more likely she is to give birth to a healthy baby. Therefore, the effect of WIC on mothers who enroll late in the pregnancy might be due primarily to the longer duration of their pregnancy and not to WIC. Controlling for gestational age at birth and the duration of enrollment in WIC are some of the possible ways to account for the simultaneity bias, although information on the time of WIC enrollment is not readily available.

I now proceed to review a number of studies on the impact of WIC on

newborns, exploring the empirical models, conclusions, and ways to address the selection and simultaneity bias used in the current literature.

4.2 "WIC Works Wonders"

Probably the greatest support for the notion that "WIC Works Wonders"[1] was expressed in the General Accounting Office report in 1992 (GAO, 1992). The report reviews 17 evaluations of WIC and concludes that, when it comes to pregnant women, WIC reduces the incidence of low birth weight by 25% and the incidence of very low birth weight by 44%.

One of the studies cited by the GAO report was the work done by Devaney et al. (1992). They evaluate the efficiency of the WIC program by examining the Medicaid cost savings due to WIC participation and use of prenatal care. For this purpose, data on Medicaid costs and WIC participation was combined with information about prenatal care and birth outcomes of all Medicaid-covered births. Multiple regression analysis is used to model the Medicaid costs from birth to 60 days after birth, controlling for WIC participation and a set of observable characteristics thought to influence Medicaid costs.

The study shows that prenatal WIC participation is associated with substantial savings in Medicaid costs and an increase in birth weight - from 51 grams in Minnesota to 117 grams in North Carolina. WIC leads to a 28% decrease in the number of low birth weight babies and a 59% drop in the number of very low

[1] "WIC Works Wonders" is a motto often found on numerous state WIC websites, for example the ones of Wisconsin or Pennsylvania

birth weight newborns.

The simultaneity bias is accounted for by controlling for gestational age. The effect of WIC decreases by 40-45% but remains positive and significant. This implies that WIC increases birth weight at any gestational age but that the effect is overestimated when gestational age is not controlled for, as predicted by the simultaneity bias.

A similar analysis was done by Buescher et al. (2000). Linking Medicaid and WIC data files from the 1997 North Carolina live birth records, the authors find that at least one dollar was saved in Medicaid newborn costs for every dollar spent on prenatal WIC services.

Buescher et al. (2000) compare the same two groups of mothers that Devaney et al. (1992) analyze – Medicaid recipients who did or did not participate in WIC. Their regression analysis is supplemented by a comparison of the mean birth weight of both groups. The authors conclude that WIC non-participants are significantly more likely than WIC participants to have smaller babies and higher Medicaid costs. This result does not change after controlling for possible bias due to gestational age, preterm delivery, and late entry into WIC. It also appeares that cost savings are higher for African American than for white babies. In some cases, as much as $4.02 is saved for every dollar spent by WIC on pregnant black women.

A positive effect of WIC participation was also observed by Bitler et al. (2005). They conclude that not only does WIC have a positive effect on birth outcomes, but the effect is also larger than previously estimated because WIC

mothers are negatively selected on a number of observables. This suggests that the selection bias is negative. The negative selection is verified by a logit model, which determines that mothers who are high-school dropouts, single, obese, black or Hispanic are more likely to participate in WIC than mothers with a college degree, who are married or white.

Bitler et al. (2005) then use both a one-stage and a two-stage model to assess the impact of WIC on birth outcomes. They conclude that the estimates of the two-stage model are unreliable because they have lower F-statistics and partial R-squared compared to the one-stage model, which according to Staiger and Stock (1997) is an indicator of weak instruments. Bitler et al. (2005) suggest that the one-stage model gives better estimates, a conclusion that will drive the model selection of the current study discussed in the next chapter. According to Bitler's analysis, WIC reduces the probability that an infant has a low birth weight by about 29% and it also decreases its chance of having a very low birth weight by almost 50%.

4.3 "WIC Works" Modestly At Best

After reviewing a number of studies, which find a positive impact of WIC on birth weight, I now consider the opposite finding: that the effect of WIC on birth weight is modest at best.

Metcoff (1985) avoids all caveats resulting from omitted variables or selection bias by analyzing data from a randomized controlled trial. In the trial, women

at mid-pregnancy, all eligible for WIC, were randomly assigned to receive or not receive a food supplement.

It appeared that, after adjusting for sex, gestational age, prenatal visits, and previous instances of low birth weight pregnancy outcomes, mothers in the treatment group (receiving the supplement) gave birth to babies with a higher birth weight than the babies of the control group (not receiving the supplement). When controlling for entry weight of the mother, however, the effect of WIC was no longer significant except for the babies of mothers who smoked. This suggested that WIC partially outweighs the negative effect that smoking has on on fetal growth but its effect does not apply to all groups of recipients.

The findings of Brien and Swann (2001) suggest a similar conclusion. They find that WIC only affects the birth outcomes of black women. Both a one-stage and a two-stage least squares model prove very sensitive to the model specification. The authors use state characteristics reflecting the availability and generosity of the program as instruments for the 2SLS model. The impact of WIC on white women does not appear significant. When the same two-stage model is used for black women, WIC participation increases birth weight by between 9.5% and 12.7%. It is possible that the instruments the authors use work better for black infants but it is also possible that the effect of WIC differs by race.

Analyzing the relationship between prenatal WIC participation and birth outcomes in New York City from 1988-2001 for women on Medicaid, Joyce et al. (2005, 2007) support the idea that the large positive effect of WIC on birth weight is exaggerated. The only association that they find between WIC and an increase

in birth weight is observed for black mothers but the authors explain the result as having to do more with the decline of the crack epidemic at that time rather than with the WIC program itself.

With information on the mother's timing of WIC enrollment from nine more states, the authors test whether greater exposure to WIC is associated with less smoking, improved weight gain during pregnancy, a better birth outcome, or a greater likelihood of breastfeeding. They conclude that the effect of WIC on all four of these is modest and most likely spurious.

In conclusion, this literature review finds that even though numerous studies have been done, the effect of WIC on newborns is unclear. My analysis will explore the effects of the program using a data source that has not received much attention in similar studies. Details about the dataset and the empirical analysis of this study follow.

Chapter 5

Main Questions, Model and Data

This chapter states the two main questions of the current study, describes a model to empirically test them, and introduces the data source used for this analysis. This chapter is organized as follows: Section 1 outlines and justifies the empirical model. Section 2 provides more information about the National Health Interview Survey. Section 3 presents a number of explanatory variables and expected results.

5.1 Main Questions and Model

This study aims to answer two main questions:

Question 1: What is the effect of WIC on birth weight?

WIC provides nutrition and guidance to pregnant mothers at risk. If we measure the program's success by looking at birth weight, does the program work? Does the program affect the incidence of low birth weight? Does the program result in cost savings and if so, what is their magnitude?

Question 2: What characteristics interact with WIC to make it a success or a failure?

WIC recipients are not homogenous - they differ by race, education, marital status, income. Does the program work for better people with a certain set of characteristics? Does the program help the very poor the most or does it work better under certain conditions?

Given these questions, the model selected for my study relies on the findings by Devaney et al. (1992), Buescher et al. (2000), and Bitler et al. (2005) described in the previous chapter. In particular, Metcoff (1985), Devaney et al. (1992), and Buescher et al. (2000) use a multiple regression analysis to predict birth weight. Bitler et al. (2005) use a two-stage least squares model (2SLS) to predict the birth weight using state-level characteristics as instruments. The 2SLS yields large standard errors and the authors reject it, concluding that an ordinary least squares model is a more sensible option.

In other words, the bulk of the literature suggests that the ordinary least squares model is sufficient for studies similar to the current one. This finding, along with the lack of appropriate instrumental variables in the particular data set, convinced me to rely on the following ordinary least squares model:

$$BW_i = b_0 + b_1 WIC_i + b_2 \mathcal{X}_i + \varepsilon_i \tag{5.1}$$

where BW_i is the birth weight of infant i, WIC_i is a binary variable for WIC participation (1=participant) of the mother of infant i when she was pregnant with infant i, $\mathcal{X}_i$ is a vector of additional independent variables (income, education, race, marital status, participation in other welfare programs, etc.), and ε_i is an error term.

5.2 The National Health Interview Survey

A unique feature of this study is the reliance on a relatively unused dataset for studies of WIC. After examining a number of data sources, the National Health Interview Survey (NHIS) was selected as the data source of choice for this analysis because it provides detailed medical history data while also containing data on birth weight, family income, and a number of other demographic variables.

The National Health Interview Survey (NHIS) is administered by the National Center for Health Statistics, which is part of the Center for Disease Control and Prevention (CDC). The National Health Interview Survey is the main source of information about the health of the civilian, noninstitutionalized, household population in the United States. The survey was started in 1957 and is conducted annually[1].

[1] All information about the format of the NHIS is obtained from the NHIS Information Package provided by the National Center for Health Statistics.

The survey contains a basic module and various supplements. The basic module contains three core files - Sample Family Core, Sample Adult Core, and Sample Child Core. For each family participating in the NHIS, one sample adult and one child under age 18 (if present) are randomly selected and information about them is recorded into the Sample Adult and Sample Child files respectively.

The NHIS sample of participants is redesigned and redrawn every ten years. Each household in the population has a known, non-zero probability of being selected to participate in the survey. The dataset provides probability sampling weights that are used at every step of this analysis.

This study uses NHIS data from three consecutive survey years: 2002, 2003, and 2004. The interviewed sample for all three years was comprised of 108,661 households, with a total of 110,870 families and 279,994 persons. The Sample Adult component of the core questionnaire was administered to 93,222 persons above the age of 18 and the Sample Child part of the survey included 37,197 children by proxy response from a knowledgeable adult. For children born the week of the interview, data was not collected.

Each household in the dataset is identified by a unique household identification number (ID). Each family within a household and each individual within the family have an identification number unique to that household or family. Therefore, by combining the household ID, the family ID and the person ID, one can obtain a compound ID for identifying individuals in the sample.

The dataset from 2002, 2003, and 2004 initially contained 279,994 observa-

tions, each one representing a single individual. The dataset was then collapsed, so that each family is represented by its youngest member. The collapsed dataset contained 110,870 observations.

The goal of this study is to analyze newborns and their birth weight. This is why for each of the three years, the subset was limited to individuals born in the year of the survey or the year before the survey. After these restrictions, the dataset contained 3790 observations. Each observation represented an individual born in 2001, 2002, 2003, or 2004. Since the NHIS questions on income and other relevant variables described below refer to the 12-month period prior to the survey, the answers of the participants are only relevant to babies born during these periods.

Although a very rich and detailed dataset, the NHIS has a few disadvantages. First of all, it does not collect information on the location of the individual, therefore not allowing for state level observables to be controlled for. Additionally, the dataset does not contain information on gestational age at birth or the history of previous pregnancies. Finally, even though the NHIS is a large survey, its main goal is not to study newborns specifically, so only a small subset of participants are of use to this analysis. Regardless of these disadvantages, the NHIS is a valuable and novel dataset in the WIC analysis field. It is worth exploring and suitable for the purpose of this thesis.

5.3 Main Variables

The two main empirical issues of simultaneity and selection bias discussed in the previous chapter are addressed by the specific variables used in this analysis. To minimize the selection bias, this study controls for a large number of maternal and family characteristics. To minimize the simultaneity bias, it uses information on birth order, namely whether the child is a firstborn. The discussion of the specific variables used in this analysis will elaborate on these points. Summary statistics for all variables are presented in Table A.1.

Dependent variable

Birth weight: The goal of this analysis is to study birth weight. Three different measures of birth weight were available in the NHIS dataset - birth weight measured in grams, ounces, and pounds. All pediatric guidelines used as a reference in Chapter 2 were cited in grams[2], which is why the variable representing birth weight in grams was the one selected for this analysis. Birth weight is a continuous variable, bottom coded at 500g (1.1 lbs) and top-coded at 5,485g (12.09 lbs).

Of the 3790 observations, thirty-three babies (0.87%) were born with an extremely low birth weight (ELBW) of less than 1,000g. Twenty-five babies (0.7%) were born with a birth weight between 1,000g and 1,500g or a very low birth weight (VLBW). Two hundred and twenty children (5.8%) weighed between 1,500g and 2,500g at birth. In total, the number of low birth weight babies in the sample

[2] 1 pound = 16 ounces = 453.59 grams = 0.453 kilograms

(500g to 2,500g) was 278 (7.34%). According to Child Health USA[3], the average incidence of low birth weight between 2001 and 2004 was 7.87%. The number of low birth weight observations in this dataset is close, yet a bit lower than this proportion.

Independent variables

WIC: A variable indicating participation in the WIC program during the twelve months prior to the survey was obtained. The variable was then recoded into a binary variable, with 0 for non-participation and 1 for participation. 3,701 individuals did not receive WIC during the last calendar year, 49 did and 40 refused to provide an answer.

Firstborn: The number of children under 18 years of age in the family was used to construct FIRSTBORN, a binary variable with 1 indicating that the child does not have older siblings. The average number of children in the family was 0.78. About fifty-one percent of the families had only one child.

Birth order is considered important when studying birth weight for a number of reasons. Women pregnant for the first time have less experience and less information about the resources available to them. They may be less likely to know about WIC or enroll early. Information on birth order, therefore, can be a reasonable proxy for time on enrollment into WIC and a possible way to address the simultaneity bias discussed before. The effect of WIC may appear greater for infants with older siblings simply because they are more likely to receive it. If this study finds no difference between the effect of WIC on firstborn and non-firstborn

[3]Child Health USA is the annual report of the U.S. Dept. of Health and Human Services on the health status and needs of children.

children, that finding will suggest that even women pregnant for the first time enroll early enough to benefit from WIC.

Race: The race of the child was important to control for in case of differences between the races that affect birth weight. NHIS separates the individuals into three broad racial categories: white, black, and other. There were 2773 white babies, 523 black babies, and 494 babies whose parents were described as not belonging to either of those.

It has been reported that African American women give birth to smaller babies (Bitler et al., 2005). In order to investigate this point, a binary variable for being black was created with 1 indicating that the individual was described as black and 0 indicating that they were described as either white or other.

Mother's weight: Metcoff (1985) concludes that controlling for maternal weight is essential in studies of birth weight. To explore whether heavier mothers give birth to heavier babies, a variable indicating the mother's current weight was obtained. The body weight was measured in pounds and was then recoded to body weight in kilograms (kg) to facilitate the interpretation of subsequent regression outputs where the newborn's birth weight is measured in grams.

To obtain the mother's weight, the sample was restricted to female sample adults who indicated that they were the parent of the child in question. Due to the fact that not all sample adults are female and that some of the females did not provide information about their body weight, the number of valid observations for this variable was reduced. Of the 3,790 sample adults, 2,654 were female adults with a valid body weight. The average body weight of the mothers was 74.04kg

(163 lbs). This is important given that heavier mothers are expected to give birth to heavier babies.

Smoking: Smoking is a necessary variable because it provides information on the health status of the mother. The March of Dimes states that smoking is a significant risk factor for low birth weight. The NHIS variable on smoking contained three relevant categories - (1) current smokers, (2) former smokers, and (3) non-smokers. A binary variable was created indicating current smoking status – combining category (2) former smokers and category (3) non-smokers into one category equal to 0, and keeping (1) current smokers as the second category equal to 1. In the final sample, 35.7% of the individuals indicated that they currently smoke.

Smoking is known to impede intrauterine growth, decrease birth weight and increase the likelihood of a pre-term delivery (Adams et al., 2002). Smoking in this analysis is thus expected to have a negative impact on birth weight.

Mother's education: Information about the education of the mother was present in the dataset and grouped in three categories: (1) less than a high school degree, (2) a high school degree or a 2-year undergraduate degree, and (3) a 4-year undergraduate degree or higher. About 20% of the mothers lacked a high school degree, 70% had either a high school degree or a 2-year degree, and the remaining 10% had at least graduated from college.

Educated mothers are expected to not only have higher income but also more access to information about WIC and other resources to improve the outcome of their pregnancy. A higher degree may therefore be associated with a higher birth

weight.

Income: Income was suspected to be an important parameter to control for when studying health outcomes. The income variable in NHIS reflects annual combined family income for the previous calendar year. Income is a categorical variable with twelve income brackets and is top coded at $75,000 in 2003 dollars. The variable was recoded by taking the midpoint of each income bracket and adjusting for inflation. All income was calculated in 2003 dollars, using the Consumer Price Index of the Bureau of Labor Statistics. The average income for the sample was $43,693 in 2003 dollars.

Income is a variable that has sometimes been overlooked when listing the determinants of birth weight. Although income is an eligibility requirement for WIC participation, the income cutoff is 185% of the poverty line. Not controlling for income ignores the fact that eligible families can be making anywhere from $0 to $185%×(poverty line) per year. Where a family is located in this distribution determines its ability to purchase medical care, food and other services. Income is expected to have a positive impact on birth weight. Diminishing returns to income are also possible.

Moreover, the source of income may be important in determining birth weight. Three sources of income will be explored: availability of income from a spouse (as proxied by marital status), income from employment, and income from government transfers.

Marital status: To better understand the characteristics of each family, data on the marital status of the parents was obtained. The marital status variable

available in the NHIS presented several different categories to describe the current living arrangement of the family. For simplicity, a binary variable was generated, coding 1 for married and 0 for single individuals. 1,523 of the mothers were single and 2,259 were married.

Marital status provides valuable information. Single women cannot rely on income or support from a spouse while pregnant. This may make it more difficult for them to stay at home while pregnant and, if working is their main source of income, it may force them to take more dangerous and stressful jobs. Being single, therefore, can have a negative impact on birth weight both because of lower income and increased levels of stress.

Employment: Information on whether the mother is employed is important when considering the income sources available to her. NHIS contains information on whether the individual received salary from employment. This information was used to create a binary variable with 1 for individuals who are employed and 0 for those who are not. 54.3% of the individuals indicated that they were employed.

Being employed can impact birth weight in either direction. A pregnant woman who is employed is able to bring more money to the family, therefore improving her quality of life and care. If the job she is involved in is dangerous, stressful or prevents her from attending prenatal visits, working can be harmful to her and her baby.

Also, a pregnant woman may be unemployed because she is unable to find a job and the exposure to stress may harm her health and the health of the baby she

is carrying. On the other hand, if the woman is not working because she would rather stay at home and take better care of herself while pregnant, the impact of not working may be positive.

TANF and SNAP: A possible alternative source of family income is welfare. Two programs were of interest for the purpose of this study - the Temporary Assistance for Needy Families (TANF) and the Supplemental Nutrition Assistance Program (SNAP). Out of the 3,790 individuals, 221 (5.83%) received TANF. One hundred individuals (2.67%) received food stamps.

TANF is an income supplement offered to low income families that requires most of them to work a minimum number of hours per week. Receiving TANF, therefore, increases both the family income and the likelihood that a woman works. As previously discussed, work can impact birth weight in either direction.

The Food Stamp program, now known as SNAP, like WIC, provides additional income to be used on food. Unlike WIC, there are no restrictions on the kinds of foods that can be purchased with food stamps. Food stamps can be thought of as a form of income supplement because families typically receive food stamps worth less than their food budget (Currie and Gahvari, 2008). The marginal propensity to consume food out of food stamps appears the same as the marginal propensity to consume food out of cash income (Hoynes and Schanzenbach, 2007).

This chapter outlined the model, the main questions, and the dataset that are in the center of this study. The next chapter will present the results of this analysis.

Chapter 6

Results and Discussion

Applying the empirical model to the data described in Chapter 5 yielded a number of interesting results that are the focus of this chapter. The chapter is organized as follows: Section 1 reviews the summary statistics. Section 2 presents and discusses the regression results.

6.1 Negative Selection and Differences Between Groups of Recipients

The first observation made based on this analysis is the fact that WIC participants are negatively selected on almost all characteristics compared to non-WIC recipients (Table A.2). This agrees with the conclusion made by Bitler et al. (2005) who also noted the negative selection of WIC recipients.

On average, the income of WIC recipients is four times lower than the income of non-WIC recipients. WIC recipients are three times more likely to be African American, and more likely to be pregnant for the first time. These women are also ten times more likely to be single, two times more likely to smoke, 50% more likely to not graduate from high school and six times less likely to have a 4-year degree. WIC recipients are also 30% more likely to be working, seven times more likely to receive TANF and almost twenty times more likely to receive food stamps.

However, WIC recipients do not appear to be negatively selected on birth weight and maternal weight. WIC recipients have babies that weigh only about 12g less than the babies of non-recipients. The mean maternal weight is virtually the same for both groups and there is a relatively small difference in the proportion of girls in the two samples, with the non-WIC group having slightly more girls than boys.

Additionally, black mothers are negatively selected on a number of characteristics compared to non-black mothers (Table A.3). Black women are 50% more likely to be single. Although maternal weight is higher for African American women, birth weight is lower for that group. On average, the income of African American mothers is 30% lower than the income of non-black mothers, and they are three times more likely to receive WIC, TANF, or food stamps.

As already mentioned, regardless of race, recipients of food stamps (Table A.4), are three times more likely to be African American and twenty times more likely to receive WIC. They also have a higher probability of smoking, being single, and receiving TANF. The birth weight of their babies is about 300g lower than

the birth weight of babies born in families not receiving food stamps. This is an interesting issue that will later be explored in further detail.

Finally, it is important to note that for all groups of recipients female babies weigh about 100g more than male babies.

6.2 Regression Results

The impact of WIC on birth outcomes and birth weight has been studied in detail to try to assess the cost-effectiveness of the program and to ensure it delivers the best possible outcomes. The goal of this study is to revisit a number of findings, while using a dataset that does not appear to have been used for a similar analysis before. Furthermore, this study will not only explore whether WIC works, but it will look deeper into investigating what drives its success or failure. It will analyze whether the impact of WIC depends on other characteristics of the family such as race and composition, and whether WIC interacts with other types of welfare to produce optimal outcomes.

A number of estimates that will be used to back up this analysis are presented in Table B.1-B.6. Each estimated regression equation is numbered E.1 through E.24 to represent different specifications.

6.2.1 Aggregate Effect of WIC

I will first consider the effect of WIC overall before I explore its interaction with other parameters. On average, WIC has a positive effect of 325.5g (see equation E.1, estimated coefficient β_1, i.e. E.1; β_1), a result that is robust to most changes in specifications. In order to find out how WIC impacts the incidence of low birth weight, 325.5g can be subtracted from the birth weight of WIC recipients to see whether this places them in the low birth weight (LBW) group (below 2,500g). Before the subtraction, there were 4 WIC recipients who were classified as LBW. Once the WIC effect of 325.5g was accounted for, we find that 7 more babies would have been placed in the LBW group in the absence of WIC. This represents an increase of almost 200%. According to the USDA Food and Nutrition Services, the average cost per WIC recipient in 2007 was $39.04 per person per month. This translates into an annual expenditure of about $470 per recipient. The March of Dimes estimates that in 2007, the total average healthcare cost for a healthy normal birth weight baby was approximately $4,500 for the first year of life. For low birth weight babies, however, the cost was about $50,000, which is a very substantial increase of $45,500.

There are 49 WIC recipients in this sample. If $470 is spent on each of them per year, the total annual cost of the program for this sample is about $23,000. After receiving WIC, seven of these babies were no longer low birth weight, therefore saving 7×$45,500 -7×$470 = $315,210 in health care costs per year. This translates into a savings rate of about $17 for each dollar spent on WIC. This rate is higher than the rate reported in previous studies. While this

simple calculation is not sufficient for any general conclusions, it is sufficient to illustrate that WIC may result in substantial cost savings.

6.2.2 Characteristics of the Mother and the Newborn

Gender of the newborn: Considering the entire sample of both WIC and non-WIC recipients, the gender of the newborn appears to be correlated with its birth weight. Specifically, girls weigh more than boys on average, an observation also made by Forsen et al. (1999) who explain that due to differences in fetal growth rates, boys are more susceptible to malnourishment. The positive and significant effect of being female on birth weight persists across all groups of recipients except for current smokers (E.4; β_2) and African American mothers (E.2; β_2). The positive impact of being a female infant on birth weight is largest for single mothers (E.6; β_2=155.8) and smallest for unemployed women (E.9; β_2=93.6) and women in poverty (E.10; β_2=99.1). This is an interesting observation. It suggests that the difference between boys and girls decreases if the mothers are very disadvantaged (unemployed or in poverty). The level of malnourishment or improper nourishment at this point may be very high and, therefore, it affects both genders in a similar way, overcoming some of the fetal advantages girls might otherwise have.

The interaction between the gender of the baby and the WIC program is a point that has not received much attention in the current literature. To study the interaction of WIC with the newborn's gender, I first consider the samples of boys and girls separately (E.11; β_1 & E.12; β_1). The effect of WIC is larger for

girls than it is boys and it is significant for both genders. When receiving WIC, girls gain an average of 349.3g and boys gain 291.6g, or about 58g less. Adding an interaction term between WIC and gender reveals a similar difference. If the baby is female, WIC increases her birth weight by 71.4g (E.13; β_{17}) more than if the baby is male. The difference, however, is not significant. It appears that, although boys are more susceptible to fetal malnourishment, they respond less to WIC but not significantly so.

On the other hand, considering the impact of gender for WIC and non-WIC recipients separately indicates that gender is a determinant of birth weight only in the non-WIC group (E.21; β_2 & E.22; β_2). This finding is worth noting: WIC appears to close the gender gap in birth weight.

Birth Order: Together with gender, birth order is another characteristic that impacts birth weight for some participants. The effect of being a firstborn is negative and, in several equations, significant. Overall, birth weight for firstborns is lowered by 89.6g (E.1; β_3). For smokers this effect appears to be strongest, with firstborns weighing 253.4g less than children with older siblings (E.4; β_3). If the mothers do not smoke, however, the difference in birth weight between firstborns and children with older siblings decreases to 65.2g (E.5; β_3). A possible reason may be the fact that, when pregnant for the first time, smoking women may have less information about the harm they are causing to their child and are, therefore, less likely to cut back on the amount of smoking. During a subsequent pregnancy, they may be more aware of the risks associated with smoking either because they are better informed, or because they have witnessed the negative

impact of smoking on their first child. They may then be more likely to decrease their *frequency* of smoking during the subsequent pregnancy. This would explain the larger difference between the birth weight of the first and the subsequent children of smokers.

Information on birth order can be used to predict WIC participation and address the simultaneity bias. Women pregnant for the first time are less likely to enroll in WIC early or enroll at all, which is why birth order is often assumed to be a plausible proxy for time of enrollment. If present, the simultaneity bias will overestimate the effect of WIC for subsequent births. However, the interaction of WIC with birth order yields surprising results. Interacting firstborn and WIC makes WIC insignificant for not-firstborn babies (E.14; β_1). However, WIC and the interaction term are jointly significant, indicating that if the baby is firstborn, receipt of WIC increases its birth weight by 349.8g (E.14; β_3+1× β_{18}). On the other hand, the effect of being firstborn for non-WIC recipients is negative 90.8g (E.14; β_3). WIC appears to narrow the disadvantage experienced by firstborns. In addition to reducing the gender gap, WIC appears to also reduce the firstborn gap.

Race: Black mothers have been reported by Buescher et al. (2000) to give birth to smaller babies. My results confirm that being African American predicts a lower birth weight.

The negative impact of being black on birth weight is significant for all groups of participants except for married women, smoking mothers, and girls. The significant negative impact is largest for unemployed mothers (E.9; β_4= -213.7),

mothers in poverty (E.10; β_4= -204.6), and mothers of boys (E.12; β_4= -246.4). As already mentioned, African American mothers are negatively selected on a large number of characteristics. A more plausible explanation for the differences in birth weight by race may thus be unaccounted-for socio-economic factors. The fact that the difference disappears for married women and is strongest for the groups of most disadvantaged women (unemployed or in poverty), weakens any purely genetic argument.

In this sample, black mothers are three times more likely to receive WIC than non-black mothers, and the impact of WIC is significant for both groups (E.2; β_4 & E.3; β_4). The impact of WIC is larger for non-black babies (E.3; β_1=376.5g) than for black (E.2; β_1=314.0g) babies. An interaction between being black and WIC (E.15; β_{19}) also suggests that the impact of WIC for African-American babies is lower; at the same time the difference is not significant.

On the other hand, the negative impact of being African-American on birth weight is greater for WIC recipients (E.15; β_4+β_{19}= -354.4) than it is for non-recipients (E.15; β_4= -181.6). The difference however is again not significant. It is likely that the more negative impact of being black on the birth weight of WIC recipients is due to unobserved characteristics proxied by WIC rather WIC itself.

Maternal Weight: The importance of controlling for maternal weight was shown by Metcoff (1985) who concluded that the weight of the mother is an important determinant of the weight of the newborn. This analysis confirms Metcoff's finding. Maternal weight has a significant positive impact on birth

weight overall (E.1; β_5). The impact is positive and significant for all groups except smokers, single mothers, unemployed mothers, and mothers in poverty. The impact is largest for black mothers, in which case an increase of 1kg in maternal weight leads to an almost 10g (E.2; β_5) increase in birth weight.

A prevailing concern about the effectiveness of the WIC program is the possibility that it is obesity and not malnourishment that society needs to address. The interaction between WIC and maternal weight suggests that the effect of WIC decreases with an increase in maternal weight (E.20). When considered jointly with the interaction term (E.20; β_1 & β_{24}), WIC is significant for maternal weight of 44kg (the minimum maternal weight in the sample) to 85kg. Moreover, the effect of WIC decreases as the maternal weight increases as shown by the negative sign of the interaction term (E.20; β_{24}= -4.3).

The average height of the mothers in the sample was 167cm (65 inches)[1]. Using the National Institute of Health (NIH) Body Mass Index (BMI) calculator, the BMI for an 85kg/165cm individual is 30.5. According to the NIH, BMI above 30 qualifies one as obese. WIC, therefore, has a positive impact for all levels of parental weight but not for obese mothers. The concern that WIC makes obese mothers worse off by increasing their weight or the weight of their babies is unfounded according to this analysis.

Smoking status: The choice of pregnant women to smoke is another determinant of birth weight that is worth exploring. Metcoff (1985) reports that smoking mothers give birth to smaller babies. The finding is confirmed by my analysis.

[1]The average height of the mother was obtained as an additional variable from NHIS

Smoking exhibits a negative impact on birth weight for all groups of recipients except for black, single, or unemployed mothers, even before the impact of WIC is taken into account. Black mothers are less likely to smoke (Table A.3) and no significant negative impact of smoking on birth weight is observed for black mothers, regardless of WIC status. The impact of smoking for married women (E.7; β_6) is significant and equal to -231.9g compared to a smaller and insignificant impact for single women of -106.3g (E.6; β_6). If married women who smoke are more likely to have spouses or other household members who also smoke, then the exposure to smoking may be even larger, therefore augmenting its negative impact.

The impact of WIC for smokers (E.4; β_1=499.4g) appears positive, large, and significant; but the subsample only contains eight WIC cases, which makes the coefficient unreliable.

For non-smokers, the impact of WIC is still positive and significant, but not as large (E.5; β_1=310.5g). Even though WIC has a greater impact on smokers, the difference is not significant (E.16; β_{20}).

Mother's education: Mother's education, and specifically whether the mother has a high school degree or not, was also accounted for. This parameter controls for maternal differences that would increase the likelihood of WIC participation for some women. It is then an additional attempt to address the possible selection bias. Mothers with higher education are expected to know more about the program and participate in it.

Having less than a high school degree appears to have a significant negative impact on the birth weight of babies with mothers who smoke or are single (E.4;

β_7= -357.8 & E.6; β_7= -135.9). The result however is not robust to the specification of the model and its sign and significance change across the different groups of recipients. The effect of WIC is smaller for mothers without a high school degree (E.23; β_1+β_{27}=375.6-183.9=191.7) than it is for mothers with a higher degree (E.23; β_1=375.6) but the difference is not significant.

Not having a high school degree has a small and insignificant negative effect on birth weight for non-WIC recipients (E.23; β_7= -7.01). The result is greater in magnitude for the WIC-group - not having a high school degree decreases the birth weight of one's child by about 190g (E.23; β_{27}+β_7= -190), which is likely to be an indication of negative selection.

6.2.3 Income Level and Type

I now turn to consider the impact of combined family income and the different sources of income on birth weight and the effectiveness of WIC. In particular, I would like to investigate whether the impact of WIC is greater at the lowest levels on income, or whether higher income combines with WIC to make WIC more effective. Furthermore, I would like to see whether the type of income matters and whether WIC has the same impact on birth weight regardless of the income source. Does income from the mother's employment have the same effect as income from a spouse or income from government transfers? If transfers matter, which transfers enhance the effect of WIC on birth weight and is WIC particularly effective if combined, for example, with TANF?

Combined family income: I first consider the impact of combined family

income on birth weight. This effect appears to be anywhere from plus 1g to minus 1g per $1,000 of extra income. This is a very small percentage of the newborn's birth weight and the result does not persist across all groups. The next point is to consider possible diminishing returns to income. This non-linearity, if not controlled for in the model, may mask the effect of income. To explore these non-linear effects a squared term was introduced in equations E.1 through E.12. Neither income nor income squared appeared significant separately or jointly in any of the specifications[2]. Income does not appear to have diminishing returns, at least for the given range of income, topcoded at $75,000.

Thirty-six of the 49 WIC recipients in the sample are located in the lowest quartile of the income distribution and it is interesting to explore whether the effect of WIC depends on the level of income for these recipients. Including an interaction term and allowing for dimishing returns, we look at the effect of WIC (E.24) for the lowest quartile of the income distribution. WIC has a significant positive impact of 169.07+0.03×(income) on birth weight showed by the joint significance of the its coefficient and the interaction term (E.24; β_1 & β_{28}). The interaction term itself is significant, suggesting that the impact of WIC changes with a change in income. Specifically, a $5,000 change in income leads to an additional 150g (E.24; β_{28} × $5,000) impact of WIC, or a total effect of 169.07+150=319.07 (E.24; β_1+β_{28}). This is an interesting finding, suggesting that extra income increases the efficiency of WIC for individuals in the lowest quartile of the income distribution.

[2]The regressions results are not presented in this study due to the lack of additional insights they contain.

Even if the aggregate level of income does not appear significant for all income groups, it might be the case that different sources of income interact with WIC. To explore this question, three main sources of income were identified: income from a spouse, income from employment, and income from TANF or SNAP.

Income from a spouse: The first source of income to consider is income from a spouse as proxied by marital status. Two-parent households are likely to have a higher combined income than single parent households. Also, the presence of a spouse can reduce the stress a pregnant woman is subject to, therefore improving the birth outcome of her baby.

Marital status does not appear to have a significant impact on birth weight overall. However, being married has a significant and positive impact on the birth weight of male babies (E.12; β_8=90.9) and African American babies (E.2; β_8=209.6), even when controls for combined family income are included. Furthermore, again controlling for family income, being married has a significant and positive impact on birth weight for the children of employed women (E.8; β_8=100.6) and non-smokers (E.5; β_8=74.6). If non-smokers marry other non-smokers, then gestation is more likely to take place in a smoke-free environment, therefore impacting birth weight positively.

Due to the small number of married WIC recipients, looking at single and married women separately does not allow for more general conclusions about the interaction between WIC and marital status. Comparing the subsample of single women to the entire sample, however, reveals that the estimated impact of WIC

is greater (E.6; β_1=407.4 & E.1; β_1=325.5) for single women by about 82g.

Income from mother's employment: The second source of income is employment of the mother. Employment status has a significant impact on birth weight only for married women (E.7; β_{10}=95), in which case being employed increases birth weight by about 95g. For single women, the effect of employment (E.6; β_{10}= -14.4) is negative although not significant. All remaining groups show insignificant but positive coefficients. Perhaps the combined stress of being both breadwinner and sole parent has negative effects. This result raises concerns about forcing single women of childbearing age into the work force.

Considering employed and unemployed women separately, the impact of WIC is larger for employed women (E.8; β_1=308.1g & E.9; β_1=244.3g). However, introducing an interaction term (E.17; β_{21}) between employment status and WIC suggests that the difference is not significant. The effect of WIC on birth weight is the same for employed and unemployed mothers.

Government transfers: TANF: The third source of income is transfers from the government in the form of welfare programs. I will consider the interaction of WIC and two such programs - TANF and the Food Stamp program. TANF provides temporary financial assistance while also trying to encourage recipients to work. Examining the effect of TANF across different groups of individuals, regardless of WIC status, reveals that its impact is not significant, and its direction is not robust to different specifications. The interaction between TANF and WIC (E.18; β_{22}) reveals that the effect of WIC for TANF recipients is more than two times larger (E.18; $\beta_1+\beta_{22}$ = 484.4g) than the effect of WIC on non-TANF

recipients (E.18; $\beta_1 = 228.3$g). Likewise, the effect of TANF is larger for WIC recipients (E.18; $\beta_{11}+\beta_{22} = 285.7$) than for non-WIC recipients (E.18; $\beta_{11} = 57.4$g). In both cases the difference is not significant but it nevertheless indicates that WIC seems to work better in combination with another welfare program, in this case TANF.

Government Transfers: SNAP: The Food Stamp program is an in-kind program that some economists find equivalent to cash (Currie and Gahvari, 2008). The Food Stamp program is similar to WIC in providing coupons for the purchase of food. A major difference is that the Food Stamp program allows recipients to purchase any kind of food rather than maintaining a list of eligible products.

Food stamps appear to have a significant negative impact on the birth weight of all recipients except employed mothers, mothers who smoke, and girls. Additionally, receipt of food stamps affects black and non-black mothers differently. While the negative impact of food stamps on birth weight for non-black mothers is 215.2g (E.3; β_{12}), for black mothers it increases to a negative 459.1g (E.2; β_{12}). The birth weight of boys appears to be affected most negatively (E.12; β_{12}= -474.9g). The impact for babies of black women and for boys is close to 500g, which is a substantial amount equal to 20% of normal birth weight (2,500g).

While the negative impact of food stamps is robust and large, it is unlikely that the Food Stamp program causes a substantial decrease in birth weight directly. Although one might argue that food stamps may enable pregnant women to purchase unhealthy food and harm their unborn children, the fact that maternal weight has a positive effect on birth weight implies that, irrespective of overall

health condition, heavier mothers give birth to heavier babies. It is interesting to consider that, according to a study done by the Carsey Institute[3], a higher proportion of rural rather than urban families (7.5% vs. 4.8% in 2001) receive food stamps. According to the National Rural Health Association, families living in rural areas have less access to medical care due to lack of physicians and transportation. At the same time, they are at a higher risk of being poor. The negative impact of food stamps appearing in this analysis might be an indication of this or a similar negative selection. Unfortunately, the NHIS dataset does not provide an indication of the type of area - urban versus rural - in which the family lives. However, as already mentioned, the dataset shows that recipients of SNAP are negatively selected on a large number of observables (Table A.4).

An interaction term between WIC and food stamps is introduced to further explore this interesting finding and its effect on WIC (E.19; β_{23}). It appears that the effect of WIC is not influenced by the receipt of food stamps: β_{23} is not significant.

The effect of food stamps, however, differs according to WIC status. For WIC recipients, food stamps have an additional effect of minus 202.2g (E.19; β_{23}) on birth weight, although the difference is not significant. Let us consider a simple example. If Family A receives food stamps but does not receive WIC, their child weighs 249.2g (E.19; β_{12}) less on average than the child of a similar Family B not receiving food stamps or WIC. Giving WIC to Family A, however, reduces the difference to -72g (E.19; β_1+β_{12}+1× β_{23} = 379.3-249.2-202.2= -72).

[3]Carsey Institute, University of New Hampshire Rural America Depends on the Food Stamp Program to Make Ends Meet, Smith and Palatan, 2005

If it is the case that receipt of food stamps is an indicator of where the family lives, then family A is more likely to live in a rural area (since it receives food stamps) and Family B has a higher chance of living in an urban area (because it does not receive food stamps). Before receipt of WIC, the gap in birth weight is 249.2g (E.19; β_{12}) and after Family A receives WIC, the gap decreases to 72g. In addition to the gender and the firstborn gap, WIC decreases the gap between more and less disadvantaged families as proxied by receipt of food stamps.

Technology: Lastly, technological changes are accounted for. Technological changes may be possible due to the fact that this analysis combines births from four years: 2001, 2002, 2003, and 2004. The omitted category in the regression analysis is the year 2001. The number of normal birth weight infants is higher and the number of low birth weight babies is lower in 2002 than in 2001. The mean birth weight for all births and the mean birth weight of both LBW and normal births is lower in 2002 than it is in 2001. This suggests that there may be babies who were on the border between low and normal birth weight in 2001, but similar babies in 2002 weighed enough to be classified as normal birth weight. As a result, the number of normal birth weight babies increased while their average weight decreased. By controlling for changes in technology the estimates of the WIC program can be measured more precisely.

According to Johnston et al.(2002), genetic influences account for eighty percent of birth weight variance, leaving twenty percent to environmental factors. This needs to be taken into account when considering the explanatory power of the

estimation models in this study. The R-squared of the different specifications is between 0.14 (E.2) and 0.04 (E.11) and the adjusted R-squared is about 0.06. Even if only six percent of the variation in birth weight is explained by the independent variables in this analyis, this would still translate into almost one-third of the 20% variation due to environmental factors. Working with a larger sample and controlling for a number of additional variables, such as state of residence, may increase the explanatory power of this analysis.

This chapter has presented and discussed the results of this study. Overall, WIC has a significant positive effect on birth weight. It also reduces the disadvantage of boys, firstborn infants and infants from disadvantaged families as proxied by receipt of food stamps. The next chapter will conclude this analysis and suggest directions for further exploration.

Chapter 7

Conclusions and Outlooks

The goal of this thesis was to study the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and its impact on birth weight. WIC aims to improve the health and diet of pregnant women at risk so they can give birth to babies unharmed by the long-term negative effects of low birth weight.

This study contributes to the current knowledge of the program‘s effectiveness in a number of ways. First, the successful use of the National Health Interview Survey, a dataset that has received little attention in the WIC analysis field, demonstrated that the detailed and varied information it provides makes it a suitable choice for similar studies.

Next, this thesis demonstrates how WIC recipients clearly differ from non-recipients. WIC mothers prove to be negatively selected on a large number of characteristics. Exploring the effect of WIC, this study finds that it is positive

and significant, indicating that the program is a success. Moreover, participation in WIC reduces the incidence of low birth weight, resulting in possible significant cost savings.

An additional contribution that this thesis makes is the comparison of the effect of WIC on different types of recipients. Single mothers appear to profit from WIC the most, which implies that WIC is successful in targeting populations at risk. If this is the case, then expanding the eligibility of WIC to include higher income families may not be efficient. WIC also appears to lessen the firstborn gap by bringing the traditionally lower birth weight of firstborns closer to that of children with older siblings. WIC also mitigates the negative impact of smoking and is more effective in combination with other welfare programs such as TANF.

This thesis also revisited the gender gap in birth weight. Not only are boys more likely to be smaller than girls, but factors associated with a lower birth weight, such as smoking, being a firstborn, and being below the poverty line, have a greater negative impact on boys than on girls. The fact that beneficial factors such as WIC have a larger positive effect on girls refutes the argument that boys are simply more susceptible to change in either direction. It is then important to consider the gender of the fetus when planning interventions for pregnant women. A program such as WIC appears to lessen the gender gap and, if tailored to the needs of boys, it may do so even more successfully than it does now.

Finally, a surprising finding, at first glance, is the conclusion that the Food Stamp program has a negative impact on birth weight. Rather than an indication

of a direct negative effect of food stamps on WIC, this thesis concludes that the result may be an indication of a negative selection of food stamps recipients. WIC, therefore, mitigates the negative impact on birth weight of the detrimental characteristics leading to Food Stamp eligibility.

In evaluating the effectiveness of WIC, this study has taken careful measures to account for possible biases and uncertainties. However, due to limitations of the sample size and the absence of certain variables, this study is far from definitive. In fact, this thesis can be criticized on the following grounds: first, while the study attempted to control for time of enrollment by proxy of birth order, a direct measure of enrollment and gestational age would have been beneficial. Secondly, due to limitations of the data set, this study did not take into account the geographical region of residence of the individuals, failing to account for state-level differences in welfare provision and labor market structure. Lastly, the small number of WIC cases in the data set means that conclusions can be drawn only for some groups of recipients.

While this thesis aspired to shed more light on the effect of WIC, many questions remain unanswered. Nevertheless, the conclusions it makes allude to further directions of study that should be of interest to policymakers in the field of child welfare. The author of this thesis hopes that her findings contribute to the current knowledge on the roles and limitations of the public sector in its effort to assure that by preventing low birth weight all members of society are given an equal start at birth.

Bibliography

Adams, K., Miller, V., Ernst, C., Nishimura, B., Melvin, C., & Merritt, R. (2002) "Neonatal Health Care Costs Related to Smoking During Pregnancy." *Health Economics* **11**: 193-196.

Alderman, H. & Behrman, J. (2006) "Reducing the Incidence of Low Birth Weight in Low Income Countries Has Substantial Economic Benefits" *Oxford University Press on behalf of the World Bank* **21**: 25-48.

Allen, L. & Gillespie, S. (2001) "What Works? A Review of Efficacy and Effectiveness of Nutrition Interventions." *Nutrition and Development Series Asian Development Bank, Manila.*

Almond, D., Chay, K., & Lee, D. (2005) "The Costs of Low Birth Weight." *Quarterly Journal of Economics* **120**: 1031-1083.

Besharov, D. & Germanis, D. (2001) "Rethinking WIC: An evaluation of the Women, Infants and Children program." *Washington, DC: AEI Press.*

Bitler, M. & Currie, J. (2005) "Does WIC work? The effects of WIC on pregnancy and birth outcomes." *Journal of Policy Analysis and Management* **24**(1): 73-91.

Boardman, J., Powers, D., Padilla, Y., & Hummer, R. (2002) "Low Birth Weight, Social factors, and Developmental Outcomes among Children in the United States." *Demography* **39**(2): 353-368.

Boissiere, M., Knight, J., & Sabot, R. (1985) "Earnings, Schooling, Ability, and Cognitive Skills." *American Economic Review* **75**(5): 1016-1030.

Buescher, P. & Horton, S. (2000) "Prenatal WIC Participation in Relation to Low Birth Weight and Medicaid Infant Costs in North Carolina – A 1997

Update." *Center for Health Informatics and Statistics.*

Burnstein, N., Fox, M., Hiller, J., Kornfeld, R., et al. (2000) "WIC generosity analysis profile: Profile of WIC children." *Cambridge, MA: ABT Associates.*

Carlson, E. (1984) "Social Determinants of Low Birth Weight in a High-Risk Population." *Demography* **21**(2): 207-215.

Currie, J. & Hyson, R. (1999) "Is the impact of health shocks cushioned by socioeconomic status? The case of birth weight." *American Economic Review* **89**(2): 245-250.

Currie, J. & Gahvari, F. (2008) "Transfers in Cash and In Kind: Theory Meets the Data." *Journal of Economic Literature* **46**(2): 333-383.

Devaney, B., Bilheimer, L., & Schore, J (1992) "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): 573-592.

Dubay, L., Joyce, T., Kaestner, R., & Kenney, G. (2001) "Changes in Prenatal Care Timing and Low Birth Weight by Race Has and Socioeconomic Status: Implications for the Medicaid Expansions for Pregnant Women." *Health Services Research* **36**(2): 373-398.

Ellen, I. (2000) "Is segregation bad for your health? The case of low birthweight." *Brookings-Wharton Papers on Urban Affairs. Washington, DC: Brookings Institution Press*

Forsen, T., Eriksson, J., Tuomilehto, J., Osmond, C., & Barker, D. (1999) "Growth in Utero and During Childhood Among Women who Develop Coronary Heart Disease: Longitudinal Study" *British Medical Journal* **319**: 1403-1407.

General Accounting Office (1992) "Early Intervention: Federal Investments Like WIC Can Produce Savings."

Hoynes, H. & Connell, F. (1994) "Consumption Responses to In-Kind Transfers: Evidence from the Introduction of the Food Stamp Program" *National Bureau of Economic Research Working Paper 13025*

Huntington, J. & Connell, F. (1994) "For Every Dollar Spent The Cost-Savings Argument for Prenatal Care." *The New England Journal of Medicine* **331**: 1303-1307.

Johnston, L., Clark, A., & Savage, M. (2002) "Genetic Factors Contributing to Birth Weight: Epidemiological Studies Suggest that Genetic Factors Ac-

count for 30-80% of Birth Weight Variance." *Archives of Disease in Childhood. Fetal and Neonatal Edition* **86**1: F2(2)

Joyce, T., Gibson, D., & Colman, S. (2005) "The changing association between prenatal participation in WIC and birth outcomes in New York City." *Journal of Policy Analysis and Management* **24**(4): 661-685.

——— (2007) "Reassessing the WIC effect: Evidence from the Pregnancy Nutrition Surveillance System." *NBER 13441.*

Kallan, J. (1993) "Race, Intervening Variables, and Two Components of Low Birth Weight." *Demography* **30**(3): 489-506.

Kowaleski-Jones, L., & Duncan, G. (2002) "Effects of Participation in the WIC Program on Birthweight: Evidence From the National Longitudinal Survey of Youth." *American Journal of Public Health* **92**(5): 799-804.

Kramer, M. (1998) "Socioeconomic Determinants of Intrauterine Growth Retardation." *European Journal of Clinical Nutrition* **52**(81): S29-33.

Kuban, K., O'Shea, T., Allred, E., et al. (2009) "Positive Screening Results on the Modified Checklist for Autism in Toddlers: Implications for Very Preterm Populations." *The Journal of Pediatrics* **154**(4): 478-480.

Lewitt, E., Baker, L., Corman, H., & Shiono, P. (1995) "The direct cost of low birthweight." *The Future of Children* **5**(1): 35-56.

Mathematica Policy Research Inc. (1990) "The Savings in Medicaid Costs for Newborns and Their Mothers from Prenatal Participation in the WIC Program.." *Washington D.C.: Food and Nutrition Service, U.S. Department of Agriculture*

Matte, T., Bresnahan, M., Begg, M., & Susser, E. (2001) "Influence in Variation in Birth Weight Within Normal Range and Within Sibships on IQ at Age 7 Years: Cohort Study." *British Medical Journal* **323**: 310-314.

Metcoff, J., Costiloe, P., Crosby, W., Dutta, S., Sandstead, H., et al. (1985) "Effect of Food Supplementation (WIC) During Pregnancy on Birth Weight." *The American Journal of Clinical Nutrition* **41**: 933-947.

Moss, N., Carver, K. (1998) "The effect of WIC and Medicaid on infant mortality in the United States." *American Journal of Public Health* **88**(9): 1354-1362.

Petrou, S., Sach, T., & Davidson, L.(2001) "The Long-term Costs of Preterm Birth and Low Birth Weight: Results of a Systematic Review." *Child Care, Health, and Development* **27**(2): 97-115.

Schramm, W. (1985) "WIC Prenatal Participation and Its Relationship to Newborn Medicaid Costs in Missouri: A Cost/Benefit Analysis." *American Journal of Public Health* **75**: 851-857.

Staiger, D. & Stock, J. (1997) "Instrumental variables regression with weak instruments." *Econometrica* **65**(3): 557-586.

Verhoeff, F., Brabin, B., Van Buuren, S., Chimsuku, L., Kazembe, P., et al. (2001) "An Analysis of Intra-uterine Growth Retardation in Rural Malawi." *European Journal of Clinical Nutrition* **55**(8): 682-689.

Victora, C., Kirkwood, B., Ashworth, A., Black, R., Rogers, S. et al. (1999) "Potential Interventions for the Prevention of Childhood Pneumonia in Developing Countries: Improving Nutrition." *American Journal of Clinical Nutrition* **70**(3): 309-320.

Appendix A

Tables of Summary Statistics

Table A.1: Summary Statistics of the Entire Sample

Variable	Obs	Mean	Std. Dev.	Min	Max
Birth weight (g)	3790	3312.689	612.036	500	5485
WIC	3750	0.013	0.114	0	1
Girl*	3790	0.518	0.500	0	1
Firstborn*	3790	0.512	0.500	0	1
Black*	3790	0.144	0.351	0	1
Mother's weight	2654	74.034	16.144	44.946	127.12
Current smoker*	3672	0.150	0.357	0	1
No High School*◇	3790	0.198	0.399	0	1
High School plus*◇	3790	0.669	0.470	0	1
4-year plus*◇	3790	0.132	0.339	0	1
Married*	3782	0.597	0.491	0	1
Income	2735	42786.930	24026.890	2406.25	75000
Employed*	3752	0.543	0.498	0	1
TANF*	3790	0.058	0.234	0	1
Food Stamps*	3757	0.027	0.161	0	1
Born 2001*	3130	0.221	0.415	0	1
Born 2002*	3130	0.335	0.472	0	1
Born 2003*	3130	0.328	0.470	0	1
Born 2004*	3130	0.115	0.319	0	1

Legend:

*Binary variable (1=yes). E.g. If *Girl=1*, the newborn is female.

◇ No High School: The individual does not have a high school degree

High School plus: The individual has a high school or a 2-year degree

4-year plus: The individual has at least a 4-year undergraduate degree

Table A.2: Summary Statistics by WIC Status

	Non-WIC Recipients			WIC Recipients		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Birth Weight	3701	3311.098	612.119	49	3298.592	620.122
Girl*	3701	0.519	0.500	49	0.490	0.505
Firstborn*	3701	0.510	0.500	49	0.673	0.474
Black*	3701	0.140	0.347	49	0.347	0.481
Mother's weight	2587	73.955	16.145	40	73.798	13.816
Current smoker*	3589	0.148	0.355	48	0.271	0.449
No High School*◇	3701	0.197	0.398	49	0.286	0.456
High School plus*◇	3701	0.670	0.470	49	0.694	0.466
4-year plus*◇	3701	0.132	0.339	49	0.020	0.143
Married*	3695	0.606	0.489	47	0.064	0.247
Income	2688	43266.86	23887.45	40	11871.040	9918.084
Employed*	3671	0.542	0.498	48	0.708	0.459
TANF*	3701	0.055	0.227	49	0.388	0.492
Food Stamps*	3694	0.022	0.148	49	0.347	0.481
Born 2001*	3070	0.222	0.416	48	0.188	0.394
Born 2002*	3070	0.332	0.471	48	0.479	0.505
Born 2003*	3070	0.330	0.470	48	0.271	0.449
Born 2004*	3070	0.116	0.320	48	0.063	0.245

Legend:

*Binary variable (1=yes). E.g. If *Girl=1*, the newborn is female.

◇ No High School: The individual does not have a high school degree

High School plus: The individual has a high school or a 2-year degree

4-year plus: The individual has at least a 4-year undergraduate degree

Table A.3: Summary Statistics by Race

	Black			Non-black		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Birth Weight	544	3186.257	642.165	2780	3338.391	606.5168
WIC*	536	0.032	0.175	2751	0.010	0.100
Girl*	544	0.480	0.500	2780	0.526	0.499
Firstborn*	544	0.504	0.500	2780	0.515	0.500
Mother's weight	372	76.448	16.096	1950	73.989	16.333
Current smoker*	515	0.136	0.343	2694	0.159	0.365
No High School*◇	544	0.154	0.362	2780	0.200	0.400
High School plus*◇	544	0.699	0.459	2780	0.677	0.468
4-year plus*◇	544	0.147	0.354	2780	0.123	0.329
Married*	540	0.356	0.479	2777	0.644	0.479
Income	372	32083.42	22760.59	2033	44994.63	23727.77
Employed*	535	0.602	0.490	2760	0.541	0.498
TANF*	544	0.123	0.329	2780	0.041	0.198
Food Stamps*	533	0.073	0.261	2761	0.020	0.140
Born 2001*	448	0.214	0.411	2357	0.206	0.404
Born 2002*	448	0.333	0.472	2357	0.339	0.473
Born 2003*	448	0.357	0.480	2357	0.335	0.472
Born 2004*	448	0.096	0.295	2357	0.120	0.326

Legend:

*Binary variable (1=yes). E.g. If *Girl=1*, the newborn is female.

◇ No High School: The individual does not have a high school degree

High School plus: The individual has a high school or a 2-year degree

4-year plus: The individual has at least a 4-year undergraduate degree

Table A.4: Summary Statistics by SNAP (Food Stamp) Receipt

	No SNAP			SNAP		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Birth Weight	3657	3317.085	610.417	100	3099.110	643.254
WIC	3643	0.009	0.093	100	0.170	0.378
Girl*	3657	0.520	0.500	100	0.480	0.502
Firstborn*	3657	0.518	0.500	100	0.320	0.469
Black*	3657	0.135	0.342	100	0.390	0.490
Mother's weight	2558	73.945	16.146	71	75.351	14.947
Current smoker*	3546	0.146	0.353	97	0.258	0.440
No High School*◇	3657	0.190	0.392	100	0.490	0.502
High School plus*◇	3657	0.676	0.468	100	0.470	0.502
4-year plus*◇	3657	0.134	0.341	100	0.040	0.197
Married*	3650	0.609	0.488	99	0.212	0.411
Income	2660	43637.46	23743.21	72	11275.88	8472.655
Employed*	3627	0.546	0.498	100	0.440	0.499
TANF*	3657	0.049	0.216	100	0.410	0.494
Born 2001*	3029	0.222	0.415	88	0.216	0.414
Born 2002*	3029	0.335	0.472	88	0.341	0.477
Born 2003*	3029	0.328	0.470	88	0.352	0.480
Born 2004*	3029	0.115	0.319	88	0.091	0.289

Legend:

*Binary variable (1=yes). E.g. If *Girl=1*, the newborn is female.

◇ No High School: The individual does not have a high school degree

High School plus: The individual has a high school or a 2-year degree

4-year plus: The individual has at least a 4-year undergraduate degree

Table A.5: Birth Weight and Incidence of LBW* by Birth Year

		LBW*	NBW◇	total
2001	*number*	54	639	693
	mean birth weight	2133.3	3445.5	3335.2
	% of all births	7.79	92.21	100
2002	*number*	68	982	1050
	mean birth weight	1996.5	3405.5	3319.7
	% of all births	6.48	93.52	100
2003	*number*	80	948	1028
	mean birth weight	1771.2	3420.7	3306.4
	% of all births	7.78	92.22	100
2004	*number*	33	326	359
	mean birth weight	1936.4	3417.7	3311.9
	% of all births	9.19	90.81	100

Legend:
*LBW: low birth weight (less than 2,500g)
◇NBW: normal birth weight (more than 2,500g)

Appendix B

Regression Results

Appendix B. Regression Results

Table B.1	E.1 full sample	E.2 black	E.3 non-black	E.4 smokers
WIC (β_1)	325.493***	314.024**	376.489***	499.424**
	[93.06]	[153.60]	[113.21]	[150.25]
Girl (β_2)	125.073***	133.847	114.706**	147.825
	[33.23]	[110.01]	[35.08]	[92.38]
Firstborn (β_3)	-89.608**	-156.614	-82.754**	-253.416**
	[36.64]	[117.48]	[38.77]	[100.80]
Black (β_4)	-189.496***			-137.605
	[57.36]			[104.74]
Mother's weight (β_5)	3.317**	9.800**	2.910**	3.657
	[1.11]	[3.54]	[1.18]	[2.57]
Current smoker (β_6)	-170.882***	7.002	-188.325***	
	[51.33]	[124.20]	[55.40]	
No High School (β_7)	-13.606	-230.558	15.499	-357.846**
	[53.05]	[160.17]	[56.60]	[119.57]
Married (β_8)	58.883	209.611*	40.99	6.904
	[40.66]	[124.25]	[43.66]	[106.45]
Income (β_9)	-0.00049	0.00192	-0.00075	-.00952***
	[0.00147]	[0.00545]	[0.00154]	[0.00357]
Employed (β_{10})	49.022	141.185	46.174	65.256
	[37.41]	[110.75]	[40.36]	[121.45]
TANF (β_{11})	87.056	139.098	62.436	-183.122
	[79.77]	[156.95]	[98.47]	[153.33]
Food Stamps (β_{12})	-280.841**	-459.100**	-215.192**	-182.577
	[89.77]	[171.89]	[108.62]	[187.98]
In poverty (β_{13})	-114.334	17.078	-132.612*	-299.307*
	[70.42]	[256.07]	[73.73]	[168.66]
Born 2002 (β_{14})	-9.223	-159.544	1.191	61.028
	[43.17]	[141.94]	[45.55]	[103.46]
Born 2003 (β_{15})	-35.097	-0.305	-41.597	-61.168
	[48.79]	[131.62]	[52.81]	[136.78]
Born 2004 (β_{16})	-18.974	41.391	-23.174	-41.532
	[62.00]	[182.69]	[65.88]	[196.47]
Constant (β_0)	3292.729***	2517.264***	3354.595***	3681.060***
	[150.60]	[508.08]	[159.47]	[376.16]
Obs	1493	179	1314	209
WIC recipients	31	13	18	8
R-sqr	0.0596	0.1404	0.0479	0.1364
Adjusted R-sqr	0.0488	0.0552	0.0362	0.0644

Standard errors in brackets.
* significant at 10%
** significant at 5%
*** significant at 1%

Table B.2	E.5 non-smokers	E.6 single	E.7 married	E.8 employed
WIC (β_1)	310.5358**	407.350***	191.206	308.114**
	[117.36]	[102.70]	[202.39]	[121.27]
Girl (β_2)	120.213***	155.788**	121.244**	139.759**
	[35.73]	[55.49]	[41.57]	[42.84]
Firstborn (β_3)	-65.156*	-92.974	-86.095*	-11.096
	[39.28]	[63.34]	[44.31]	[48.54]
Black (β_4)	-191.594**	-197.526**	-134.052	-160.943**
	[63.32]	[76.27]	[86.88]	[77.96]
Mother's weight (β_5)	3.359**	1.95	3.719**	3.638**
	[1.19]	[1.96]	[1.35]	[1.40]
Current smoker (β_6)		-106.302	-231.949**	-180.181**
		[74.57]	[72.33]	[59.74]
No High School (β_7)	84.118	-136.949*	85.341	-119.351
	[57.41]	[70.96]	[75.73]	[91.37]
Married (β_8)	74.607*			100.642*
	[44.33]			[53.85]
Income (β_9)	0.00064	.00455*	-.00367**	-0.00029
	[0.00158]	[0.00247]	[0.00182]	[0.00203]
Employed (β_{10})	51.681	-14.385	95.010**	
	[38.86]	[62.05]	[47.35]	
TANF (β_{11})	169.425*	94.048	67.608	91.121
	[94.53]	[90.49]	[138.38]	[93.70]
Food Stamps (β_{12})	-356.802***	-232.764**	-299.963**	-204.677
	[95.09]	[107.14]	[118.86]	[140.56]
In poverty (β_{13})	-100.393	76.73	-225.278**	-37.797
	[76.31]	[117.54]	[88.51]	[92.67]
Born 2002 (β_{14})	-19.839	-166.497*	33.83	-7.915
	[47.68]	[85.09]	[48.86]	[54.14]
Born 2003 (β_{15})	-22.875	-105.346	-30.341	-35.488
	[51.96]	[79.57]	[63.61]	[63.80]
Born 2004 (β_{16})	-18.34	-81.656	-1.456	-3.948
	[65.35]	[93.85]	[88.51]	[79.28]
Constant (β_0)	3202.996***	3259.687***	3431.697***	3169.337***
	[164.34]	[254.84]	[181.12]	[191.02]
Obs	1284	572	921	897
WIC recipients	22	28	3	22
R-sqr	0.0550	0.0833	0.0593	0.0589
Adjusted R-sqr	0.0432	0.0569	0.0427	0.0418

Standard errors in brackets.
* significant at 10%
** significant at 5%
*** significant at 1%

Table B.3	E.9 unemployed	E.10 in poverty	E.11 girls	E.12 boys
WIC (β_1)	244.286*	328.877***	349.349**	291.621**
	[130.07]	[94.64]	[156.62]	[91.45]
Girl (β_2)	93.641*	99.117*		
	[52.86]	[54.17]		
Firstborn (β_3)	-215.951***	-87.418	-50.207	-131.832**
	[58.74]	[63.49]	[54.22]	[49.42]
Black (β_4)	-213.658**	-204.587**	-135.081	-246.384***
	[84.05]	[75.44]	[90.55]	[70.32]
Mother's weight (β_5)	2.203	1.096	2.734*	3.871**
	[1.84]	[1.98]	[1.62]	[1.49]
Current smoker (β_6)	-145.797	-138.442**	-131.602*	-223.642**
	[100.27]	[65.82]	[71.39]	[74.06]
No High School (β_7)	60.273	-39.208	-58.797	8.566
	[62.38]	[58.51]	[74.63]	[73.73]
Married (β_8)	-4.334	82.859	25.605	90.912*
	[63.16]	[59.02]	[62.95]	[52.33]
Income (β_9)	-0.00146	0.00014	0.00089	-0.00264
	[0.0020]	[0.00278]	[0.00227]	[0.00183]
Employed (β_{10})		84.076	50.168	39.801
		[62.27]	[57.45]	[49.08]
TANF (β_{11})	36.915	123.889	2.402	174.741*
	[138.01]	[88.37]	[124.03]	[92.15]
Food Stamps (β_{12})	-380.488**	-249.794**	-148.391	-474.885***
	[117.46]	[95.04]	[117.51]	[119.30]
In poverty (β_{13})	-221.315**		-43.573	-199.381**
	[106.76]		[108.88]	[88.60]
Born 2002 (β_{14})	-3.001	-16.702	-17.845	13.81
	[74.89]	[73.78]	[61.01]	[61.94]
Born 2003 (β_{15})	-47.341	-55.889	-99.995	36.066
	[77.35]	[79.89]	[71.11]	[67.50]
Born 2004 (β_{16})	-26.61	-82.654	-51.273	43.653
	[100.83]	[104.58]	[99.85]	[76.91]
Constant (β_0)	3639.180***	3180.827***	3186.334***	3555.592***
	[247.78]	[217.01]	[212.25]	[212.20]
Obs	596	617	754	739
WIC Recipients	9	31	18	13
R-sqr	0.0832	0.0584	0.0375	0.086
Adjusted R-sqr	0.0579	0.0333	0.0166	0.0657

Standard errors in brackets.
* significant at 10%
** significant at 5%
*** significant at 1%

Table B.4	E.13	E.14	E.15	E.16
WIC (β_1)	287.048***	216.471	398.771***	286.557**
	[85.27]	[137.97]	[106.76]	[118.60]
Girl (β_2)	123.960***	125.737***	125.450***	126.101***
	[33.72]	[33.36]	[33.24]	[33.37]
Firstborn (β_3)	-89.306**	-90.838**	-89.190**	-89.684**
	[36.72]	[36.89]	[36.67]	[36.66]
Black (β_4)	-189.670***	-189.456***	-181.596**	-189.229***
	[57.36]	[57.36]	[59.41]	[57.37]
Mother's weight (β_5)	3.314**	3.320**	3.347**	3.336**
	[1.11]	[1.11]	[1.11]	[1.11]
Current smoker (β_6)	-169.801**	-171.190***	-170.673***	-174.660***
	[51.72]	[51.37]	[51.36]	[52.72]
No High School (β_7)	-13.24	-13.431	-12.681	-14.239
	[53.11]	[53.07]	[53.14]	[53.08]
Married (β_8)	59.067	59.283	60	58.122
	[40.69]	[40.68]	[40.68]	[40.76]
Income (β_9)	-0.00049	-0.00049	-0.00048	-0.0005
	[0.0014732]	[.0014739]	[.0014735]	[.0014748]
Employed (β_{10})	48.923	48.823	48.457	49.062
	[37.43]	[37.42]	[37.43]	[37.43]
TANF (β_{11})	86.581	90.491	86.025	83.218
	[79.80]	[80.73]	[80.14]	[80.58]
Food Stamps (β_{12})	-280.839**	-277.929**	-275.541**	-280.274**
	[89.94]	[89.54]	[90.23]	[89.46]
In poverty (β_{13})	-114.614	-114.856	-114.624	-113.938
	[70.43]	[70.46]	[70.45]	[70.49]
Born 2002 (β_{14})	-9.051	-9.347	-9.98	-9.014
	[43.21]	[43.18]	[43.18]	[43.18]
Born 2003 (β_{15})	-34.897	-34.992	-33.965	-35.703
	[48.83]	[48.80]	[48.79]	[48.85]
Born 2004 (β_{16})	-18.941	-18.483	-18.49	-19.003
	[62.02]	[62.05]	[62.00]	[62.02]
Interaction term	wic×gender	wic×fborn	wic×black	wic×smoke
	(β_{17})	(β_{18})	(β_{19})	(β_{20})
	71.371	133.323	-172.949	140.406
	[159.84]	[161.16]	[175.42]	[150.73]
Constant (β_0)	3293.932***	3292.655***	3287.433***	3292.266***
	[150.70]	[150.61]	[150.76]	[150.68]
Obs	1493	1493	1493	1493
R-sqr	0.0597	0.0597	0.0599	0.0598
Adjusted R-sqr	0.0482	0.0482	0.0484	0.0483

Standard errors in brackets.
* significant at 10%
** significant at 5%
*** significant at 1%

Table B.5	E.17	E.18	E.19	E.20
WIC (β_1)	214.946*	228.326**	379.323***	630.737
	[111.82]	[108.26]	[108.00]	[416.15]
Girl (β_2)	125.157***	125.159***	124.859***	125.344***
	[33.23]	[33.23]	[33.23]	[33.25]
Firstborn (β_3)	-89.791**	-88.861**	-89.567**	-89.369**
	[36.65]	[36.69]	[36.64]	[36.66]
Black (β_4)	-188.263**	-188.211**	-188.989**	-187.135**
	[57.46]	[57.43]	[57.38]	[57.62]
Mother's weight (β_5)	3.339**	3.319**	3.337**	3.365**
	[1.11]	[1.11]	[1.11]	[1.12]
Current smoker (β_6)	-170.895***	-171.717***	-171.043***	-171.941***
	[51.35]	[51.36]	[51.36]	[51.45]
No High School (β_7)	-10.717	-13.033	-13.489	-12.922
	[53.36]	[53.07]	[53.06]	[53.06]
Married (β_8)	59.003	57.326	59.888	59.31
	[40.67]	[40.69]	[40.70]	[40.67]
Income (β_9)	-0.00049	-0.00052	-0.000476	-0.000487
	[.0014736]	[.0014739]	[.0014738]	[.0014735]
Employed (β_{10})	46.823	48.835	49.327	48.427
	[37.76]	[37.43]	[37.42]	[37.44]
TANF (β_{11})	86.44	57.383	88.886	86.034
	[79.62]	[86.92]	[79.67]	[80.06]
Food Stamps (β_{12})	-280.335**	-286.912**	-249.184**	-274.398**
	[89.47]	[89.98]	[100.69]	[91.05]
In poverty (β_{13})	-115.912	-113.11	-115.441	-114.668
	[70.56]	[70.45]	[70.48]	[70.47]
Born 2002 (β_{14})	-9.884	-7.242	-10.812	-9.75
	[43.21]	[43.23]	[43.23]	[43.18]
Born 2003 (β_{15})	-34.724	-34.764	-35.16	-34.558
	[48.81]	[48.80]	[48.79]	[48.80]
Born 2004 (β_{16})	-18.712	-18.808	-19.034	-18.757
	[62.01]	[62.03]	[62.03]	[62.01]
Interaction term	wic×empl	wic×tanf	wic×fstamps	wic×weight
	(β_{21})	(β_{22})	(β_{23})	(β_{24})
	156.384	256.109	-202.239	-4.286
	[148.17]	[184.60]	[185.35]	[5.61]
Constant (β_0)	3293.938***	3294.190***	3289.893***	3288.636***
	[150.61]	[150.56]	[150.76]	[151.00]
Obs	1493	1493	1493	1493
R-sqr	0.0598	0.0602	0.0599	0.0597
Adjusted R-sqr	0.0483	0.0487	0.0484	0.0483

Standard errors in brackets.
* significant at 10%
** significant at 5%
*** significant at 1%

Table B.6	E.22 WIC	E.21 No WIC	E.23	E.24 Lowest 25%
WIC (β_1)			375.625**	169.071
			[115.76]	[146.09]
Girl (β_2)	-69.071	123.962***	124.774***	131.045**
	[205.32]	[33.71]	[33.24]	[65.41]
Firstborn (β_3)	60.978	-90.906**	-89.462**	-14.554
	[242.75]	[36.92]	[36.66]	[73.89]
Black (β_4)	-470.393**	-181.654**	-188.341**	-277.735***
	[166.74]	[59.55]	[57.46]	[78.80]
Mother's weight (β_5)	0.716	3.371**	3.329**	1.909
	[8.35]	[1.12]	[1.11]	[2.47]
Current smoker (β_6)	-230.456	-173.758**	-169.947***	-147.612*
	[162.49]	[52.70]	[51.44]	[81.35]
No High School (β_7)	-145.298	-8.21	-7.008	-76.363
	[243.75]	[54.67]	[54.73]	[68.43]
Married (β_8)	-163.695	58.034	59.088	132.010*
	[359.87]	[41.00]	[40.68]	[74.48]
Income (β_9)	0.017	-0.001	0	-0.002
	[0.01]	[0.00]	[0.00]	[0.02]
Employed (β_{10})	-4.577	47.39	47.818	21.053
	[249.93]	[37.79]	[37.46]	[86.84]
TANF (β_{11})	286.276	51.48	85.896	81.934
	[188.33]	[86.98]	[79.71]	[92.62]
Food Stamps (β_{12})	-428.683**	-245.526**	-278.517**	-228.809**
	[196.35]	[101.02]	[89.92]	[103.80]
In poverty (β_{13})	0	-118.818*	-116.454*	
	[.]	[70.87]	[70.61]	
Born 2002 (β_{14})	-398.812	-6.256	-9.393	-37.957
	[251.39]	[43.53]	[43.18]	[79.08]
Born 2003 (β_{15})	57.407	-36.115	-33.951	-2.429
	[277.43]	[49.34]	[48.88]	[85.38]
Born 2004 (β_{16})	-258.134	-17.336	-17.741	23.028
	[363.32]	[62.49]	[62.06]	[148.52]
Interaction term			wic×edu (β_{27})	wic×income (β_{28})
			-183.953	0.030**
			[136.61]	[0.009]
Income squared (β_{29})				-0.000002
				[0.00009]
Constant (β_0)	2881.527**	3302.685***	3292.143***	3010.545***
	[892.60]	[151.60]	[150.59]	274.84
Obs	28	1465	1493	381
R-sqr	0.7208	0.0572	0.0599	0.1050
Adjusted R-sqr	0.3719	0.0468	0.0484	0.0605

Standard errors in brackets.
* significant at 10%
** significant at 5%
*** significant at 1%