THREE ESSAYS IN HEALTH ECONOMICS

by

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Abstract

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This dissertation consists of three essays. In my first essay, I examine the relationship of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC program) to breastfeeding. Although WIC promotes breastfeeding among its participants through education, counseling, and the provision of enhanced food packages to breastfeeding women, the program has been criticized for discouraging breastfeeding by providing free infant formula. In order to estimate the extent to which participation in WIC discourages breastfeeding, I employ a methodology that disentangles selection bias associated with WIC participation from the incentives associated with the provision of free infant formula. Findings suggest that postpartum entrants are less likely to breastfed for at least 6 months and have shorter breastfeeding durations than non-participants, and the effects are significantly larger among twin mothers than among singleton mothers.

In my second essay, I investigate the association between WIC participation and infant health. How effective WIC is at improving birth outcomes is under debate. Identifying treatment effect is challenged by selection bias and gestational age bias. We use twins to minimize selection bias associated with WIC participation because twin pregnancy increases the probability of adverse birth outcomes significantly but is unlikely related to other risky behaviors. Our focus is on measures of fetal growth as outcomes amenable to nutritional supplementation. Our findings from two national datasets, PNSS and ECLS-B, suggest that prenatal WIC participation has very limited effect on fetal growth. We do not find evidence of causal effect between WIC and better birth outcomes, especially among twin births.

In my third essay, I turn my interest to a different research question, the association between retirement and alcohol consumption. Retirement is life transition whose significance may provoke lifestyle

and health behavioral alterations such as alcohol consumption. We examine the effect of retirement on subsequent period alcohol consumption within a two period follow up. We use seven waves of the data from Health and Retirement Study (HRS) and found retirement lead to consume 1.3 more alcoholic drinks per day within men. No effect has been found within retired women.

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Table of Contents

Chapter I

Examining the Effect of WIC on Breastfeeding 1

Chapter II

WIC and Birth Outcomes: Evidence from Two National Datasets 39

Chapter III

The Effect of Retirement on Alcohol Consumption 81

Bibliography 98

Lists of Tables

Chapter I: Examining the Effect of WIC on Breastfeeding

Table 1: FY01 estimated average monthly WIC food package cost per person in $ 29

Table 2: Characteristics by WIC participation status among singleton births 30

Table 3: Characteristics by WIC participation status among twin births 32

Table 4: Unadjusted breastfeeding outcomes by WIC participation status 33

Table 5: WIC participation patterns among eligible households at prenatal and postnatal periods, and corresponding prevalence rates 33

Table 6: WIC participation patterns among eligible households at prenatal and postnatal periods, and corresponding prevalence rates 34

Table 7: Adjusted differences in breastfeeding outcomes when compare women who participated in both prenatal and postnatal periods to postpartum entrants, under difference-in-differences regressions 35

Table 8: Adjusted differences in breastfeeding outcomes when compare women who participated in both prenatal and postnatal periods to postpartum entrants by race/ethnicity, education and age under difference-in-differences regressions 36

Table 9: Adjusted differences in breastfeeding outcomes when compare postpartum entrants to two comparison groups of non-WIC women 37

Table 10: Adjusted differences in breastfeeding outcomes when compare postpartum entrants to two comparison groups of non-WIC women, under difference-in-differences regressions 38

Chapter II: WIC and Birth Outcomes: Evidence from Two National Datasets

Table A1: Distribution of WIC enrollment, by trimester and by States for infants born in 2001 (PNSS) 60

Table A2: Distribution of missing information on birth plurality, birth weight, preterm and gestation, by State (PNSS) 60

Table A3: Composition of final sample by State (PNSS) 60

Table A4: Characteristics by the timing of WIC enrollment among singleton births (PNSS) 61

Table A5: Characteristics by the timing of WIC enrollment among twin births (PNSS) 62

Table A6: Unadjusted birth outcomes by the timing of WIC enrollment (PNSS) 65
Table A7: Adjusted differences in birth outcomes among singletons and twins when compare prenatal participants to postpartum entrants (PNSS) 66

Table A8: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal participants to postpartum entrants (PNSS) 67

Table A9: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal participants to postpartum entrants, among mothers who initiated early prenatal care (PNSS) 67

Table B1: Characteristics by WIC participation status among singleton births (ECLS-B) 69

Table B2: Characteristics by WIC participation status among twin births (ECLS-B) 71

Table B3: Unadjusted birth outcomes by WIC participation status among singleton births (ECLS-B) 72

Table B4: Unadjusted birth outcomes by WIC participation status among twin births (ECLS-B) 73

Table B5: Differences in birth outcomes when compare prenatal WIC participants to three groups of women among singleton births (ECLS-B) 74

Table B6: Differences in birth outcomes when compare prenatal WIC participants to three groups of women among twin births (ECLS-B) 75

Table B7: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all singleton births (ECLS-B) 76

Table B8: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all singleton mothers who initiated early prenatal care (ECLS-B) 77

Table B9: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all twin births (ECLS-B) 78

Table B10: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all twin mothers who initiated early prenatal care (ECLS-B) 79

Chapter III: The Effect of Retirement on Alcohol Consumption

Table 1: Unadjusted breastfeeding outcomes by WIC participation status 94

Table 2: Estimation by random and fixed effects models within men: 95

Table 3: Estimation by random and fixed effects models within women: 96

Table 4: Estimation by random and fixed effects models within individuals whose age between 62 and 66, and ever received Social Security benefits 97

Lists of Figures

Chapter II: WIC and Birth Outcomes: Evidence from Two National Datasets

Figure A1: Proportion of LBW, VLBW and preterm births by timing of WIC enrollment (PNSS)................68

Figure A2: Proportion SGA and FTLBW by timing of WIC enrollment (PNSS) 68

Figure B 1: Proportion of LBW, VLBW, preterm births, SGA, and FTLBW by timing of WIC enrollment among singleton births 80

Figure B 2: Proportion of LBW, VLBW, preterm births, SGA, and FTLBW by timing of WIC enrollment among twin births 80

CHAPTER I: EXAMINING THE EFFECT OF WIC ON BREASTFEEDING

1. INTRODUCTION:

1.1 WIC Program

The Special Supplemental Nutrition Program for Women, Infants, and Children (commonly referred to as WIC) was conceived as a national program during the White House Conference on Nutrition in 1969 and was first operated as a 2-year pilot program beginning in 1972. In 1974, the first WIC site officially opened in Pineville, KY. Legislation established WIC as a permanent national health and nutrition program in October 1975. The mission of WIC is to safeguard the health of low-income women, infants, and children up to age 5 who are at nutritional risk. The WIC program is administered at the Federal level by the United States Department of Agriculture's (USDA) Food and Nutrition Service(FNS) and is available in all 50 States, the District of Columbia, 34 Indian Tribal Organization, and 5 territories (Guam, the U.S.Virgin Islands, American Samoa, the Commonwealth of Puerto Rico, and the Commonwealth of the Northern Mariana Islands). The ninety WIC State agencies administer the program through approximately 2200 local agencies and 9000 clinic sites.

The WIC program provides three types of benefits to participants: supplemental food packages; nutrition education; and referrals to health care and other services. WIC's supplemental food packages are designed to address the nutritional needs of the specific population of low-income pregnant, breastfeeding and non-breastfeeding postpartum women, infants, and children at nutritional risk. Federal regulations define specific WIC foods and the maximum quantities in the packages, depending on participant category and the nutritional needs of the participants. Prior to revisions made in 2007, the food packages were designed for the following seven groups of program participants: infants through 3 months, infants 4-11 months, children or woman with special dietary needs, children ages 1-4, pregnant and breastfeeding women (basic), non-breastfeeding postpartum women, and breastfeeding women (enhanced). WIC provides nutrition education free of charge to all participants, or to caretakers of infant/child participants. WIC agencies are required to offer participants or caretakers at least two nutrition education sessions during each 6-month period. All pregnant participants are encouraged to breastfeed, unless medically contraindicated. Local WIC agencies also assist WIC participants in obtaining health care and social services through onsite health services or referrals to other agencies.

Since its initiation in 1974, WIC has become one of the central components of the Nation's food and nutrition assistance system. In fiscal year 2008, with federal expenditures of $6.2 billion, WIC is third-largest food and nutrition assistance program after the Food Stamp Program ($37.5 billion) and the National School Lunch Program ($9.3 billion). Over time, WIC participation has grown dramatically, increasing from 88,000 participants in 1974 to approximately 9.3 million in 2009. In FY2008, of the 8.7 million people who received WIC benefits each month, approximately 4.33 million were children, 2.22 million were infants, and 2.15 million were women. WIC has expanded to serve a quarter of all pregnant women, half of all infants, and 30 percent of all children up to age 5 in the United States.

1.2 Background

Evaluation of the WIC program has raised significant concerns about its effectiveness among researchers and government agencies. Today, WIC participation has expanded to the point that it serves almost half of all infants in the US. However, more than half of all infant formula sold in the US is purchased through the WIC program. This suggests that WIC infants are more likely to get formula than non-WIC infants. WIC's promotion of free infant formula has raised much debate on the negative effect of WIC on mothers' breastfeeding practice. Oliveira and Prell in a report for the USDA (2004) acknowledged that breastfeeding rates among WIC women continued to be lower than those of non-WIC women, although both were increasing while in the hospital immediately after giving birth and at 6 months. Kent (2006) provided evidence indicating that WIC has the effect of promoting the use of infant formula, thus placing infants at higher risk. Kent suggested that the large scale distribution of free infant formula by a governmental agency, such as WIC, should be discontinued.

The benefit of breastfeeding has been widely cited (CDC 2002 PRAMS[1] surveillance report, AHRQ[2] 2007 report by Ip et.al, ADA[3] 2001). The World Health Organization (WHO) recommends that all infants should be exclusively breastfed for 6 months, and that breastfeeding be continued for up to two years and beyond with appropriate complementary. The U.S Department of Health and Human Services

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[1] Pregnancy Risk Assessment Monitoring System, is a surveillance project of the Centers for Disease Control and Prevention (CDC) and the state health departments. http://www.cdc.gov/prams/

[2] Agency for Healthcare Research and Quality

[3] American Diabetes Association

Healthy People 2020 recommends the following: at least 81.9 percent of women initiate breastfeeding, and; at least 60.6 percent continue breastfeeding for at least 6 months. Breast milk is considered the most nutritionally beneficial form of infant nourishment during the postpartum period. Breastfeeding provides a range of benefits for infant's health, growth, immunity, and development as well as for maternal health. Breastfeeding also strengthens the infant-mother bond. An AHRQ 2007 report based on an analysis of almost 400 individual studies reviewed evidence on the effects of breastfeeding on infant and maternal health outcomes in developed countries. This review included a broad range of studies such as meta-analyses, randomized and non-randomized comparative trials, prospective cohort, and case-control studies. The conclusion of this review was that the benefit of breastfeeding on infant health includes a reduced the risk of acute otitis media, non-specific gastroenteritis, severe lower respiratory tract infections, atopic dermatitis, asthma, obesity, type1 and 2 diabetes, childhood leukemia, sudden infant death syndrome (SIDS), and necrotizing enterocolitis. The effect of breastfeeding on maternal health includes reduced incidence of type 2 diabetes, breast and ovarian cancer. There is also evidence that breastfeeding women more easily return to their pre-pregnancy weight. Breastfeeding also provides significant economic benefits, reducing health care costs and other costs. Weimer (2001) estimated a minimum of $3.6 billion would be saved if breastfeeding rates increased from 1996 levels (64 percent in hospital, 29 percent at 6 months) to the level recommended by the U.S Surgeon General in 2000 (75 and 50 percent, respectively). Riordan (1997) examined the extra health care costs associated with non-breastfeeding for three health conditions-otitis media, infant diarrhea, and respiratory syncytial virus. Riordan showed over $1 billion of extra health care costs each year occurred with non-breastfeeding. Ball and Wright (1999) showed that these three conditions cost the managed care health system between $331 and $475 per non-breastfed infant during the first year of life.

1.3 WIC's past efforts to promote breastfeeding

Since its inception, WIC has tried to promote healthy behaviors, of which breastfeeding is one. WIC has been revised several times since its inception to benefit breastfeeding women and encourage pregnant participants to breastfeed unless contraindicated for medical concerns. The Child Nutrition and WIC Reauthorization Act of 1989 (P.L. 101-147) required the USDA to promote breastfeeding. WIC state

agencies are required to hire breastfeeding promotion coordinators to provide education on and promotion of breastfeeding. The WIC Farmers' Market Nutrition Act of 1992 (P.L. 102-314) added an enhanced WIC food package to encourage breastfeeding among WIC mothers. The enhanced food package added carrots and canned tuna along with increased amounts of juice, cheese, peas, beans and peanut butter exclusively for breastfeeding women. In 1997, the USDA initiated the National Breastfeeding Promotion Campaign to encourage WIC participants to begin and continue breastfeeding. In December 2007, an interim final rule made the most recent revision in WIC food packages by adding fruits, vegetables, and whole grains as well as reducing the amounts of certain foods in the existing food package to better promote and support the goal of successful, long-term breastfeeding. The new WIC food package is consistent with the 2005 Dietary Guidelines for Americans and infant feeding practice guidelines of the American Academy of Pediatrics[4].

1.4 Lower breastfeeding rates among WIC participants

Despite WIC's efforts on promoting breastfeeding, researchers have questioned the sufficiency of WIC's investment in breastfeeding promotion and support. Ryan & Zhou (2006) estimated that less than one percent of WIC's post-rebate costs ($34million) were designated for increasing breastfeeding initiation among women receiving WIC. Lawrence (2006) also pointed out the insufficiency of funds invested in breastfeeding promotion.

In addition, researchers have provided evidence that breastfeeding rates among women on WIC are much lower when compared to non-WIC recipients. Ryan & Zhou (2006) used longitudinal breastfeeding data in the United States between 1978 and 2003 to compare the trend of breastfeeding rate of WIC participants to that of non WIC participants. Their analysis controlled for a variety of demographic characteristics, including mother's race, age, education, employment status, and census region, and showed that WIC mothers continue to have lower breastfeeding rates both in the hospital and at 6 months compared to their non-WIC counterparts. Since the early 1990s, the racial/ethnic composition of WIC participants has showed dramatic change. From 1992 to 2006, Hispanic participants have

[4] Information was obtained from USDA website.

increased from 23 percent to 41 percent which is more than any other racial/ethnic group. During the same period, the percentage of Whites and Blacks combined decreased from 72 percent to 52 percent (Bartlett et al., 2007). In a commentary on Ryan & Zhou (2006), Lawrence pointed out that Hispanics and Southeast Asian women historically have had relatively high breastfeeding rates. When participating in WIC, these women do not maintain such high breastfeeding rates.

1.5 Selection bias

However, the discrepancy in breastfeeding rates between WIC participants and non WIC participants may be related to WIC participant's characteristics that discourage breastfeeding, rather than WIC's provision of free infant formula. Researchers have actually showed evidence that WIC participants are different to non WIC participants. Tiehen & Jacknowitz (2008) showed that WIC women differ from their non-WIC counterparts based on a broad range of observable characteristics. For example, compared to non WIC participants, WIC participants are more likely to have lower social economic status such as being, poor, unmarried, black, and less educated. Li, et al. (2002) showed that mothers in lower socioeconomic groups have traditionally been less likely to breastfeed their children.

In addition, not all eligible women actually choose to participate in WIC. Currie (2006) explained nonparticipation among eligible individuals on the basis of two primary costs -stigma (social cost) and transaction costs. An eligible woman may choose not to participate because she may feel embarrassed about receiving benefits from a government assistance program. Secondly, there are transaction costs associated with applying for a program; Complying with the program rules and redeeming benefits. If an eligible woman gives greater weight to the transaction costs over the benefits received from participation, she may choose not to participate.

WIC participation is not random. There might be many other unobservable characteristics associated with both WIC participation decision and breastfeeding decision. The examination of WIC effect on breastfeeding has been complicated by selection bias. Minimizing the selection bias will help to disentangle the discrepancy in breastfeeding rates between WIC participants and non-WIC participants.

2. LITERATURE REVIEW:

Studies on the association between WIC participation and breastfeeding initiation and duration showed mixed results. Fox et al. (2004) reviewed published research on the effect of WIC on breastfeeding and found no solid evidence that WIC had an impact on breastfeeding initiation or duration. These WIC studies have used different data sources, comparison groups and statistical methods. Some studies have tried to address the selection bias issue, many have not.

Schwarts et al. (1995) used data from the National Maternal and Infant Health Survey (NMIHS) to analyze the effect of prenatal WIC participation on breastfeeding behavior. NMIHS is a nationally representative retrospective survey conducted in 1988 collecting data to study factors related to poor pregnancy outcomes, including low birth weight, stillbirth, infant illness, and infant death. Schwarts et al. compared the breastfeeding initiation and duration activities of prenatal WIC participants and income-eligible non-WIC participants. They also tested the effect of WIC participation during pregnancy with breastfeeding advice and without breastfeeding advice. They use a multivariate model specifies an interrelated chain of observable behaviors (whether an income-eligible woman participates in the WIC during her pregnancy; whether she breastfeeds after the child is born; and the duration of breastfeeding) for the income-eligible women, regardless of WIC participation. They use a maximum-likelihood technique that estimates the three equations jointly to correct the selection bias by estimating the correlation in unobserved factors that affect WIC participation and breastfeeding behavior. Maximum-likelihood technique can find the coefficients of the three equations simultaneously to maximize their fit to the data. It was found that WIC participation during pregnancy may significantly improve breastfeeding initiation among those who have been given breastfeeding advice. They found no effect of prenatal WIC participation on breastfeeding duration. However, Schwarts et al. also pointed out that the information on breastfeeding advice which was the key variable to support their analysis might be biased. Participants who breastfed were more likely to recall advice received from WIC. This is the disadvantage of using retrospective data. Their estimates were also likely to be biased upwards due to favorable selection -

women who breastfed were more likely to seek breastfeeding advice therefore receive such advice during pregnancy.

Chatterji and Brooks-Gunn (2004) analyzed the 1999 to 2000 survey data from the Fragile Families and Child Wellbeing Study, consisting of 2136 unmarried, low-income mothers. However, this study did not have information on WIC participation during pregnancy. Their tests on WIC effect were based on WIC status following birth. Since they lacked information on the timing of WIC participation, their estimation model did not rule out selection bias which could lead to biased estimates. Their multivariate analysis showed that postpartum WIC participation was associated with an increased probability of breastfeeding initiation of about 7 percentage points. They did not find any effect of postnatal WIC participation on breastfeeding duration.

Bitler and Currie (2005) used data from the Pregnancy Risk Assessment Monitoring System (PRAMS), to assess the WIC effect on maternal and infant health. Bitler and Currie pointed out that most extant WIC research had failed to correct for the selection bias associated with WIC evaluation work and tried several methods to correct for it. PRAMS provide rich information about pregnancy, birth, infant health and WIC participation. Bitler and Currie used data from PRAMS in 19 states over the period 1992 to 1999. They constructed a sample of 60,731 women whose deliveries were paid for by Medicaid and who also had prenatal WIC use information. To address the possibility of selection bias associated with WIC participation, they compared the observable characteristics of WIC participants and non-participants in the sample of women who were on Medicaid. Women on Medicaid but not on WIC is a common comparison group which has been chosen by many researchers (Devaney et al.1992; Buescher &Horton 2000; Lazariu-Bauer et al. 2004; Joyce et al. 2005), since Medicaid eligibility automatically confers WIC eligibility, even if the woman’s income is above the 185% poverty cutoff for WIC. Bitler and Currie found that WIC mothers were negatively selected into the WIC program among eligible women. To correct for the selection bias, they included a full set of state and year interaction terms to control for unobservable time-varying and time-invariant state level factors. They then estimated two-stage least squares (2SLS) models using state-level program characteristics as instruments. They found that WIC helped participants to have healthier infants. However, they found that WIC have depressing effect on breastfeeding

initiation. Bitler and Currie pointed out that the provision of free infant formula removed the mothers' incentive to breastfeed. However, they also showed evidence of the weak explanatory power of their WIC program instruments. In addition, PRAMS only provided information on prenatal WIC participation without information on postpartum participation. Their interpretation of lower breastfeeding initiation rate among WIC prenatal participants due to WIC free infant formula distribution in postpartum does not sound supportive.

Jacknowitz et al. (2007) examined the association between WIC participation and adherence to American Academy of Pediatrics recommendations on exclusive breastfeeding and the introduction of infant formula, cow's milk, and solid foods. They constructed a sample of 5,276 WIC eligible mothers from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B). ECLS-B provides rich information on WIC participation, breastfeeding and other infant feeding practices, demographic characteristics, income, assets and health status and behaviors. Having detailed information on income and other assistance program participation, they could identify a sample of women who were eligible for WIC. Their dichotomous WIC participation variable was constructed using 9-month survey data from ELCS-B and defined as the mother having received WIC benefits during pregnancy, during the first 6 months after pregnancy, or having received WIC vouchers to purchase food or formula for her infant in the 30 days before the survey. Jacknowtiz and her coauthors found that WIC participants were less likely to breastfeed exclusively than eligible non-participants. For example, WIC participants were 5.9 percentage point less likely to exclusively breastfeeding for more than 4 months and 1.9 percentage point less likely to exclusively breastfeeding for more than 6 months. WIC mothers were also 8.5 percentage points less likely to adhere to the AAP recommendation to delay introduction of infant formula until month 6. They included a large set of control variables in their regression analysis to reduce the possibility of unobservable maternal characteristics were associated with WIC participation decision and infant feeding decision. Their study was limited to the difficulty of determining the causal effect of WIC participation on infant feeding practice given selective enrollment in WIC. In addition, due to the data limitation, their exclusive breastfeeding definition might have overestimated the number of exclusively breastfed infants.

Joyce et al. (2008) use data from the Pregnancy Nutritional Surveillance System (PNSS) to assess WIC's effect on birth outcomes and maternal health behavior. PNSS data from nine states collected between 1995 and 2004 were used to create an analysis sample of 3,311,976 women who participated in WIC either prenatally or postpartum. PNSS data provides rich information on maternal characteristics, health and behavior, infant health as well as the timing of WIC enrollment. To minimize the selection bias associated with WIC participation, they chose women who enrolled in WIC initially in postpartum period as the comparison group when compared to prenatal WIC enrollees. Choosing this comparison group can avoid the possibility of being eligible but choose not to participate in WIC due to stigma or other barriers, because both treatment and comparison group are eligible women and participated in WIC. To construct more homogeneous treatment and control group in terms of preference, motivation, and experience with pregnancy, they further limited the sample to women with no previous live births and who initiated early prenatal care. Women with no previous live births won't be motivated to enroll in WIC early because of a bad experience in previous pregnancies. Therefore they can lessen the adverse selection bias. On the contrary, early prenatal care can be reviewed as a marker for favorable selection. Since the first prenatal care visit is initiated by the woman, a woman who initiates prenatal care early are more likely to have a stronger awareness towards maternal health. Joyce et al. also used their large sample size to stratify their analysis within different social economic groups to further reduce the heterogeneity between treatment and control group. Lastly, Joyce et al. used propensity score matching as a robust check. Propensity score matching method will improve the balance of observable characteristics between treatment and control group. However, it cannot lessen the selection bias caused by unobservable characteristics. Joyce et al. found that prenatal enrollees are 2.6 percentage points more likely to have ever breastfed than postpartum entrants. They also found differences by trimester of WIC enrollment. Women who enroll in WIC in the first trimester are 3.0 and 3.9 percentage points more likely to have ever breastfed than women who enrolled in the second and third trimester respectively. Their within race analysis show almost similar stories that prenatal enrollees are tend to be more likely to have ever breastfed than postpartum entrants.

Jiang et al. (2010) used propensity score matching and sibling fixed-effects regression models to examine the association between WIC participation and breastfeeding. Their WIC participation variable was measured for prenatal participation. Like regression analysis, propensity score matching assumes that there are no unobservable confounders. However, the authors argued that propensity score matching is more advanced than regression analysis in a way which allows nonlinear relationship between treatment and the covariates, and produces an almost unique comparison group based on balanced characteristics between treatment and comparison groups. On the other hand, mother fixed effects will control time-invariant unobservable characteristics within mothers. However, by looking at within-mother variation only, researchers will lose a great deal of information. The authors used 1997 data from the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID) and constructed a sample of 3,276 children- mother pairs. For the mother fixed effect model, they had a sample of 2,124 children who were twin. Their OLS results showed that WIC mothers are less likely to initiate breastfeeding and breastfeed for a shorter time. However, the propensity score and fixed-effects models showed no significant difference in breastfeeding by WIC participants.

The results from these studies are mixed and inconsistent. Without randomized trials, selection bias remains as the major concern for WIC evaluation among researchers. Researchers have used large set of covariates, matched samples, instrument variables, and identification strategies to lessen contamination from selection bias. There are several possible explanations for the lack of consistent findings. First, observed characteristics that are correlated with WIC participation may also be correlated with unobserved characteristics that partially determine participation. This is a violation of the unconfoundedness condition, as expressed by some econometricians. Second, the instruments that are used to predict WIC participation have weak explanatory power. Third, different comparison groups may produce different estimates. Finally, identification strategies limit some studies to small samples of women within a particular group and thus cannot be generalized to the larger population of WIC-eligible women.

3. MY STUDY

3.1 Analysis on both singleton and twin births

Previous studies on WIC effect were mainly focused on singleton births. In this study I examined WIC effect on breastfeeding for both singleton and twin births. Breastfeeding is associated with personal and public inconvenience, including: embarrassment in work and public situations; enduring pain and discomfort while feeding baby; and difficulty in returning to work after giving birth. Compared to breastfeeding singletons, breastfeeding twins is even more demanding, which is accompanied by longer breastfeeding time, probably more pain and discomfort. Breastfeeding twins also demand more breast milk from the mother. Because of these extra burden associated with breastfeeding twins, a mother of twins could be less willing to breastfeed their babies and more likely to seek out infant formula as an alternative feeding.

WIC participants are usually low income women. The high infant formula cost could be a stressful economic burden to these women. For example, the cost of a 6 pack (12.4 ounces per pack) of Similac Advance Complete Nutrition Powder formula is $86.99 (www.Abbott.com) or $1.17 per ounce. Depending on baby's weight, age and sex, feeding a baby on infant formula could cost a family $4 to $6 a day, an annual cost of $1,460 to $2,190 a year[5]. This cost would be doubled for mothers of twins. In addition, studies have shown that approximately 50% of twins are low-birth weight babies. Health care professional recommend that low-birth weight and premature infants receive specialized infant formula, such as Similac Expert Care NeoSure, Enfamil Premature LIPIL. Specialized infant formulas provide more protein, vitamins and minerals than formulas for full-term babies, at significantly higher costs. For example, Similac Expert Care NeoSure infant powder formula cost $102 for a package of 76.8 ounces on Abbott. This will cost a mother of low-birth weight twins between $3,800 and $4,500 a year.

[5] My estimation was based on the information from http://www.babycenter.com/0_how-to-tell-how much-formula-your-baby-needs_9136.bc?startIndex=30 . If the baby isn't eating any solids, offer him 2.5 ounces of formula per pound of body weight each day. Besides weight, the amount of feeding also depends on baby's age. Start with 1 or 2 ounces at each feeding for the first week, then work up to 2 to 4 ounces for every two to three hours each day during 0 to 2 months. From 2 to 4 month, the baby may down to 6 to 8 bottles of 4 to 6 ounces each every day. From 4 to 6 month, he probably drops to 4 or 5 bottles of 6 or 7 ounces each every day. From 6 to 12 month, he probably down to 3 or 4 bottles of 7 to 8 ounces each every day.

However, WIC provides infant formula to its participants at free of charge. With appropriate medical documentation, furthermore, WIC provides free specialized infant formula to low birth weight babies. In Table 1 in appendix, I showed the estimated average monthly WIC food package cost per person for fiscal year 2001 from USDA website. The average of pre-rebate food cost for infants is $94.75, which is more than doubled than average food package cost for pregnant, or breastfeeding, or postpartum women.

Given the difficulties associated with breastfeeding and the high market price of infant formula, WIC may attract eligible women to participate through provision of free infant formula. One of my hypotheses is that WIC will attract more mothers of twins to enroll at postpartum period than mothers of singletons. The second hypothesis is that these eligible women who only entered into WIC at postpartum period (postpartum entrants) will have a lower breastfeeding initiation rate and breastfeed for a shorter duration. The negative effect of free infant formula on breastfeeding should be larger among mothers of twins than mothers of singletons.

3.2 Assessing the effect of both prenatal and postnatal WIC participation on breastfeeding

Most of previous WIC studies assess the effect of WIC participation at either prenatal period or postnatal period due to data limitation. Some other studies examined the effect of any WIC participation and couldn't separate whether the participants were on WIC during prenatal period or postpartum period. However, WIC may have conflict effects on breastfeeding decision among its prenatal and postpartum participants. At prenatal period, WIC's promotion on breastfeeding may increase breastfeeding among its participants. At postpartum period, WIC's free infant formula may decrease breastfeeding incentive among its participants. Therefore, examining the WIC effect separately at prenatal period and postpartum period is important to disentangle the conflict WIC effect on breastfeeding.

4. DATA

4.1 Data description

The data source is from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) file. ESLC-B is a longitudinal nationally representative data set that was collected by the National Center for Education Statistics (NCES), US Department of Education. The data constructed a national representative sample of 10,700 children who were born in 2001. The ECLS-B follows these children from birth through kindergarten, collecting four waves of data when the child is approximately 9 months, 2 years, 4 years old, and at kindergarten entry. I will use the ECLS-B data collected from the first two waves in this study. Of the 10,700 children that participated in the first wave, 9850 participated in the second wave. The ECLS-B oversampled children who are American Indian, Chinese, Asian and Pacific Islander, twin, and low and very low birth weight children. In the first two waves of the data, the ELCS-B collected information from child, parents, birth certificates, and child care providers. The survey contains detailed information on both mother and children, including demographic characteristics, health status and behavior, prenatal and postpartum WIC participation, other welfare program participation, and mothers' breastfeeding practice.

The ECLS-B data is suitable for my analysis for the following reasons: Firstly, it provides considerable information regarding changes in a household's WIC participation over time. Thus I can observe the transition in and out of WIC during the prenatal and postpartum period. Secondly, ECLS-B allows for the comparison of WIC participants (at both prenatal and postnatal) to nonparticipants (both eligible and ineligible due to income just above the program threshold). Thirdly, the ECLS-B provides detailed information on mother's feeding practice. I was able to examine three breastfeeding outcomes: breastfeeding initiation, whether mother breastfed for at least 6 months, and the actual breastfeeding length in months. Lastly, ECLS-B oversampled twin births with approximate 800 mother infant pairs. This relatively large sample of twins will allow me to stratify my analysis by twins, which is a very important aspect of this paper.

4.2 Coding WIC eligibility and defining WIC prenatal and postpartum participants

Not all children on ECLS-B are eligible to WIC. To be eligible to receive WIC benefits, an applicant must meet income and nutritional risk requirement. To code WIC eligibility, I followed the same

procedure in Tiehen and Jacknowitz (2008). To meet the nutritional risk requirement, an individual must be seen by a health professional who determine whether the individual has at least one of the medical-based conditions (such as anemia and underweight) or dietary-based conditions (such as a poor diet). ECLS-B does not provide information to determine whether a woman meets the nutritional risk requirement. However, Tiehen & Jacknowitz (2008) documented that almost all income eligible individuals are also at nutritional risk. To meet the income requirement, a household income must be at or below 185 percent of the poverty line, or the household participate in the Food Stamp Program, TANF, or Medicaid. ECLS-B does not include information on prenatal participation in the Food Stamp Program or TANF. Thus I only used Medicaid participation information for adjunctive eligibility. But given the stricter eligibility requirement for Food Stamp Program and TANF, the misclassification of eligible women is likely to be minimal. Therefore, all women who reported prenatal Medicaid participation are considered eligible for WIC. The income threshold for Medicaid varies by state. If the state's income threshold for Medicaid is higher than 185 percent of the poverty line, I used the state's threshold to determine the WIC eligibility. I calculated the household income-to-poverty ratio to determine whether a woman's income is at or below the 185% of the poverty threshold. The midpoint of the income is used from income bracket data from ECLS-B. For the top income threshold bracket, I use the lower limit instead of the midpoint method to code income-to-poverty ratio since the top limit was unavailable. The 2000 State Medicaid income-eligibility thresholds for pregnant women were obtained from the *Maternal and Child Health Update: States Have Expanded Eligibility and Increased Access to Health Care for Pregnant Women and Children (National Governors Association Center for Best Practices, 2001)*.

Two WIC participation periods, prenatal and postnatal period, were coded in the same way as in Tiehen and Jacknowitz (2010). A prenatal participant was defined as the mother who responded in ECLC-B that she participated in WIC prior to giving birth. The postnatal participants were coded at the household level. A household was coded as a postnatal participant if the mother responded that she used WIC for herself during the 6 months after giving birth, or if she used WIC for herself, the survey child, or the twin during the 30 days before the 9 month survey and the child/twin was less than 12 months old at the time.

5. EMPIRICAL MODEL:

5.1 Baseline WIC evaluation model

Consider the following baseline WIC evaluation models:

$$H = \alpha_0 + \alpha_1 WIC_{prental} + \beta X + e \quad (1)$$

$$H = \alpha_0 + \alpha_1 WIC_{postnatal} + \beta X + e \quad (2)$$

H in equation (1) and (2) are the outcome variables, that is, mother's breastfeeding behavior. When the outcome variable is breastfeeding length, equation (1) and (2) was estimated under Ordinary Least Square (OLS) regressions. When the outcome variable is ever breastfed or breastfed for at least 6 months, both equations were estimated by maximum likelihood Probit. X is a vector of covariates which include mother's characteristics such as the mother's race (with Non-Hispanic white as the basis), the mother's education (with less than a high school education as the basis), the mother's age (with age younger than 20 as the basis), the mother's citizenship, the mother's marital status, whether the survey child is a twin, and whether the survey child is mother's first birth. I included indicator variables for the region of residence (with living in the west as the basis), and urbanicity (with population of at least 50,000 as the basis). Indicator variables for household income, assets, other program participation and employment status include household income to poverty ratio (with household income above 185 percent of the poverty line as the basis), whether participated in other assistance program (TANF, the Food Stamp Program, or Medicaid) since the birth of the child, whether the household owns home, whether mother worked year before birth and anytime after birth. Variables for prenatal care include whether the mother receive any prenatal care, and how she paid for it (with paid by private insurance as the basis). A health behavior indicator, whether the mother smoked at least 100 cigarettes in lifetime, also included as a covariate.

Equation (1) is estimated to examine the effect of prenatal WIC participation. $WIC_{prental}$=1, which means a woman was a prenatal participant and remained in WIC in the postpartum period. $WIC_{prental}$ =0, which means a woman was an eligible participants but only entered into WIC at postpartum period, ie. a

postpartum entrant. Since majority of women in ECLS-B who participated in the prenatal period were remained in WIC at postpartum period, using women who only participated in the prenatal period as the treatment group would leave me with a very small sample size. By comparing the breastfeeding behavior among women who participated in both prenatal and postnatal period to women who only participated in postnatal period, essentially I am examining the net effect of prenatal participation. Joyce et al.(2008) also explained the advantage of using postpartum entrants as the comparison group. Since everyone is eligible for WIC and everyone participates in either prenatal or postnatal period. Stigma or other barriers to participation in government assistant program can be ignored in the analysis.

Equation (2) is estimated to examine the effect of postnatal WIC participation. $WIC_{postnatal}$=1 indicates that a woman is a postpartum entrant. Two nonparticipants groups have been constructed as comparison groups to postpartum entrants. $WIC_{postnatal}$=0 indicates that a woman is an eligible nonparticipant or an ineligible nonparticipant. An eligible nonparticipant is defined as the woman is eligible for WIC but not participated in WIC in either prenatal or postnatal period. An ineligible nonparticipant is defined as the woman did not participate in WIC and is ineligible for WIC because her income just above the program threshold. To define this group of women I used income threshold between 300%-400% of income-to-poverty ratio as the cutoff. The highest states income threshold for Medicaid is income-to-poverty ratio of 300% in California. Therefore if a woman's household income above 300% poverty ratio threshold she will not be eligible for WIC. The advantage of choosing ineligible nonparticipants as one of the comparison group is that these women have no option to choose whether to participate in WIC or not. Therefore we don't face the problem of selection bias.

5.2 <u>Selection bias</u>

The estimate of interest is α_1 in equation (1) and (2). The empirical challenge of estimating above equations is how to obtain an unbiased treatment effect. To illustrate the selection bias issue, consider the potential outcome of a woman in two states:

$$H_1 = X\beta_1 + U_1 , \qquad E(U_1) = 0$$

$H_0 = X\beta_0 + U_0$, $E(U_0) = 0$

Where H_1 is the outcome if the individual participates in WIC, and H_0 is the outcome if the same individual does not participate. Let H be the observed outcome such that

$H = (WIC)H_1 + (1 - WIC)H_0$, substituting H_1 and H_0 into H,

$H = X\beta_0 + WIC(X\beta_1 - X\beta_0 + U_1 - U_0) + U_0$, taking conditional expectation on both sides of the equation, we have

$$E(H|X, WIC = 1) = X\beta_1 + E(U_1 - U_0|X, WIC = 1) + E(U_0|X, WIC = 1)$$

$$E(H|X, WIC = 0) = X\beta_0 + E(U_0|X, WIC = 0)$$

The α_1 in equation (1) measures the differences in outcome H before and after treatment, that is:

$\alpha_1 = E(H|X, WIC = 1) - E(H|X, WIC = 0)$, this is equivalent to

$$\alpha_1 = X\beta_1 - X\beta_0 + E(U_1 - U_0|X, WIC = 1) + [\,E(U_0|X, WIC = 1) - E(U_0|X, WIC = 0)]$$

Following Heckman (1997), under the assumption of $E(U_1 - U_0|X, WIC = 1) = 0$ and $[\,E(U_0|X, WIC = 1) - E(U_0|X, WIC = 0)] = 0$, $\alpha_1 = E(H_1 - H_0|X) = X\beta_1 - X\beta_0$ yields an average treatment effects estimate (ATE).

Heckman (1997) defines this term $E(U_0|X, WIC = 1) - E(U_0|X, WIC = 0)$ as the selection bias. The selection bias is the difference in the base state between participants and nonparticipants. If $E(U_0|X, WIC = 1) - E(U_0|X, WIC = 0) > 0$ WIC participants were favorably selected, for example, women who were more likely to breastfeed in the base state choose to participate in WIC. In this case, regressing breastfeeding outcome on WIC will overestimate the program effect. In the case of adverse selection, $E(U_0|X, WIC = 1) - E(U_0|X, WIC = 0) < 0$, women who were less likely to breastfeed in the base state choose to participate, the treatment effects will be underestimated.

The above two assumptions for obtaining an unbiased ATE estimate $\alpha_1$is equivalent to say: First, the effect of participation on breastfeeding among participants is constant across individual mothers. Second, holding other factors constant, mother's breastfeeding behavior won't affect her WIC participation decision. The fundamental problem when estimating the treatment effects is that we cannot observe two outcomes for the same individual when exposed, and when not exposed, to the treatment. The simplest case is when participation to WIC is randomized, and thus uncorrelated to covariates and the potential outcomes. With a randomized control trial, the above two assumptions can be guaranteed. Randomization will yield a ATE estimate.

5.3 Correction for selection bias

Without randomization, a popular method for minimizing selection bias is to use instrument variables. A valid instrument should be highly correlated with the decision to participate in WIC and uncorrelated with the error term e in equation (1) and (2). Unfortunately, credible instruments have been very difficult to find. To minimize the selection bias, I have applied the following identification strategies to estimate above equations.

First, I included a rich set of controls to reduce the probability that some unobservable determinants may affect both mother's decision to breastfeed and to participate in WIC. Second, I have carefully selected my comparison groups when examining the effect of both prenatal and postnatal WIC participation. Third, I estimated equation (1) and (2) among singleton births and twin births separately. Twin births can be considered as exogenous health shock to mothers. Having a twin pregnancy should be orthogonal to mother's characteristics associated with WIC participation decision in the prenatal period, however, should affect mother's breastfeeding decision at postpartum. Estimation within twins may provide a less contaminated estimate. However, one exception of the exogeneity of twinning is when multi-fetal conceptions result from assisted reproductive technologies (ART). Women who use ART are likely to be motivated about achieving a healthy birth outcome thus may self-select into WIC. However, ART is relatively rare among poor women. In addition, researchers have provided evidence that women who received ART are more likely to be 30 years of age or older (Jain et al. 2004; Schieve et al. 2002).

To lessen this potential bias, I have run some of analysis within teen mothers under difference-in-difference regressions.

Another concern is that the exogeneity of twining will also be compromised if a pregnant woman acknowledges her twin pregnancy from prenatal care and thus make her decision on WIC participation. The first prenatal care visit is initiated by the woman. If a woman initiates her prenatal care earlier, she is more likely to find out about her twin pregnancy earlier. The latest ultrasound technology can discover twin pregnancy as early as in the six to eight weeks of pregnancy (http://www.babycenter.com/0_when-and-how-to-find-out-if-youre-carrying-twins-or-more_3579.bc). Early prenatal care initiators usually are women with strong health awareness and tend to have healthier maternal behavior, thus are very likely to enroll in WIC earlier. On the other hand, if a woman initiates her prenatal care at a late month of pregnancy, she may have less strong health awareness and more likely to have unhealthier behavior, such as not willing to breastfeed. Thus she is likely to be on WIC at postpartum period to take advantage of WIC's free infant formula. Unfortunately I do not have the information on the timing of the diagnosis of multiple pregnancies. Therefore, my fourth measure to minimize the selection bias is to restrict the sample to women who initiated prenatal care within the first four months of pregnancy, a standard definition of early prenatal care (Kotelchuck 1994). One argument is that early enrollment on WIC provides more opportunity to encourage breastfeeding behavior among its participants. The reverse may occur—early WIC enrollment may lead to earlier prenatal care. I cannot examine how many women who have initiated prenatal care before WIC enrollment, since I do not have the information on WIC enrollment by months. However, given about 89% women initiated early prenatal care in my sample, this concern is less likely to be troublesome.

5.4 Differences -in-Differences model

Differences-in-Differences (DID) method is another popular estimation in program evaluation. I used DID method as a robust check for my findings from equation (1) and (2). One of my hypotheses is that if there is any negative WIC effect on breastfeeding, it will be larger among twins than among

singletons. To compare the WIC effect on breastfeeding among singleton births to twin births, let's consider the following standard DID specification:

$$H = \gamma_0 + \gamma_1 WIC_{prenatal} + \gamma_2 Twin + \gamma_3 (WIC_{prenatal} * Twin) + \beta X + e \qquad (3)$$

$$H = \gamma_0 + \gamma_1 WIC_{postnatal} + \gamma_2 Twin + \gamma_3 (WIC_{postnatal} * Twin) + \beta X + e \qquad (4)$$

H, X and WIC indicator have been defined in the same way as in equation (1) and (2). $Twin$=1 indicates that the woman is a mother of twins. $Twin$=0 indicates that the woman is a mother of singleton. Estimating equation (1) and (2) among twins have reduced sample size significantly. One advantage of estimating DID equations is that it allows me to stratify my analysis by race/ethnicity, age, and education and compare results between singleton births and twin births without cutting sample by birth plurality.

The estimate γ_1 in this specification represents the effect of WIC participation on breastfeeding outcome holding birth plurality constant. γ_2 represents the effect of twin births on breastfeeding holding WIC participation status constant. γ_3 is the DID estimate, which measures the differences of the effect of prenatal WIC participation on breastfeeding outcomes between mothers of twins and mothers of singletons. γ_3 is obtained through subtracting the population average difference between singletons and twins in the comparison group from the population average difference between singletons and twins in the treatment group. To obtain an unbiased estimate γ_3, it requires that the structure of the model is correct, the error term is on average zero, and the error term is uncorrelated with the other covariates. These assumptions are essentially equivalent to those assumptions for obtaining an unbiased α_1 in equation (1) and (2). Therefore I estimated equation (3) and (4) by including a large set of covariates and within women who initiated prenatal care in the first trimester of pregnancy. In addition, I ran some analysis within different social economic groups. Some researchers (Lazariu-Bauer et al.2004; Joyce et al. 2005) have shown that treatment effects can vary substantially by race and ethnicity. Mothers who have a less than high school education and are younger than 20 years old are also examined. Since these women are more likely to have unhealthy behavior, such as not breastfeeding.

6. RESULTS

6.1 Characteristics of analysis sample

Characteristics of women by WIC participation status among singleton births and twin births are displayed in Table 2 and Table 3. Column (1) and column (2) show the characteristics of two types of WIC participants who are women participated in WIC at both prenatal and postnatal period (all WIC participants), and women who only entered into WIC at postnatal period (postpartum entrants). Column (3) and column (4) show the characteristics of non-WIC participants who are women eligible for WIC but did not participate in WIC (eligible non-participants), and women who did not participate in WIC because income just above WIC threshold (ineligible non-participants). All summary statistics were weighted by using wave two weighting variable in ECLS-B.

Table 2 shows that among singleton births WIC participants are more disadvantaged than non-WIC participants. Compared to non-WIC participants, WIC participants are more likely to be Blacks and Hispanics, have a less than high school education, to be teenage mothers, to be a non-U.S citizen, to be unmarried, to live in the South, to have income below poverty level, to participate in other assistant programs, to have prenatal care paid by Medicaid, and to smoke at least 100 cigarettes in lifetime. For example, 46.1% of all WIC participants and 38.2% of postpartum entrants who had a less than high school education. These are higher proportions than those among eligible non-participants (22.9%) and ineligible non-participants (6.5%). There are 48.3% of prenatal participants and 37.5% of postpartum entrants who had household income below poverty level compared to the corresponding proportion of 20.2% among eligible non-participants. These proportions by WIC participation patterns also show that postpartum entrants in general are better off than women who participated in both prenatal and postnatal period, and eligible non-participants are better off than ineligible non-participants.

The similar pattern appeared in Table 2 exists in Table 3. It shows that WIC participants in general are more disadvantaged than non-WIC participants among twins as well. For example, in terms of wealth condition, there are 21.7% of eligible nonparticipants whose household income below poverty level. This proportion is significantly higher among participants, 53.5% among all WIC participants and 36.6% among postpartum entrants respectively. There are only 26% of all WIC participants who own home, while 56.5%

of postpartum entrants and 58.6% of eligible non-participants own home. This percentage of having a home ownership is much higher among ineligible non-participants (85.4 %).

The unadjusted breastfeeding outcomes are displayed in Panel A and B in Table 4. Among mothers of singletons (in Panel A), non-WIC participants are more likely to initiate breastfeeding and breastfeed longer than WIC participants. In addition, postpartum entrants are more likely to breastfeed and breastfeed longer than women participated in both prenatal and postnatal period. Ineligible non-participants are more likely to breastfeed and breastfeed longer than eligible non-participants. For example, breastfeeding initiation rate is 59.7% for prenatal participants, 64.2% for postpartum entrants, 76.1% for eligible nonparticipants, and 78.1% for ineligible nonparticipants. The increasing pattern in breastfeeding outcomes from column (1) to column (4) in Panel A does not repeat consistently in Panel B. Among mothers of twins, women who participated in both prenatal and postnatal period still have the lowest breastfeeding initiation rate as well as shortest breastfeeding duration on average. However, postpartum entrants have the smallest likelihood to breastfeed for at least 6 months (5.7%), but surprisingly a higher breastfeeding initiation rate than all WIC participants and eligible non-WIC participants. Those ineligible nonparticipants who are not eligible for WIC and not affected by WIC have the highest breastfeeding initiation rates (71.2%) among all other groups. Eligible non-WIC participants have the highest likelihood to breastfeed for at least 6 months (33.9%), and longest breastfeeding duration on average (4.517).

The characteristics and unadjusted breastfeeding outcomes by WIC participation status show the evidence of adverse selection associated with WIC participation. Women with lower social economic status are more likely to participate in WIC and enter into WIC during pregnancy. And these women are less likely to initiate breastfeeding and breastfeed for a shorter duration. This pattern is especially prevailing in Panel A among singletons. In Panel B, all WIC participants who are more disadvantaged than other three groups of women have the lowest breastfeeding initiation rate and shortest breastfeeding duration.

6.2 Transition in and out of WIC

My first hypothesis is that WIC attract mothers, especially mothers of twins, to participate in postpartum period through the provision of free infant formula. To test this hypothesis, let's take a look at the dynamic WIC participation patterns in Table 5.

In Table 5, based on the participation status in prenatal and postnatal period, I show four possible ways transition into and out of WIC at these two periods. The corresponding prevalence rate associated with each of the transition patterns is also reported. Transition patterns among singleton births, twin births and low birth weight twins are displayed separately in Panel A, B and C. Participation pattern 1 indicates that households participated in both prenatal and postnatal periods. Participation pattern 4 indicates that households did not participate in neither prenatal nor postnatal period. Participation pattern 2 and 3 indicates that households participated in either one of the two participation periods. In panel A, among singleton births, there are 65.45% of eligible households who participated in both periods. These households comprised 95.71% of prenatal participation, 83.60% of postnatal participation. There are 17.53% of eligible households who never participated in either prenatal or postnatal periods. 2.98% of eligible households participated in prenatal period but exit during postpartum. 13.03% eligible households only entered into WIC in postnatal period. Compared to singleton births, Panel B shows that twin births are more likely to be on WIC. 66.96% of eligible households with twins were on WIC in both prenatal and postnatal periods, while 13.23% were not on WIC at all. Eligible households among twin births were less likely to exit from postnatal participation than singleton births, only 1.29% of mothers of twins exit from postnatal period. More importantly, twin mothers are more likely to enter into WIC in postnatal period, 18.51% among twin mothers compared to 13.03% among singleton mothers. The prevalence rate for entering into WIC at postpartum period (18.60%) is even higher among low-birth-weight twins.

These prevalence rates based on transition between prenatal and postnatal WIC participation confirms the hypothesis that mothers of twins are more likely to participate in WIC, especially more likely to enter into WIC postpartum compared to mothers of singletons. One limitation of this transition table is that the distribution of transition patterns was based on a fixed number of eligible households from prenatal to postnatal period. This is the limitation of using ECLS-B data to code the WIC eligibility. Household incomes vary over time thus may affect her eligibility for WIC at a given time. In this paper, I

constructed a fixed sample of households who were eligible based on their annual income during the year before the 9-months survey and their receipt of prenatal Medicaid. Thus ECLS-B did not rule out the possibility of that an eligible woman in the prenatal period may exit from WIC in the postpartum period if she loses her eligibility.

6.3 Regression results

I want to separate the effect of prenatal WIC participation on breastfeeding from the effect of postnatal participation. To identify the effect of prenatal participation, I show the comparison of breastfeeding outcomes among all WIC participants to postpartum participants. Three outcomes, ever breastfed, breastfed for at least 6 months, and breastfeeding duration, were examined. Results among singleton births and twin births are displayed in Panel A and Panel B from Table 6. Table 6 shows that prenatal WIC participation has no effect on mother's breastfeeding behavior among singletons. Among mothers of twins, although prenatal participation has no effect of increasing breastfeeding initiation or breastfeeding length on average, it increases the likelihood of breastfeeding for at least 6 months by 6.6 percentage points.

To check the robustness of the findings in Table 6, I estimated the effect of prenatal WIC participation under the difference-in-differences models. Results under DID estimation are presented in Table 7 and consistent to those in Table 6. There is no significant effect of prenatal WIC participation on breastfeeding initiation and average breastfeeding length. In Panel B of Table 7, all WIC participants compared to postpartum entrants, are 25.8 percentage points more likely to breastfed for at least 6 months among mothers of twins than among mothers of singletons. The larger effect of prenatal WIC participation on twin births verses singletons births is also consistent to the findings in Table 6, which shows no effect of prenatal participation among singletons but among twins. In addition, Panel B and Panel C show evidences that mothers of twins are more likely to breastfeed for a shorter duration than mothers of singletons holding their WIC participation status constant. For example, a mother of twins is 15.6 percentage points less likely to breastfed for at least 6 months than a mother of singleton. This is not a surprising result given the extra difficulties associated with breastfeeding twins.

With the preservation of large sample size under the estimation of the difference-in-differences models, I then investigated the breastfeeding behavior within women of sub-groups which are stratified by race/ethnicity, age and education. The results are displayed in Table 8. From column (1) to column (5), five sub-groups of women are whites, blacks, Hispanics, mothers who have a less than high school education, and teenage mothers. Results in Panel A, B, and C indicate that Hispanic mothers' breastfeeding behaviors are significantly affected by her prenatal WIC participation status and the number of children she has. Holding WIC participation status constant, a Hispanic mother of twins is 27.9 percentage points less likely to initiate breastfeeding, 34.3 percentage points less likely to breastfed for at least 6 months, and breastfed 3.457 months shorter on average than a Hispanic mother of singleton. However, Hispanic mothers after participating in WIC, an all WIC participant compared to a postpartum entrant, is 70.3 percentage points more likely to breastfed for at least 6 months, and breastfed for 2.170 months longer on average among mothers of twins than among mothers of singletons. In addition, white mothers and teenage mothers who have twins are less likely to breastfed for at least 6 months than those who have singletons, holding their WIC participation status constant. Holding birth plurality constant, prenatal WIC participation only increases breastfeeding initiation rate among mothers who have a less than high school education. Except the findings among Hispanic mothers, there are a few more DID estimators also show meaningful results. For example, within mothers of white and mothers who have a less than high school education, all WIC participants compared to postpartum entrants are less likely to initiate breastfeeding among mothers of twins than among mothers of singletons.

In summary, prenatal WIC participation show larger effects among mothers of twins than among mothers of singletons. The effect of prenatal participation increasing the likelihood to breastfed for at least 6 months is larger among mothers of twins than among mothers of singletons, and the effect is driven by the group of Hispanic mothers and teenage mothers.

Although WIC promotes breastfeeding among its participants, the provision of free infant formula in postnatal period has been criticized as a disincentive for mothers to breastfeed. The dynamic WIC participation pattern has shown WIC attracts more mothers of twins to enter into WIC postpartum compared to mothers of singletons. My second hypothesis is that these postpartum entrants as opposed to women in comparison group are less likely to initiate breastfeeding or breastfed for a shorter duration

under the incentive of receiving WIC's free infant formula. The effect should be larger among twin mothers than singleton mothers. To examine the effect of postpartum WIC participation on breastfeeding behaviors, two comparison groups of non-participants have been selected. Results of estimation of equation (2) are displayed in Table 9. Estimation within singleton births and twin births are displayed separately in Panel A and Panel B. Column (1) show results when eligible non-WIC participants were selected as the comparison group, while column (2) displays results when ineligible non-WIC participants as the comparison group. The estimates in column (1) of Panel A indicate that among singleton births postpartum entrants are 8.8 percentage points less likely to initiate breastfeeding, 12.4 percentage points less likely to breastfed for at least 6 months, and breastfed 1.575 months shorter on average compared to eligible non-participants. The differences are not significant when compared to ineligible non-participants in Panel A, except that postpartum entrants breastfed 1.397 months shorter on average. In Panel B, results among twins are significant everywhere. When compared to both groups of non-participants, postpartum entrants are less likely to breastfed for at least 6 months and breastfed for few months on average, and the effects are much larger than those among singletons. However, very surprisingly, postpartum entrants are more likely to initiate breastfeeding when compared to women who were not on WIC at all, although they breastfed for a significant shorter duration.

Robustness checks under DID estimation on WIC postnatal effect are presented in Table 10. Three breastfeeding outcomes are in Panel A, B and C. Compared to eligible non-WIC participants, holding birth plurality constant, postpartum entrants are 8.8 percentage points less likely to initiate breastfeeding, 12.5 percentage points less likely to breastfed for at least 6 months, and breastfed for 1.6 months shorter. Column (1) of Table 10 also indicates that postpartum entrants compared to eligible non-participants are 20.3 percentage points less likely to breastfed for at least 6 months among twin mothers than among singleton mothers. In addition, postpartum entrants are 15.7 percentage points more likely to initiate breastfeeding among twin mothers than among singleton mothers when compared to eligible non-participants. These are consistent to the larger effects found among twins in Table 9. Compared to ineligible non-participants, results are less significant. Holding birth plurality constant, postnatal participation decreases breastfeeding duration by 1.553 months. In addition, postpartum entrants are more likely to initiate breastfeeding among twin mothers than among singleton mothers compared to

ineligible non-participants. This is also driven by the large positive effect found among twin mothers in terms of breastfeeding initiation.

7. DISCUSSION:

WIC as the third largest Federal nutrition program, its goal is to safeguard the nutrition status of low-income women, infants, and children in the United States. Given the significant benefits associated with breastfeeding, WIC is promoting breastfeeding among its participants through education, counseling, and providing enhanced food packages. However, WIC's large scale distribution of free infant formula at postpartum period has been criticized as a disincentive for breastfeeding. Selection bias has always been an issue associated with WIC evaluation. Using twining, I identify a group of women whose breastfeeding decisions affected by her twin pregnancy but not her WIC participation decision.

My results show that prenatal WIC participation has limited effects on achieving better breastfeeding outcomes. Positive prenatal WIC effects were only found among twin mothers and within some groups of women. The dynamic WIC participation patterns show that WIC attracts more mothers of twins than singletons to participate, especially to participate in the postpartum period. These postpartum entrants are less likely to breastfed for at least 6 months and have shorter breastfeeding durations than non-participants, and the effects are significantly larger among twin mothers than among singleton mothers. However, postpartum entrants are more likely to initiate breastfeeding compared to non-participants, and the results are driven by mothers of twins.

My findings suggest that WIC need to restructure incentives while insuring that all eligible infants are not deprived of formula. The provision of WIC's free infant formula is to help low income women who cannot breastfeed under medical reasons to feed their babies, or provide specialized formula as a supplemental feeding to infants who are in need. WIC should not stimulate unhealthy behavior, such as in favor of feeding infants formula than feeding breast milk, among its participants. WIC need to introduce a stricter screen system to distribute its resources in a better efficient way to help women and infants who are most in need.

APPENDIX (Chapter I):

Table 1: FY01 estimated average monthly WIC food package cost per person in $

Category	% of Total WIC Participants	Average Pre-Rebate Food Package Cost	Average Post-Rebate Food Package Cost
Pregnant	11.3%	$ 39.78	$ 39.78
Breastfeeding	5.5%	$ 41.57	$ 41.57
Postpartum	7.5%	$ 32.16	$ 32.16
Total Women[1]	24.4%	$ 37.84	$ 37.84
Infants	26.3%	$ 94.75	$ 30.78
Children	49.3%	$ 34.45	$ 34.45
Total	100.0%	$ 51.13	$ 34.31

Note: The table was obtained from http://www.fns.usda.gov/ora/WICFoodCosts/FY2001/FY2001.pdf

Table 2: Characteristics by WIC participation status among singleton births

Singleton Births	*Prenatal & postnatal WIC (1)*	*Postpartum entrants (2)*	*Eligible non-WIC (3)*	*Ineligible non-WIC (4)*
Mother's characteristics				
Non-Hispanic white	0.410	0.444	0.605	0.800
Non-Hispanic black	0.218	0.178	0.080	0.055
Hispanic	0.325	0.321	0.244	0.093
Other race	0.047	0.057	0.070	0.052
Less than high school	0.461	0.382	0.229	0.065
High school graduate	0.303	0.257	0.254	0.140
Some college or vocational degree	0.214	0.305	0.339	0.360
College graduate	0.021	0.056	0.178	0.435
younger than 20	0.128	0.124	0.043	0.005
Age 20-34	0.790	0.752	0.791	0.734
Age 35 or older	0.082	0.124	0.166	0.261
Mother is a U.S. citizen	0.796	0.765	0.837	0.951
Married	0.429	0.523	0.755	0.957
Birth is mother's first	0.371	0.336	0.267	0.213
Region and urbanicity				
Northeast	0.124	0.172	0.118	0.156
Midwest	0.206	0.208	0.200	0.255
South	0.416	0.390	0.342	0.368
West	0.254	0.230	0.339	0.221
Population at least 50,000 (City)	0.652	0.747	0.715	0.728
Population of 2500-49,999 (Town)	0.158	0.128	0.130	0.126
Population less than 2500 (Rural)	0.190	0.124	0.155	0.146
Income/assets/employment				
Household income below poverty level	0.483	0.375	0.202	0.000
Household income between poverty level and 185% poverty	0.396	0.485	0.581	0.000
Household income above 185% poverty level	0.121	0.140	0.217	1.000
Other program participation since birth of child	0.777	0.595	0.306	0.012
Owns home	0.221	0.256	0.464	0.776
Mother employed during year before birth	0.657	0.709	0.666	0.793
Mother did not work anytime after birth	0.314	0.344	0.345	0.266

Table 2: Characteristics by WIC participation status among singleton births (cont'd)

Prenatal care and health				
Prenatal care paid by private insurance	0.208	0.421	0.669	0.963
Prenatal care paid by Medicaid	0.693	0.507	0.246	0.000
Prenatal care paid by neither Medicaid nor private insurance	0.099	0.072	0.085	0.037
Mother smoked at least 100 cigarettes in lifetime	0.394	0.354	0.333	0.289
Observations	2300	500	650	650

Notes: Sample excludes: non-biological mothers, observations with missing child's age at assessment, missing information on WIC participation and eligibility, missing values no more than 40 on all relevant variables, and missing weights. Mothers with multiple births were included as a single observation. The final sample only includes women who initiated early prenatal care within the first four months of pregnancy. Estimates in column (1) show characteristics of women who participated in both prenatal and postnatal periods. Estimates in column (2) show characteristics of women who entered into WIC at postpartum period. Estimates in column (3) show characteristics of women who were eligible for WIC but not on WIC. Estimates in column (4) show characteristics of women who were ineligible for WIC and not on WIC because income just above WIC threshold. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50.

Table 3: Characteristics by WIC participation status among twin births

Twin Births	*Prenatal & postnatal WIC (1)*	*Postpartum entrants (2)*	*Eligible non-WIC (3)*	*Ineligible non-WIC (4)*
Mother's characteristics				
Non-Hispanic white	0.481	0.553	0.733	0.902
Non-Hispanic black	0.249	0.108	0.077	0.000
Hispanic	0.238	0.285	0.159	0.033
Other race	0.032	0.000	0.000	0.044
Less than high school	0.361	0.382	0.117	0.035
High school graduate	0.365	0.260	0.253	0.059
Some college or vocational degree	0.239	0.253	0.381	0.341
College graduate	0.035	0.105	0.250	0.566
younger than 20	0.075	0.000	0.000	0.000
Age 20-34	0.849	0.825	0.773	0.731
Age 35 or older	0.076	0.152	0.206	0.269
Mother is a U.S. citizen	0.889	0.818	0.921	0.961
Married	0.491	0.660	0.796	0.964
Birth is mother's first	0.281	0.294	0.188	0.438
Region and urbanicity				
Northeast	0.191	0.204	0.234	0.234
Midwest	0.222	0.147	0.243	0.269
South	0.382	0.342	0.304	0.276
West	0.205	0.307	0.219	0.221
Population at least 50,000 (City)	0.638	0.814	0.718	0.757
Population of 2500-49,999 (Town)	0.116	0.000	0.099	0.107
Population less than 2500 (Rural)	0.246	0.130	0.184	0.135
Income/assets/employment				
Household income below poverty level	0.535	0.366	0.217	0.000
Household income between poverty level and 185% poverty	0.439	0.487	0.604	0.000
Household income above 185% poverty level	0.026	0.147	0.178	1.000
Other program participation since birth of child	0.814	0.448	0.225	0.009
Owns home	0.260	0.565	0.586	0.854
Mother employed during year before birth	0.655	0.753	0.655	0.847
Mother did not work anytime after birth	0.378	0.452	0.525	0.283
Prenatal care and health				
Prenatal care paid by private insurance	0.239	0.608	0.777	0.963
Prenatal care paid by Medicaid	0.701	0.354	0.135	0.000
Prenatal care paid by neither Medicaid nor private insurance	0.060	0.000	0.087	0.037
Mother smoked at least 100 cigarettes in lifetime	0.397	0.476	0.329	0.308
Observations	200	50	50	100

See notes under table 1. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50.

Table 4: Unadjusted breastfeeding outcomes by WIC participation status

Panel A: Singletons	*Prenatal & postnatal WIC (1)*	*Postpartum entrants (2)*	*Eligible non-WIC (3)*	*Ineligible non-WIC (4)*
Ever breastfed	0.597	0.642	0.761	0.781
Breastfed for at least 6 months	0.207	0.245	0.393	0.444
Breastfeeding length (months)	3.291	3.735	5.754	6.286
N	2300	500	650	650
Panel B: Twins	*Prenatal & postnatal WIC (1)*	*Postpartum entrants (2)*	*Eligible non-WIC (3)*	*Ineligible non-WIC (4)*
Ever breastfed	0.465	0.670	0.611	0.712
Breastfed for at least 6 months	0.135	0.057	0.339	0.285
Breastfeeding length (months)	2.050	2.185	4.517	3.785
N	200	50	50	100

Notes: Estimates in Panel A and B are unadjusted mean of three breastfeeding outcomes (ever breastfed, breastfed for at least 6 months, and breastfeeding length) by four WIC participation statuses (in four columns) among singletons and twins respectively. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50.

Table 5: WIC participation patterns among eligible households at prenatal and postnatal periods, and corresponding prevalence rates

Participation pattern	*Prenatal period*	*Postnatal period*	*All eligible household*	*Prenatal participants*	*Postnatal participants*
Panel A: Singleton births					
Observations			3550	2400	2800
1	Y	Y	65.45%	95.71%	83.60%
2	Y	N	2.98%	4.29%	
3	N	Y	13.03%		16.40%
4	N	N	17.53%		
Panel B: Twin births					
Observations			300	200	250
1	Y	Y	66.96%	98.11%	78.34%
2	Y	N	1.29%	1.89%	
3	N	Y	18.51%		21.66%
4	N	N	13.23%		
Panel C: LBW twin births					
Observations			200	100	150
1	Y	Y	65.32%	96.24%	77.84%
2	Y	N	2.55%	3.76%	
3	N	Y	18.60%		22.16%
4	N	N	13.53%		

Notes: Sample sizes were rounded to the nearest 50.

Table 6: WIC participation patterns among eligible households at prenatal and postnatal periods, and corresponding prevalence rates

Panel A: Singletons	
	Postpartum entrants
Ever breastfed	-0.001
	(0.032)
N	2800
Breastfed for at least 6 months	0.006
	(0.025)
N	2800
Breastfeeding length	0.075
	(0.363)
N	2800
Panel B: Twins	
	Postpartum entrants
Ever breastfed	-0.088
	(0.104)
N	250
Breastfed for at least 6 months	0.066***
	(0.022)
N	250
Breastfeeding length	0.429
	(0.923)
N	250

Notes: Results were estimated under equation (1) $H = \alpha_0 + \alpha_1 WIC_{prenatal} + \beta X + e$, where $WIC_{preantal}$=1 indicates that a woman participated in both prenatal and postnatal period. $WIC_{prenatal}$=0 indicates that a woman is a postpartum entrant. Postpartum entrants are women who only entered in WIC at postpartum period. Results in Panel A are among singleton births. Results in Panel B are among twin births. Estimates for ever breastfed and breastfed for at least 6 months are marginal effects obtained by maximum likelihood probits. Estimates for breastfeeding length were obtained by OLS. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, region of residence, urbanicity, participation in Medicaid, AFDC and the Food Stamp Program, household income, assets, household income to poverty ratio, whether owns home, whether worked year before birth and anytime after birth, whether the survey child is the mother's first birth, how the mother paid for prenatal care, and whether smoked at least 100 cigarettes in lifetime. Sample was limited to women who initiated prenatal care in the first trimester of pregnancy. Standard errors (se) were adjusted at state level. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table 7: Adjusted differences in breastfeeding outcomes when compare women who participated in both prenatal and postnatal periods to postpartum entrants, under difference-in-differences regressions

Panel A: Ever breastfed	
	Postpartum entrants
1) $\mathbf{WIC_{prenatal}}$	0
	(0.032)
2)Twin	0.02
	(0.069)
3) $\mathbf{WIC_{prenatal}}$***Twin**	-0.136
	(0.093)
N	3100
Panel B: Breastfed for at least 6 months	
	Postpartum entrants
1) $\mathbf{WIC_{prenatal}}$	0.006
	(0.025)
2)Twin	-0.156***
	(0.026)
3) $\mathbf{WIC_{prenatal}}$***Twin**	0.258*
	(0.148)
N	3100
Panel C: Breastfeeding length	
	Postpartum entrants
1) $\mathbf{WIC_{prenatal}}$	0.079
	(0.362)
2)Twin	-1.715*
	(0.915)
3) $\mathbf{WIC_{prenatal}}$***Twin**	0.742
	(0.846)
N	3100

Notes: Results were estimated under equation (3) $H = \gamma_0 + \gamma_1 WIC_{prenatal} + \gamma_2 Twin + \gamma_3 (WIC_{prenatal} * Twin) + \beta X + e$, where$WIC_{prenatal}$=1 indicates that a woman participated in both prenatal and postnatal period. $WIC_{prenatal}$=0 indicates that a woman is a postpartum entrant. Postpartum entrants are women who only entered in WIC at postpartum period. Estimates for ever breastfed, breastfed for at least 6 months, and breastfeeding length are in panel A, B, and C respectively. Estimates for ever breastfed and breastfed for at least 6 months are marginal effects obtained by maximum likelihood probits. Estimates for breastfeeding length were obtained by OLS. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, region of residence, urbanicity, participation in Medicaid, AFDC and the Food Stamp Program, household income, assets, household income to poverty ratio, whether owns home, whether worked year before birth and anytime after birth, whether the survey child is the mother's first birth, how the mother paid for prenatal care, and whether smoked at least 100 cigarettes in lifetime. Sample was limited to women who initiated prenatal care in the first trimester of pregnancy. Standard errors (se) were adjusted at state level. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table 8: Adjusted differences in breastfeeding outcomes when compare women who participated in both prenatal and postnatal periods to postpartum entrants by race/ethnicity, education and age under difference-in-differences regressions

Panel A: Ever breastfed	*Whites (1)*	*Blacks (2)*	*Hispanics (3)*	*less than high school (4)*	*Teen mothers (5)*
1) $\mathbf{WIC_{prenatal}}$	-0.035	-0.006	0.079	0.137***	-0.020
	(0.045)	(0.05)	(0.053)	(0.047)	(0.132)
2)Twin	0.154	0.198	-0.279**	0.135	0.200
	(0.101)	(0.147)	(0.134)	(0.144)	(0.205)
3) $\mathbf{WIC_{prenatal}}$*Twin	-0.267**	-0.181	0.022	-0.242*	-0.065
	(0.132)	(0.143)	(0.141)	(0.14)	(0.326)
N	1100	750	800	1300	400

Panel B: Breastfed for at least 6 months	*Whites (1)*	*Blacks (2)*	*Hispanics (3)*	*less than high school (4)*	*Teen mothers (5)*
1) $\mathbf{WIC_{prenatal}}$	0.026	0.002	0.028	0.042	-0.025
	(0.028)	(0.005)	(0.041)	(0.027)	(0.060)
2)Twin	-0.116***	0.025	-0.343***	-0.096	-0.132***
	(0.032)	(0.058)	(0.019)	(0.088)	(0.02)
3) $\mathbf{WIC_{prenatal}}$*Twin	0.142	-0.010**	0.703***	0.057	0.882***
	(0.145)	(0.005)	(0.017)	(0.174)	(0.018)
N	1100	750	800	1300	250

Panel C: Breastfeeding length	*Whites (1)*	*Blacks (2)*	*Hispanics (3)*	*less than high school (4)*	*Teen mothers (5)*
1) $\mathbf{WIC_{prenatal}}$	0.423	-0.298	0.500	0.587	-0.896
	(0.36)	(0.558)	(0.587)	(0.488)	(0.983)
2)Twin	-0.915	3.22	-3.475***	-0.545	0.135
	(0.809)	(4.671)	(1.236)	(1.984)	(2.17)
3) $\mathbf{WIC_{prenatal}}$*Twin	-0.308	-3.623	2.170**	-0.483	-0.247
	(0.903)	(4.652)	(0.968)	(1.77)	(2.238)
N	1100	750	800	1300	400

See notes under Table 7.

Table9: Adjusted differences in breastfeeding outcomes when compare postpartum entrants to two comparison groups of non-WIC women

Panel A: Singletons		
	Eligible non-WIC (1)	***Ineligible non-WIC (2)***
Ever breastfed	-0.088***	-0.065
	(0.03)	(0.069)
N	1150	1150
Breastfed for at least 6 months	-0.124***	-0.12
	(0.036)	(0.088)
N	1150	1150
Breastfeeding length	-1.573***	-1.397*
	(0.502)	(0.816)
N	1150	1150
Panel B: Twins		
	Eligible non-WIC (1)	***Ineligible non-WIC (2)***
Ever breastfed	0.232**	0.349*
	(0.108)	(0.202)
N	100	150
Breastfed for at least 6 months	-0.258***	-0.955***
	(0.094)	(0.026)
N	100	100
Breastfeeding length	-2.218**	-3.728**
	(0.9)	(1.537)
N	100	150

Notes: Results were estimated under equation (2) $H = \alpha_0 + \alpha_1 WIC_{postnatal} + \beta X + e$, , where$WIC_{postnatal}$=1 indicates that a woman is a postpartum entrant $WIC_{postnatal}$0 indicates that 1) a woman is eligible for WIC but not on WIC; 2) a woman is ineligible for WIC and not on WIC. Postpartum entrants are women who only entered in WIC at postpartum period. Estimates for ever breastfed and breastfed for at least 6 months are marginal effects obtained by maximum likelihood probits. Estimates for breastfeeding length were obtained by OLS. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, region of residence, urbanicity, participation in Medicaid, AFDC and the Food Stamp Program, household income, assets, household income to poverty ratio, whether owns home, whether worked year before birth and anytime after birth, whether the survey child is the mother's first birth, how the mother paid for prenatal care, and whether smoked at least 100 cigarettes in lifetime. Sample was limited to women who initiated prenatal care in the first trimester of pregnancy. Standard errors (se) were adjusted at state level. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table10: Adjusted differences in breastfeeding outcomes when compare postpartum entrants to two comparison groups of non-WIC women, under difference-in-differences regressions

Panel A: Ever breastfed	***Eligible non-WIC (1)***	***Ineligible non-WIC (2)***
1) $\mathbf{WIC_{postnatal}}$	-0.088***	-0.057
	(0.03)	(0.069)
2)Twin	-0.211**	-0.102
	(0.09)	(0.08)
3) $\mathbf{WIC_{postnatal}}$*Twin	0.157***	0.114*
	-0.053	(0.064)
N	1250	1300

Panel B: Breastfed for at least 6 months	***Eligible non-WIC (1)***	***Ineligible non-WIC (2)***
1) $\mathbf{WIC_{postnatal}}$	-0.125***	-0.136
	(0.036)	(0.083)
2)Twin	-0.075	-0.188***
	(0.074)	(0.051)
3) $\mathbf{WIC_{postnatal}}$*Twin	-0.203***	-0.143
	(0.06)	(0.134)
N	1250	1300

Panel C: Breastfeeding length	***Eligible non-WIC (1)***	***Ineligible non-WIC (2)***
1) $\mathbf{WIC_{postnatal}}$	-1.600***	-1.553**
	(0.496)	(0.766)
2)Twin	-1.583	-2.993***
	(1.061)	(0.741)
3) $\mathbf{WIC_{postnatal}}$*Twin	-0.013	1.198
	(1.141)	(1.474)
N	1250	1300

Notes: Results were estimated under equation (4) $H = \gamma_0 + \gamma_1 WIC_{postnatal} + \gamma_2 Twin + \gamma_3 (WIC_{postnatal} * Twin) + \beta X + e$, where$WIC_{postnatal}$=1 indicates that a woman is a postpartum entrant . $WIC_{postnatal}$=0 indicates that 1) a woman is eligible for WIC but not on WIC; 2) a woman is ineligible for WIC and not on WIC. Postpartum entrants are women who only entered in WIC at postpartum period. Estimates for ever breastfed and breastfed for at least 6 months are marginal effects obtained by maximum likelihood probits. Estimates for breastfeeding length were obtained by OLS. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, region of residence, urbanicity, participation in Medicaid, AFDC and the Food Stamp Program, household income, assets, household income to poverty ratio, whether owns home, whether worked year before birth and anytime after birth, whether the survey child is the mother's first birth, how the mother paid for prenatal care, and whether smoked at least 100 cigarettes in lifetime. Sample was limited to women who initiated prenatal care in the first trimester of pregnancy. Standard errors (se) were adjusted at state level. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

CHAPTER II: WIC AND BIRTHOUTCOMES

---EVIDENCE FROM TWO NATIONAL DATASETS

1. INTRODUCTION:

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a national program which provides supplemental food packages, nutrition education, and health care and social service referrals to low-income women, infants and children up to age 5 who are at nutritional risk. Since its initiation, WIC participation has grown dramatically, increasing from 88,000 participants in 1974 to approximately 9.3 million in 2009. Based on the federal expenditures of $6.2 billion in fiscal year 2008, WIC has become the third-largest food and nutrition assistance program in the U.S.

WIC serves a quarter of all pregnant women in the United States (Olivera Frazao, 2009). One central goal of the WIC program is to improve the nutritional status of low-income pregnant women during the dynamic stages of fetal growth. The evaluation of prenatal WIC participation has been focused on the improvement in infants' birth outcomes. Poor birth outcomes have been linked to future health problems, increased health costs, and lower educational attainment (Hack, Klein, & Taylor, 1995). How effective the WIC program is at improving infant health is under debate. A large number of studies have demonstrated that prenatal WIC participation increases birth weights (Devaney, Bilheimer, & Schore, 1992; Kowaleski-Jones & Duncan, 2002), reduce the incidence of low and very low birth weight births (Brien and Swann, 2001; Bitler & Currie, 2005a) and small-for-gestational age births (Ahluwalia et. al., 1998; Brown, Watkins, & Hiett, 1996), and prolong gestation (Stockbauer 1987; Gordon and Nelson, 1995).

However, some studies have challenged the perception that "WIC works". Besharov and Germanis (2001) reviewed the literature on WIC evaluation and pointed out that past WIC study is subject to the problem of selection bias, gestational age bias, and generalizability. Joyce, Gibson, and Colman (2005) and Joyce, Racine, and Yunzal-Butler (2008) focused on the association between WIC and fetal growth and found limited effect of prenatal WIC participation. They did find the strong positive effect of prenatal WIC participation on preterm birth, but they concluded that the association is largely artificial without clinical evidence support for such an association. Foster. Jiang & Gibson-Davis (2010) applied the method of propensity score matching and showed WIC has no statistically significant effect on either birth weight or fetal growth.

Given the fact of WIC's rapid expansion, the efficacy of WIC program remains the focus of policy evaluation among researchers. However, findings have been inconsistent. The challenge of identifying the treatment effect associated with WIC under the problem of selection bias and gestational age bias remains. There are many unobservable factors could be correlated with both WIC participation and birth outcomes. Omitted variables may lead to an upward or downward bias on the effect of WIC on birth outcomes. Gestational age bias is another source of bias will challenge researchers to identify credible WIC effect. Gestational age bias occurs when women whose pregnancies last longer simply have more time to enroll in WIC; a more likely positive birth outcome among these women is independent of any WIC effect and is due to the length of their pregnancy.

In this paper, we use two national data sets to reassess the association between prenatal WIC participation and infant health. Our data sets allow us to compare birth outcomes among four groups of women: women who enrolled in WIC in prenatal period, women who entered into WIC at postpartum period, women who were eligible for WIC but not on WIC, and women who were ineligible for WIC and not on WIC because their income above program threshold. In addition to analysis among singleton births as done mostly in past research, we propose to use twins to provide a novel test of the association between WIC and infant health. The rate of low birth weight is over 50 percent among twins in the United States. Using twins we randomly assign women a health shock that significantly increase the probability of adverse birth outcomes, but such a health shock is unlikely to be related to other risky behaviors. Thus using twins we can minimize adverse selection associated with WIC participation because of the randomness of the shock. We test the association between WIC and two groups measurement of birth outcomes: birth weight unadjusted for gestation and birth weight adjusted for gestation (or fetal growth). We focus on measures of fetal growth as outcomes amenable to nutritional supplementation. Our results suggest that the association between prenatal WIC participation and birth weight and preterm birth among singleton births is likely to be spurious and driven by the better birth outcomes among third trimester enrollees. We do not find such an association among twin births. We find some evidence in support that early enrollment in WIC in prenatal period as compared to late enrollment reduces the likelihood of small for gestational age and full term low birth weight.

2. BACKGROUND AND LITERATURE

Poor maternal nutritional status has been linked to adverse birth outcomes, however, the association is complex and is influenced by socioeconomic factors which can affect mothers' habitual and pregnancy dietary intake. This association is further complicated by the indirect link between maternal and fetal nutrition which is mediated by the mother's habitual dietary intake and the mother's health status and other health behaviors.

WIC promotes healthy birth outcomes through provision of three types of benefits to its participants. WIC's supplemental food package aims to improve mother's nutrition status and aid in fetal development. WIC also provides its participants nutrition education and health care and social service referrals to stress the importance of nutrition on good health and birth outcomes, and to promote healthy dietary habits and other maternal behaviors.

The claim that "WIC works" is based on the positive association between WIC and favorable birth outcomes. General Accounting Office (GAO) in 1992 synthesized 17 studies in the literature and determined that WIC reduced rates of low-birth-weight (LBW) by 25% and very-low-birth-weight (VLBW) by 44%. As a result, GAO estimated a cost-saving ratio of $3.5 achieved from prenatal WIC participation, which means each federal dollar yields an estimated return of $3.5 over 18 years.

Many more evaluations on prenatal WIC have been published after GAO's report. Brein and Swann (2001) use data from the 1988 National Maternal and Infant Health Survey (NMIHS) to examine the effect of prenatal WIC participation. They used instrumental variable approach and a fixed-effect model to deal with the potential endogeneity of WIC participation. The instruments they used are state level WIC program rules, availability of WIC clinics, and generosity of other welfare programs. They found racial differences in the impact of the program. Prenatal participation only increases birth weight by 13% among blacks. No effects were found among whites. However, results from Hausman test suggest that their instruments are not strong predictors of WIC participation. They then pursue a mother fixed-effect model and use women who had birth prior to the NMIHS birth to see the association between change in WIC participation status and birth outcomes. They find WIC increase birth weight by 5% among blacks, no

significant effect among whites. However, mother fixed-effect model assumes that the correlation between WIC and birth weight are constant over time within the mother; it does not eliminate bias from time-varying factors.

Another study also used fixed-effect model to study the association between WIC and birth weight. Kowaleski-Jones and Duncan (2002) use data from National Longitudinal Survey of Youth (NLSY) and compare the differences in birth weight among 71 discordant-sibling groups in terms of change in their mother's participation status. They found prenatal WIC participation increase birth weight by 185 grams. However, their sample of children were born to relative older mothers whose age between 25 to 38, and their sibling sample were very small, thus their results may be difficult to generalize.

Bitler and Currie (2005) used data from the Pregnancy Risk Assessment Monitoring System (PRAMS), to assess the WIC effect on maternal and infant health. They used data from PRAMS in 19 states over the period 1992 to 1999, and constructed a sample of 60,731 women whose deliveries were paid for by Medicaid and who also had prenatal WIC use information. To correct for adverse selection bias associated with WIC participation, they included a full set of state and year interaction terms to control for unobservable time-varying and time-invariant state level factors. They then estimated two-stage least squares (2SLS) models using state-level program characteristics as instruments. They found that WIC reduces the probability of LBW by 27%, reduces the probability of VLBW by more than half, and reduces the probability of very premature infants by 53%. However, their instruments are proven to be weak instruments.

By far the most common birth outcomes studied is birth weight or the rate of low birth weight, which is governed by duration of gestation and intrauterine growth rate, or a combination of both. The cause of preterm birth largely remains unexplained. Findings on large reduction in preterm birth and low birth weight are inconsistent with the clinical literature which fails to support such association. Nutritional supplementation is more plausibly associated with weight gain and fetal growth.

Joyce et.al (2005) took a different approach to correct selection bias and focused on the association between prenatal WIC participation and fetal growth. They had data on over 800,000 births to

women on Medicaid in New York City. To lessen heterogeneity between WIC participants and non-participants, they limited their sample to women who had no previous live births and who initiated early prenatal care to construct more homogeneous treatment and control group in terms of preference, motivation, and experience with pregnancy. They found no association between prenatal WIC participation and fetal growth among singleton birth. In their sub-sample analysis of twins, among U.S born blacks, they found prenatal participation increases birth weight adjusted for gestation by 57 grams, and reduces the probability of SGA by 4.1 percentage points. They also found association between WIC and prematurity, but they concluded such an association is likely spurious without clinical evidence.

Some researchers have argued that WIC provides more than nutritional supplementation and the lack of clinical support for the association between nutritional supplementation and preterm birth did not rule out the possibility that some other risk factors targeted by WIC might protect prematurity. In response to the debate over the association between WIC and prematurity, Joyce et al. (2008) provided further evidence to support their argument by analyzing WIC effect by timing of WIC enrollment. They used nine states data from the Pregnancy Nutritional Surveillance System (PNSS) between 1995 and 2004 and created an analysis sample of 3,311,976 women who participated in WIC either prenatally or postpartum. In attempt to minimize the selection bias associated with WIC participation, they included a large set of covariates and limited the sample to women with no previous live births and who initiated early prenatal care. In addition, based on the large sample size of PNSS they stratified the sample within different social economic groups to further reduce the heterogeneity between treatment and control group. Lastly, they used propensity score matching as a robust check. They found third trimester enrollees have higher birth weight and lower rates of LBW, VLBW, and preterm birth compared to postpartum and first trimester enrollees. These findings are counterintuitive and suggest that the association between WIC and LBW and preterm are likely spurious. In terms of fetal growth, they found WIC has very limited effects.

3. DATA

In this paper, we assess the effect of prenatal WIC participation on birth outcomes using two national data sets: Pregnancy Nutrition Surveillance System (PNSS) and the Early Childhood

Longitudinal Study-Birth Cohort (ECLS-B). Each data set contains considerable information on measures of birth outcomes, WIC participation status, mothers and infants' characteristics and demographic, and mothers' health behavior and status. In addition, each data has its unique advantage over the other.

3.1 PNSS

The Pregnancy Nutrition Surveillance System (PNSS) is "a program-based public health surveillance system that monitors risk factors associated with infant mortality and poor birth outcomes among low-income pregnant women who participate in federally funded public health programs".[6] The majority of the PNSS data are from the WIC program. The PNSS collects information from WIC participants during prenatal and postnatal clinic visits. At the prenatal WIC interview, demographic as well as maternal health and behavioral data are collected. Infant health data is added during the postpartum clinic visit. The PNSS data is overseen by the Centers for Disease Control and Prevention (CDC). The data collected in clinics will be integrated to state level and submitted to CDC on a quarterly basis. CDC will produce an annual report based on the received quarterly data. To evaluate the quality of the data submitted, CDC creates its own data quality parameters based on a variety of statistical measures. Only data meet the specific criteria to be included in the National annual report. The PNSS has its advantage in including both administrative data and survey data. The administrative data, which is more accurate than those obtained from survey data, provide detailed information on the timing of WIC enrollment. The PNSS interview data contains more detailed information on health outcomes and behavior than birth certificates, which limits the analysis from some of previous WIC evaluation studies. We have access to PNSS data from six states, which are: Florida, Indiana, Michigan, Missouri, North Caroline and Ohio. To be consistent with the individuals constructed within ECLS-B which surveyed a sample of infants who were born in 2001, we only used cases from year 2001 from PNSS. Table A1 in Appendix A shows distribution of PNSS data by six states and trimester of WIC enrollment for infants born in 2001. Distribution of missing information on key measures of birth outcomes and birth plurality are displayed in Table A2. We dropped Florida from our analysis sample due to its huge volume of missing information on

[6] http://www.cdc.gov/pedness/.

trimester of enrollment and gestational age as shown Table A1 and Table A2. The composition of our final sample by states and birth plurality are displayed in Table A3.

3.2 ***ECLS-B***

Our second data source is from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) file. ESLC-B is a longitudinal nationally representative data set that was collected by the National Center for Education Statistics (NCES), US Department of Education. The data constructed a national representative sample of 10,700 children who were born in 2001. The ECLS-B follows these children from birth through kindergarten, collecting four waves of data when the child is approximately 9 months, 2 years, 4 years old, and at kindergarten entry. I will use the ECLS-B data collected from the first two waves in this study. Of the 10,700 children that participated in the first wave, 9850 participated in the second wave. The ECLS-B oversampled twins, and low birth weight and very low birth weight children. In the first two waves of the data, the ELCS-B collected information from child, parents, birth certificates, and child care providers. The survey contains detailed information on both mother and children, including demographic characteristics, health status and behavior, other welfare program participation, income and wealth, timing of WIC enrollment, and infant health measures.

Not all children on ECLS-B are eligible to WIC. WIC serves low-income women, infants, and children up to age 5 who are at nutritional risk. To be eligible to receive WIC benefits, an applicant must meet income and nutritional risk requirement. To code WIC eligibility, we followed the same procedure in Tiehen and Jacknowitz (2008). To meet the income requirement, a household income must be at or below 185 percent of the poverty line, or the household participate in the Food Stamp Program, TANF, or Medicaid. ECLS-B does not include information on prenatal participation in the Food Stamp Program or TANF. Therefore we only used Medicaid participation information for adjunctive eligibility. All women who reported prenatal Medicaid participation are considered eligible for WIC. The income threshold for Medicaid varies by state. If the state’s income threshold for Medicaid is higher than 185 percent of the poverty line, we used the state’s threshold to determine the WIC eligibility. We calculated the household income-to-poverty ratio to determine whether a woman’s income was at or below the 185% of the poverty threshold. The midpoint of the income was used from income bracket data from ECLS-B. For the top

income threshold bracket, we used the lower limit instead of the midpoint method to code income-to-poverty ratio since the top limit was unavailable. The 2000 State Medicaid income-eligibility thresholds for pregnant women were obtained from the *Maternal and Child Health Update: States Have Expanded Eligibility and Increased Access to Health Care for Pregnant Women and Children (National Governors Association Center for Best Practices, 2001)*.

ECLS-B does not provide information to determine whether a woman meets the nutritional risk requirement. Researchers have pointed out that the definition of nutritional risks has been loosely applied (Besharov and Germanis 2001). Researchers may be able to identify women at nutritional risk based on their observable characteristics. However, risk status of these women may also be correlated with unobservable factors that could lead to downward biased estimate (Joyce et al. 2005, 2008; Kowaleski-Jones and Duncan 2002). Our proposal of using twins has overcome this major limitation in separating nutritional risk from general risks. Twin pregnancy represents a health shock that increases risks of anemia, inadequate weight gain and adverse birth outcomes, but should be orthogonal to other risky behaviors. By using twins, we can identify a group of women at nutritional risk, but minimize adverse selection since the risk is randomly assigned.

One of our comparison groups using ECLS-B is women who were not on WIC and ineligible because their incomes were just above the program threshold. To define this group of women I used income threshold between 300%-400% of income-to-poverty ratio as the cutoff. The highest states income threshold for Medicaid is income-to-poverty ratio of 300% in California. Therefore if a woman's household income above 300% poverty ratio threshold she will not be eligible for WIC.

4. EMPIRICAL MODELS

4.1 <u>Baseline model</u>

Consider the following baseline WIC evaluation model:

$$H = \alpha_0 + \alpha_1 WIC + \beta X + e \quad (1)$$

WIC in equation (1) is a dichotomous indicator for WIC enrollment status. The omitted category is the comparison group. In both PNSS and ECLS-B, $WIC = 1$ means the woman was a prenatal participant and remained in WIC in the postpartum period. PNSS only contains WIC participants, women who participated in either prenatal period or postpartum period, or both. In PNSS, $WIC = 0$ means the woman was a postpartum entrant who only participated in WIC in postpartum period. In ECLS-B, we have constructed three comparison groups. $WIC = 0$ indicates that 1) a woman is a postpartum entrant; 2) a woman who is eligible for WIC but not on WIC; 3) a woman is not on WIC because her income is just above the threshold. X is a vector of other relevant variables which may affect birth outcomes, such as mother's characteristics including age, education, race, marital status, income, other program participation, and health status and health behaviors. Let e be the error term.

4.2 ***Outcomes***

H in equation (1) are the outcome variables, that is, measures of birth outcomes. We categorize birth outcomes into two groups: birth weight unadjusted for gestation; and birth weight adjusted for gestation. Low birth weight is mainly caused by a short gestation (prematurity), intrauterine growth retardation (IUGR), or a combination of both (Michael S. Kramer, 1987). Prematurity is usually defined as a gestational age less than 37 weeks. The causes of prematurity are remained largely unknown (Institute of Medicine, 2007). IUGA is an indication of fetal growth retardation which is an outcome more likely influenced by nutrition supplementation. Therefore our focus is on the association between WIC participation and fetal growth. Our measures of birth outcomes in the first group include birth weight in grams, and three dichotomous indicators for low birth weight (<2500 grams), very low birth weight (<1500 grams), and preterm birth (<37 weeks gestation). Three measures in the second group of birth outcomes are birth weight adjusted for gestation, small for gestational age (SGA) and full term low birth weight. Small for gestational age is a dichotomous indicator of infants below the 10th percentile in weight for gestation within gender based on all singleton births to US residents in 1991 (see Alexandra et. al 1996). Full term low birth weight is another dichotomous indicator for Infants whose gestational age was no less than 37 weeks and birth weight is smaller than 2500 grams.

4.3 <u>Selection bias and gestational age bias</u>

The estimate of interest is α_1 in equation (1). The empirical challenge of estimating above equation is how to obtain an unbiased treatment effect. Two assumptions for obtaining an unbiased estimate α_1 are: First, holding all other factors constant, infant birth outcome won't affect the mother's WIC participation decision. Second, the effect of WIC participation on birth outcomes is constant across all individuals. These assumptions are too strong to be held without a randomized trial. If there are underlying unobservable factors create differences in birth outcomes between WIC participants and comparison group, then the estimated effect may incorrectly reflect the true program effect. For example, a favorable selection occurs when a prenatal WIC participant is more motivated and concerned about health and nutrition than her counterpart, the more likely better birth outcomes among these participants may be achieved even in the absence of the WIC program. In this case, the program effect will be overestimated. On the other hand, when there is an adverse selection associated with WIC participation, the estimated effect will be underestimated. For example, a woman with a history of poor reproductive health may be more likely to reach out WIC to minimize the risk of having an adverse birth outcome. Thus, downward biased estimate is likely to be derived under such case.

In addition to selection bias problem, researchers have recognized the importance of gestational age bias. The findings of large positive effect of WIC on birth outcomes have not been supported by clinical evidence. Researchers have demonstrated that gestational age bias occurs when a woman whose pregnancy last longer is more likely to have healthy infant and has more time to enroll in WIC. In another words, women who enter WIC at late trimester of pregnancy are likely to have healthy infants because the pregnancy lasted long enough for them to enroll, not because of the program itself. Evidence of gestational age bias show WIC has larger impact on birth outcomes among late WIC enrollees than of early WIC enrollees (Joyce et al., 2008). There is no effective way of controlling for gestational age bias, thus it is more plausible to focus our analysis on the association between WIC and birth outcomes adjusted for gestation.

4.4 <u>Approaches to selection bias</u>

To minimize the selection bias, one popular method is to use instrumental variable. However, we know there are not credible instruments available for prenatal WIC participation. Alternatively, we have included a rich set of control variables to mitigate the omitted variable bias. Previous research has pointed out the importance of creating a comparison group as similar as possible to the treatment group. To see how sensitive our results subject to different comparison groups, using ECLS-B we have compared prenatal WIC participants to three groups of women: postpartum entrants, eligible non-WIC participants, and ineligible non-WIC participants.

Our approach to minimize the selection bias is focused on using twins to provide a novel test of the association between WIC and birth outcomes. Women with twin pregnancy are 2.4 times more likely to have anemia and are more likely to gain more weight compared to women with singleton pregnancy (Gall 1996). The rate of low birth weight is over 50 percent among twins in the United States as compared to 6 percent for singletons. There are many factors can put the mother at risk for adverse birth outcomes. Examples include mothers' poor health status, such as having a low pre-pregnancy weight, a history of diabetes and hypertension, or a previous preterm birth; and mothers' risky health behavior such as smoking, use of other harmful substances, lack of exercise, or bad habit of dietary intake. However, few risk factors increase the probability of low birth weight to more than 50 percent. Thus using twins we randomly assign women a health shock that put women at nutritional risk and significantly increase the probability of adverse birth outcomes. Such a health shock is likely to dominate all other factors and is unrelated to other risky behaviors. Therefore, using twins we can minimize adverse selection associated with WIC participation because of the randomness of the shock.

One argument arise in this research design is that some women may enroll in WIC after diagnoses of twin pregnancies. Women with stronger preferences for health and more motivated for better birth outcomes are more likely to reach out for WIC after learning their twin pregnancy. In response to this form of favorable selection, we limit our analysis to women who initiated early prenatal care to capture a sample of women whose preferences and motivations are similar. The first prenatal care is initiated by the woman herself. Few women will be aware of their multiple gestations at early stage of pregnancy thus

visit doctor office early. We have assumed women who initiate early prenatal care are more likely to have similar attitude towards prenatal care and WIC.

4.5 Testing the dose-response effect

Gestational age bias has been a serious concern in the evaluation of WIC effect on birth outcomes. Should we find the association between prenatal WIC participation and birth outcomes is true program effect, we test a dose-response effect by taking into account the timing of WIC enrollment.

$$H = \theta_0 + \theta_1 WIC_1 + \theta_2 WIC_2 + \theta_3 WIC_3 + \beta X + e \qquad (2)$$

WIC_1 , WIC_2 and WIC_3 in equation (2) are indicators designate the trimester of pregnancy in which a woman enrolled in WIC at prenatal period. The omit category is the comparison group. If greater exposure to prenatal WIC participation provide more opportunities for women to receive nutrition supplement, education and advices thus increasing the probability of a good birth outcomes, we would expect θ_1>θ_2>θ_3>0. However, if early enrollment in WIC is not associated with a better birth outcome compare to late enrollment, the findings of a positive effect of prenatal participation on birth outcomes are likely to be spurious.

5. RESULTS

5.1 PNSS

All results from PNSS are displayed in appendix A. In Table A4, we show characteristics of women who gave singleton births in 2001 from five states by the timing of WIC enrollment. Postpartum entrants as compared to prenatal participants were less likely to be teenage mothers, unmarried, high school drop-outs, underweight or overweight pre-pregnancy and participate in other assistant program such as Medicaid, TANF and Food stamps. Differences by trimester of enrollment among prenatal WIC participants are less prominent. Characteristics of women who gave twin births in year 2001 are displayed in Table A5. The patterns in Table A5 are similar as those in Table A4. In addition, mothers of twins who enrolled in WIC postpartum are much more likely to be over 30 years old and to be white. The

characteristics of women by timing of WIC enrollment show evidence of which women were negatively self-select into the program.

The means of our seven measures of birth outcomes by the timing of WIC enrollment for singleton and twin births are displayed in Panel A and B of Table A6. Estimates in column one and five are means for birth weight in gram (BW) and weeks of gestation. Estimates in other columns are means for indicators of low birth weight (LBW), very low birth weight (VLBW), preterm birth, small-for-gestational age (SGA), and full-term low birth weight (FTLBW). Estimates in top row of both panels are means among prenatal participants. The next three rows are estimates among women who enrolled in WIC in either the first, second, or third trimester of pregnancy. The bottom row show estimates for postpartum entrants. In general, among both singleton and twin births, prenatal participants have better birth outcomes. For example, in panel A, average birth weight among prenatal participants is 3276.4, which is 64.4 gram higher than birth weight among postpartum entrants. The rate of LBW, VLBW, preterm, SGA and FTLBW are also lower among prenatal participants compared to postpartum entrants. However, women who enrolled in WIC in the third trimester of their pregnancy have better birth outcomes than women who enrolled in WIC in the previous two trimesters as well as those postpartum entrants.

In Table A7, we show adjusted differences in birth outcomes estimated under equation (1). Estimates for birth weight and birth weight adjusted for gestational age (BW|gest) were obtained by OLS. Estimates for other birth outcome indicators--LBW, VLBW, preterm, SGA, and FTLBW, are marginal effects obtained by maximum likelihood probits. The odd numbered columns show results among full sample of singleton births and twin births respectively, and the even numbered columns show results among a subsample of women who initiated early prenatal care within the first trimester of pregnancy. In the left panel, our estimates among singleton births are almost significant everywhere and consistent with previous findings (Joyce et. al. 2008). For example, our estimates show that prenatal participation is associated with 3.3 and 1.0 percentage points decreases in the rate of LBW and VLBW. The corresponding estimates in Joyce et. al. (2008) are 2.7 and 0.9 percentage points. In addition, women who participated in WIC prenatally are 2.4 percentage points less likely to have a premature birth. The effect of WIC on fetal growth is smaller and statistically less significant than the effect on birth weight. The

increase in birth weight benefited from prenatal participation reduced from 76 grams to 42 grams after adjusted for gestational age. In addition, WIC reduce the probability of SGA and FTLBW by 1.9 and 1.3 percentage points.

Results among singleton birth women who initiated early prenatal care are almost the same as those among full sample but with smaller effects. This is not surprising, because the subsample analysis is intended to reduce favorable selection bias, thus the WIC effects are expected to be smaller. The WIC effect on reducing the probability of FTLBW among singleton births is not stable within these two samples, and is not significant any more after restricting sample among women who initiated early prenatal care.

Using twins we minimize selection bias associated with WIC participation, should we still find positive WIC effect on birth outcomes. Results in Table A7 show almost no effect of WIC was found on birth outcomes among twins, except prenatal WIC participation in fact is associated with 1.7 percentage point increases in probability of preterm birth among early care initiators.

To investigate whether the positive WIC effects on birth weight among singletons in Table A7 are true effects, we estimated equation (2). Results among full sample and sub-sample of early care initiators are displayed in Table A8 and Table A9 respectively. Column (1) to (4) show estimates on birth outcomes without adjustment of gestations. In panel A, from column (1) to (4), WIC has positive effects on all birth outcomes. However, the effect of WIC among third trimester enrollees is larger than of first trimester enrollees. For example, participation in the third trimester is associated with an increase in birth weight by 99 grams which is higher than the gain in birth weight among the first two trimester enrollees. In addition, third trimester participation is associated with the largest decline in the probability of LBW, VLBW, and preterm. The better birth outcomes among third trimester enrollees is counterintuitive and indicate that findings of WIC effect may be driven by omitted variable bias, gestational age bias or other factors we are unable to capture in our model. Column (5) to (7) show estimates on fetal growth adjusted for gestation. Once we control for gestation, we observe first trimester enrollment is associated with largest positive

effect on fetal growth as compared to second and third trimester enrollment. But results on fetal growth are less significant and the effects are smaller in general.

We attempt to use twins to minimize selection bias. The results in panel B of Table A8 show that only third trimester participation has positive effect on birth weight among twin births. Results on preterm births show that enrollment in first and second trimester of pregnancy actually associated with increase in likelihood of a preterm birth, except for third trimester enrollment. Our complex finding on preterm birth is consistent with clinical literature that the effective prevention of a preterm birth is so far not viable. The estimates in column (5) to (7) indicate WIC has very limited effect on fetal growth. Only enrolling in WIC in first trimester increases BW|gest by 65 grams and reduces the probability of SGA by 4.4 percentage points, and estimates are only statistically significant at 10% level. We then restricted our sample to women who initiated early prenatal care and showed our results in Table A9. Table A9 tells the very similar story as shown in Table A8, but with smaller effects as expected. No effects were found on fetal growth among twins at all.

In summary, our results from PNSS indicate that the effect of prenatal WIC participation on birth weight and prematurity is likely to be spurious. The effect of WIC on fetal growth is also very limited, especially under stricter specification when dealing with selection bias. We also provide evidences of gestational age bias in Figure A1 and Figure A2. Figure A1 show proportion of LBW, VLBW, and preterm births by weeks of WIC enrollment. We observe that the later a woman enrolls, the lower the rate of an adverse birth outcome. Women with longer pregnancies have more time to enroll in WIC; women who would have enrolled in WIC prenatally but instead giving birth prematurely may end up in the postpartum cohort, therefore increasing the rate of adverse outcomes for postpartum cohorts. This explains why we observe third trimester enrollees have the best birth outcomes among all prenatal and postpartum participants. Women who enrolled in WIC at very late weeks of pregnancy have better birth outcome just not because of the program itself. In Figure A1, among women who enrolled in WIC after 33rd weeks, the rate of prematurity is much lower than earlier enrollees and continue to decline until reaching zero at 37th weeks which is by default. We do not have effective measures to remove gestational age bias, it is more appropriate to evaluate WIC effect on gestation adjusted outcomes. In Figure A2, with adjustment for

gestation, the rate of SGA and FTLBW are much flatter by weeks of WIC enrollment, which indicates early enrollment has little advantage over late enrollment in terms of fetal growth.

5.2 ECLS-B

In this section we discuss results estimated using our second data set ECLS-B. All results of ECLS-B are displayed in appendix B. In Table B1, we show characteristics of ECLS-B by WIC participation status among singletons. We compare prenatal participants to postpartum participants; then to women who were eligible for WIC but not on WIC, and those who were ineligible for WIC and not on WIC. Among these four groups of women, we see evidence that women are negatively self-selected into WIC. Women with lower social economic status are more likely to enroll in WIC and enroll in WIC in prenatal period. For example, prenatal participants are more likely to be black, Hispanic, high school drop-out, teen mother, smoker, unmarried, have higher poverty level and less assets, participate in other assistance program, and have prenatal care paid by Medicaid than other groups of women. Characteristics by WIC participation status among twins are similar to singletons and displayed in Table B2. WIC participants among twin births in general have lower social economics status than non-participants. However, the differences between prenatal and postpartum participants are less clear than those among singletons.

The unadjusted means of birth outcomes among singletons and twins are displayed in Table B3 and Table B4. Estimates in the top rows are means among prenatal WIC participants. Estimates in the next three rows are means among women who enrolled in WIC in the first, second, or third trimester of pregnancy; then followed by means among postpartum entrants, eligible non-WIC participants, and ineligible non-WIC participants. Estimates in Table B3 indicate that among all WIC participants, third trimester enrollees have higher birth weight, longer gestations, and lower rate of LBW, VLBW and prematurity. And ineligible non-WIC participants have better birth outcomes than third trimester enrollees, except for a slightly shorter gestation. In terms of birth outcomes adjusted for gestation, the differences of rate of SGA and FTLBW are less clear among WIC participants. However, both eligible and ineligible non-participants have lower rate of SGA and FTLBW compared to WIC participants.

Mean birth outcomes among twins by WIC participation status are displayed in Table B4. Within prenatal WIC participants, birth outcomes with or without adjustment for gestation among third trimester enrollees in general are better than women who enrolled in first and second trimester. Differences in prematurity, SGA and FTLBW among all prenatal participants and three comparison group women are less clear among twins.

In both Table B3 and B4, women who enrolled in the third trimester have longest gestations among all groups of women. As we have discussed early, gestational age bias occurs when women with longer gestations have more opportunity to enroll in WIC; the better birth outcomes associated with third trimester enrollees are not because of WIC. In Figure B1 and Figure B2, gestational age bias is shown more clearly. In terms of LBW, VLBW, and preterm births, third trimester enrollees have the lowest rate among WIC participants. After adjusted for gestation, the differences on SGA and FTLBW by timing of enrollment are modest.

In Table B5, we show differences in birth outcomes estimated under equation (1) among singleton births. We compare prenatal WIC participants to three groups of women: postpartum entrants, eligible non-participants, and ineligible non-participants. In odd numbered columns we show estimates among all singleton births; in even numbered columns we restricted our sample to women who initiated early prenatal care. Compared to previous results in PNSS, we find less association between prenatal WIC participation and birth outcomes using ECLS-B. We only find prenatal participants are less likely to have LBW, VLBW and FTLBW births when compared to postpartum entrants. We didn't find significant difference on birth outcomes between prenatal participants to non-WIC participants among singletons.

Differences in birth outcomes estimated under equation (1) among twin births are presented in Table B6. Findings among twins are very different to those among singletons. Participation in WIC in prenatal period does not help improve birth outcomes at all among twins. In fact, results suggest that prenatal participants are at greater risk of fetal growth retardation than postpartum entrants. The differences between prenatal participants and ineligible non-participants are even substantial. Compare to

ineligible non-participants, prenatal participants have worse birth outcomes in terms all measures within our restricted sample, except for prematurity.

From Table B7 to B10, we show results estimated under equation (2) by the timing of WIC enrollment in the prenatal period. Results in Table B7 were estimated among full sample of singleton births. Estimates in Panel A of Table B7 show that prenatal WIC participants are less likely to have a LBW and VLBW. However, the effect among third trimester enrollees is larger than among earlier enrollees. We should expect the opposite findings if WIC does help improve birth outcomes since the longer the enrollment the more benefits the enrollees will obtain from the program. Enrollment in the first two trimesters of pregnancy does not make a difference in the likelihood of prematurity. However, enrollment in the third trimester is associated with a lower probability of preterm. In terms of birth weight adjusted for gestation, we only found second trimester enrollees are 1.3 percentage points less likely to have a FTLBW compared to postpartum entrants. In Panel B and C, we also observe that WIC effects were more likely to be found within third trimester enrollees. In Table B8, we restrict sample to singleton birth women who initiated early prenatal care. Results tell a similar story as in Table B7.

Estimation results of equation (2) within twins are presented in Table B9. Results of twins are more complicated. In panel A and C, our main finding is that prenatal WIC participants are more likely to have SGA births, but early enrollment reduces the likelihood. We also find first trimester enrollees have lower birth weight conditional on gestation when compared to postpartum entrants and ineligible non-participants. In terms of birth weight unadjusted for gestation, the findings are very mixed and inconsistent across different comparison groups, and the inconsistency may be indicative of omitted variable bias.

In Table B10, we restricted sample to women who initiated early prenatal care. Similar to findings in Table B6, results in panel C show prenatal participants are much more disadvantaged than ineligible non-participants. The differences by trimester of enrollment do not show evidence that early enrollment is associated with improved birth outcomes. We do not find significant differences between prenatal participants to eligible non-participants, except third trimester enrollment associated with a larger birth weight. Compared to postpartum entrants, prenatal participants are associated with higher probability of

SGA birth, but enrollment in first trimester reduces probability of SGA compared to enrollment in third trimester. For example, in column (6) panel A, a third trimester enrollee is 24.3 percentage points more likely to have SGA birth, this probability reduces to 16.8 associated with first trimester enrollee.

6. DISCUSSION

A large body of studies has demonstrated the strong association between prenatal WIC participation and birth outcomes (Devaney, Bilheimer, & Schore, 1992; Kowaleski-Jones & Duncan, 2002; Brien and Swann, 2001; Bitler & Currie, 2005a). Others have argued that without clinical evidence to support such an association the results claimed by social scientists are largely artificial (Besharov and Germanis, 2001; Joyce, Gibson, and Colman, 2005; Joyce, Racine, and Yunzal-Butler, 2008). Low birth weight is mainly caused by prematurity, fetal growth retardation, or a combination of both (Michael S. Kramer, 1987). The causes of prematurity are remained largely unknown (Institute of Medicine, 2007). Fetal growth is an outcome more likely influenced by nutrition supplementation. Without effective approaches to control for gestational age bias, we focus our analysis on the association between WIC participation and measures of fetal growth.

We use twins to minimize selection bias associated with WIC participation because twin pregnancy increases the probability of adverse birth outcomes significantly but is unlikely related to other risky behaviors. Using rich information from two national datasets-PNSS and ECLS-B, we can compare birth outcomes among four groups of women: prenatal participants, postpartum entrants, eligible non-participants, and ineligible non-participants. Both datasets contain detailed information on the timing of WIC enrollment which allows us to test the WIC effect by trimester of enrollment.

We are able to replicate the positive effect of prenatal WIC participation on birth outcomes among singletons often reported in previous studies. After controlling for timing of WIC enrollment, we find the effects of WIC on increasing birth weight, reducing likelihood of LBW, VLBW and preterm birth are largest among third trimester enrollees compared to first and second trimester enrollees. This counterintuitive finding does not support for a causal effect of WIC and better birth outcomes. Results on

fetal growth using PNSS show modest effect of WIC in reducing probability of SGA and FTLBW births. We do not find evidence of WIC improve birth outcome among twins.

Results from ECLS-B are robust than those from PNSS. We find prenatal participants are less likely to have LBW, VLBW and FTLBW when compared to postpartum entrants among singletons. Again, after conditioning on the timing of WIC enrollment, we find the rate of LBW and VLBW decline for women enrolled in third trimester relative to women enrolled in early trimesters. We do not find significant WIC effect as compared to non-WIC participants among singletons. Our results from ECLS-B among twins are showing negative effect of WIC on birth outcomes. Compared to ineligible non-participants, prenatal participants are more likely to have adverse birth outcomes in all cases except for preterm births among twin women who initiated early prenatal care. However, although prenatal participants are more likely to have SGA births, early enrollment in WIC reduces the likelihood compared to late enrollment.

In summary, we do not find a causal effect of WIC on birth weight and preterm births. WIC has some effect in reducing the likelihood of fetal growth retardation, but the effect is very limit. The findings among singleton births are more significant and larger than among twins. Our findings suggest that the potential for WIC to affect birth outcomes through nutritional supplementation and counseling are very slim. WIC needs to construct a more efficient way to use resources to benefit disadvantaged women thus affect birth outcomes.

APPENDIX (Chapter II):

Appendix A: PNSS data

Table A1: Distribution of WIC enrollment, by trimester and by States for infants born in 2001 (PNSS)

	Florida	Indiana	Michigan	Missouri	North Carolina	Ohio	Total N
# of 1st trimester enrollees	4361	4344	15745	14684	17109	17561	73804
# of 2nd trimester enrollees	8087	5636	18607	10467	19015	19491	81303
# of 3rd trimester enrollees	4716	3128	10672	5477	10294	12669	46956
# of postpartum enrollees	25846	5851	10893	9285	9436	11720	73031
unknown trimester of enrollment	51875	770	132	109	59	0	52945
Total N	94885	19729	56049	40022	55913	61441	328039

Table A2: Distribution of missing information on birth plurality, birth weight, preterm and gestation, by State (PNSS)

	Florida	Indiana	Michigan	Missouri	North Carolina	Ohio	Total N
Unknown birth plurality		47	3422		5	114	3588
Unknown birth weight	184	116	9289	1108	53	2037	12787
Unknown gestation	74948	6619	6821	1668	49	4241	94346

Table A3: Composition of final sample by State (PNSS)

State	# obs	# dropped	final sample	final sample of singletons	final sample of twins
Florida (FL)	94885	94885	0	0	0
Indiana(IN)	19729	6654	13075	12889	178
Michigan(MI)	56049	10548	45501	44837	587
Missouri(MO)	40022	1851	38171	37572	590
North Carolina(NC)	55913	110	55803	54240	1516
Ohio(OH)	61441	5153	56288	55666	607
Total N	233154	24316	208838	205204	3478

Notes: Cases with unknown trimester of WIC enrollment, unknown birth plurality, unknown birth weight, and unknown gestation have been excluded from the final sample. Since Florida has huge amount of missing information on trimester of WIC enrollment and gestation, it has been excluded from the final sample.

Table A4: Characteristics by the timing of WIC enrollment among singleton births (PNSS)

	1st trimester	*2nd trimester*	*3rd trimester*	*Postpartum entrants*
Age				
Mother's age is under 20	0.268	0.259	0.230	0.163
Mother's age is between 20-29	0.593	0.592	0.614	0.640
Mother's age is 30 and above	0.138	0.149	0.156	0.197
Agegroup Unknown	0.000111	0.0000452	0.000130	0.000241
Education				
<12 years Education	0.374	0.375	0.350	0.299
12 years Education	0.445	0.434	0.437	0.445
>12 years Education	0.173	0.180	0.199	0.242
Education Unknown	0.00885	0.0111	0.0136	0.0135
Race				
White	0.676	0.545	0.538	0.568
Black	0.221	0.313	0.326	0.317
Native American	0.00831	0.00849	0.00729	0.00681
Asian	0.00709	0.0104	0.0127	0.0141
Hispanic	0.0777	0.111	0.104	0.0794
Other/unknown race	0.0103	0.0115	0.0124	0.0151
Family structure				
Married	0.348	0.312	0.328	0.409
Unknown Marital Status	0.0135	0.0158	0.0191	0.0142
Singleton Birth	1	1	1	1
Child is twin	0	0	0	0
Other program participation				
Medicaid at WIC Prenatal and/or Postpartum	0.816	0.757	0.678	0.506
Medicaid Unknown	0	0	0	0.000214
AFDC/TANF	0.144	0.148	0.142	0.133
AFDC unknown	0	0	0	0
Foodstamps	0.271	0.250	0.230	0.195
Foodstamps Unknown	0	0	0	0.00434
Standardized poverty distribution				
0-50	0.373	0.395	0.390	0.381
51-100	0.236	0.206	0.183	0.177
101-130	0.128	0.114	0.109	0.112
131-150	0.0695	0.0614	0.0634	0.0693
151-185	0.0702	0.0670	0.0748	0.0946
186-200	0.0166	0.0176	0.0210	0.0295
Over 200	0.0322	0.0337	0.0380	0.0488
Unknown or adjunctive eligibility	0.0742	0.106	0.121	0.0872

Table A4: Characteristics by the timing of WIC enrollment among singleton births (PNSS) (Cont'd)

Mother prepregnancy BMI				
Underweight Pre-pregnancy	0.114	0.123	0.125	0.112
Normal Weight Pre-pregnancy	0.349	0.378	0.405	0.369
Overweight Pre-pregnancy	0.114	0.115	0.117	0.113
Obese Pre-pregnancy	0.272	0.245	0.224	0.213
Unknown BMI Pre-pregnancy	0.150	0.139	0.130	0.193
State of residence				
Indiana	0.0676	0.0827	0.0795	0.00212
Michigan	0.199	0.217	0.217	0.256
Missouri	0.217	0.150	0.138	0.231
North Carolina	0.264	0.277	0.263	0.243
Ohio	0.252	0.273	0.302	0.268
Observations	63081	66420	38401	37302

Notes: Sample includes singleton births in 2001 from five States.

Table A5: Characteristics by the timing of WIC enrollment among twin births (PNSS)

	1st trimester	*2nd trimester*	*3rd trimester*	*Postpartum entrants*
Age				
Mother's age is under 20	0.153	0.147	0.121	0.0913
Mother's age is between 20-29	0.623	0.628	0.596	0.560
Mother's age is 30 and above	0.224	0.224	0.283	0.349
Agegroup Unknown	0	0	0	0
Education				
<12 years Education	0.303	0.279	0.248	0.224
12 years Education	0.447	0.470	0.486	0.421
>12 years Education	0.242	0.246	0.262	0.343
Education Unknown	0.00783	0.00468	0.00391	0.0114
Race				
White	0.596	0.526	0.572	0.603
Black	0.314	0.375	0.328	0.328
Native American	0.00447	0.0133	0.00391	0
Asian	0.0101	0.00857	0.0176	0.00760
Hispanic	0.0638	0.0717	0.0723	0.0444
Other/unknown race	0.0112	0.00546	0.00586	0.0165
Family structure				
Married	0.421	0.394	0.484	0.577
Unknown Marital Status	0.00895	0.0133	0.0117	0.0127
Singleton Birth	0	0	0	0
Child is twin	1	1	1	1
Other program participation				
Medicaid at WIC Prenatal and/or Postpartum	0.794	0.728	0.586	0.458
Medicaid Unknown	0	0	0	0
AFDC/TANF	0.153	0.138	0.156	0.120
AFDC unknown	0	0	0	0
Foodstamps	0.294	0.245	0.207	0.175
Foodstamps Unknown	0	0	0	0.00507
Standardized poverty distribution				
0-50	0.378	0.387	0.322	0.299
51-100	0.232	0.193	0.152	0.179
101-130	0.115	0.112	0.0938	0.0925
131-150	0.0537	0.0561	0.0859	0.0634
151-185	0.0380	0.0725	0.0918	0.0760
186-200	0.0101	0.0171	0.0352	0.0304
Over 200	0.0324	0.0530	0.0645	0.0976
Unknown or adjunctive eligibility	0.141	0.109	0.154	0.162

Table A5: Characteristics by the timing of WIC enrollment among twin births (PNSS) (cont'd)

Mother prepregnancy BMI				
Underweight Pre-pregnancy	0.0615	0.0904	0.0566	0.0545
Normal Weight Pre-pregnancy	0.286	0.326	0.342	0.304
Overweight Pre-pregnancy	0.0996	0.110	0.123	0.0900
Obese Pre-pregnancy	0.330	0.270	0.299	0.252
Unknown BMI Pre-pregnancy	0.223	0.203	0.180	0.299
State of residence				
Indiana	0.0604	0.0663	0.0762	0
Michigan	0.0951	0.161	0.207	0.241
Missouri	0.209	0.133	0.141	0.204
North Carolina	0.487	0.451	0.352	0.409
Ohio	0.149	0.190	0.225	0.146
Observations	894	1283	512	789

Notes: Sample includes twin births in 2001 from five States.

Table A6: Unadjusted birth outcomes by the timing of WIC enrollment (PNSS)

Panel A: Singletons							
	BW (grams)	***LBW***	***VLBW***	***Preterm***	***Gestation(weeks)***	***SGA***	***FTLBW***
Prenatal enrollment	3276.4	0.0720	0.00980	0.0820	39.19	0.144	0.0390
N	167902	167902	167902	167902	167902	167902	167902
1st trimester	3283.7	0.0718	0.0115	0.0946	39.07	0.133	0.0346
N	63081	63081	63081	63081	63081	63081	63081
2nd trimester	3259.5	0.0799	0.0119	0.0863	39.16	0.151	0.0431
N	66420	66420	66420	66420	66420	66420	66420
3rd trimester	3293.8	0.0587	0.00336	0.0539	39.43	0.148	0.0390
N	38401	38401	38401	38401	38401	38401	38401
Postpartum entrants	3212.0	0.103	0.0205	0.104	39.01	0.167	0.0561
N	37302	37302	37302	37302	37302	37302	37302
Panel B: Twins							
	BW (grams)	***LBW***	***VLBW***	***Preterm***	***Gestation(weeks)***	***SGA***	***FTLBW***
Prenatal enrollment	2350.0	0.583	0.0878	0.504	36.19	0.447	0.369
N	2689	2689	2689	2689	2689	2689	2689
1st trimester	2310.1	0.602	0.111	0.586	35.48	0.381	0.351
N	894	894	894	894	894	894	894
2nd trimester	2312.2	0.607	0.0951	0.513	36.19	0.478	0.395
N	1283	1283	1283	1283	1283	1283	1283
3rd trimester	2514.1	0.492	0.0293	0.336	37.43	0.486	0.338
N	512	512	512	512	512	512	512
Postpartum entrants	2344.8	0.588	0.108	0.446	36.52	0.456	0.414
N	789	789	789	789	789	789	789

Notes: Estimates in Panel A and B are unadjusted means of seven measures of infant health among singletons and twins respectively. Estimates in the top row of each panel are means among prenatal participants who are women participated in both prenatal and postnatal periods. The estimates in the next three rows are means among women who enrolled in WIC in either the first, second, or third trimester of pregnancy. The estimates in the bottom row are means among women who only enrolled in WIC postpartum.

Table A7: Adjusted differences in birth outcomes among singletons and twins when compare prenatal participants to postpartum entrants (PNSS)

	Singletons		***Twins***	
	Full sample	***Early prenatal care initiators***	***Full sample***	***Early prenatal care initiators***
	(1)	***(2)***	***(3)***	***(4)***
BW	75.891***	70.472***	33.200	17.942
N	205204	148986	3478	2743
LBW	-0.033***	-0.031***	-0.018	-0.009
N	205196	148980	3474	2741
VLBW	-0.010***	-0.011***	-0.020	-0.026
N	205196	148980	3474	2737
Preterm	-0.024***	-0.022***	0.007	0.017**
N	205204	148986	3437	2739
BW|gest	42.479*	39.349*	29.825	16.316
N	205204	148986	3478	2743
SGA	-0.019**	-0.018**	0.007	0.022
N	204735	148715	3478	2741
FTLBW	-0.013*	-0.011	-0.031	-0.032
N	187530	136367	1770	1359

Notes: Results were estimated under equation $H = \alpha_0 + \alpha_1 WIC + \beta X + e$, where WIC=1 indicates that a woman is a prenatal participant, WIC=0 indicates that a woman is a postpartum entrant. Prenatal participants include women who participated in both prenatal and postpartum period. Postpartum entrants are women who only entered in WIC at postpartum period. Estimates for birth weight (BW) and birth weight adjusted for gestational weeks (BW|gest) were obtained by OLS. Estimates for all other birth outcomes are marginal effects obtained by maximum likelihood probits. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, pre-pregnancy BMI, poverty level, participation in Medicaid, AFDC and the Food Stamp Program, and residence of States. Sample includes births in 2001 from five states. Standard errors were adjusted at state level. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table A8: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal participants to postpartum entrants (PNSS)

Panel A: Singletons							
	BW (grams)	***LBW***	***VLBW***	***Preterm***	***BW|gest***	***SGA***	***FTLBW***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	70.877**	-0.026***	-0.005**	-0.012**	56.751*	-0.024**	-0.014*
2nd trimester	65.420***	-0.022***	-0.005***	-0.017***	35.818	-0.014	-0.009
3rd trimester	99.403***	-0.039***	-0.011***	-0.035***	32.479	-0.018***	-0.012***
N	205204	205196	205196	205204	205204	204735	187530
Panel B: Twins							
	BW (grams)	***LBW***	***VLBW***	***Preterm***	***BW|gest***	***SGA***	***FTLBW***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	0.320	-0.000	-0.000	0.073***	64.617*	-0.044*	-0.030
2nd trimester	-4.244	0.005	-0.011	0.031**	1.832	0.031	-0.012
3rd trimester	158.812***	-0.092***	-0.065***	-0.144***	39.063	0.029	-0.062
N	3478	3474	3474	3437	3478	3478	1770

Notes: Results were estimated under equation $H = \theta_0 + \theta_1 WIC_1 + \theta_2 WIC_2 + \theta_3 WIC_3 + \beta X + e$, where WIC_1=1, $WIC_2 = 1, or\ WIC_3 = 1$ indicates that a woman is a prenatal participant who enrolled in WIC either in first trimester, second trimester, or third trimester. The women in comparison group are postpartum entrants. Prenatal participants include women who participated in both prenatal and postpartum period. Postpartum entrants are women who only entered in WIC at postpartum period. Estimates for birth weight (BW) and birth weight adjusted for gestational weeks (BW|gest) were obtained by OLS. Estimates for all other birth outcomes are marginal effects obtained by maximum likelihood probits. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, pre-pregnancy BMI, poverty level, participation in Medicaid, AFDC and the Food Stamp Program, and residence of States. Sample includes births in 2001 from five states. Standard errors were adjusted at state level. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table A9: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal participants to postpartum entrants, among mothers who initiated early prenatal care (PNSS)

Panel A: Singletons							
	BW (grams)	***LBW***	***VLBW***	***Preterm***	***BW|gest***	***SGA***	***FTLBW***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	66.062**	-0.025***	-0.006***	-0.009	55.430*	-0.023**	-0.012
2nd trimester	58.821***	-0.020***	-0.006***	-0.017***	28.686	-0.011	-0.007
3rd trimester	97.059***	-0.038***	-0.011***	-0.035***	30.780	-0.017**	-0.011**
N	148986	148980	148980	148986	148986	148715	136367
Panel B: Twins							
	BW (grams)	***LBW***	***VLBW***	***Preterm***	***BW|gest***	***SGA***	***FTLBW***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-12.218	0.003	-0.005	0.071***	54.680	-0.032	-0.031
2nd trimester	-11.105	0.007	-0.018	0.039***	-12.646	0.048	-0.012
3rd trimester	125.105***	-0.061	-0.064***	-0.116***	20.875	0.048	-0.063
N	2743	2741	2737	2739	2743	2741	1359

See notes under table A10.

Figure A1: Proportion of LBW, VLBW and preterm births by timing of WIC enrollment (PNSS)

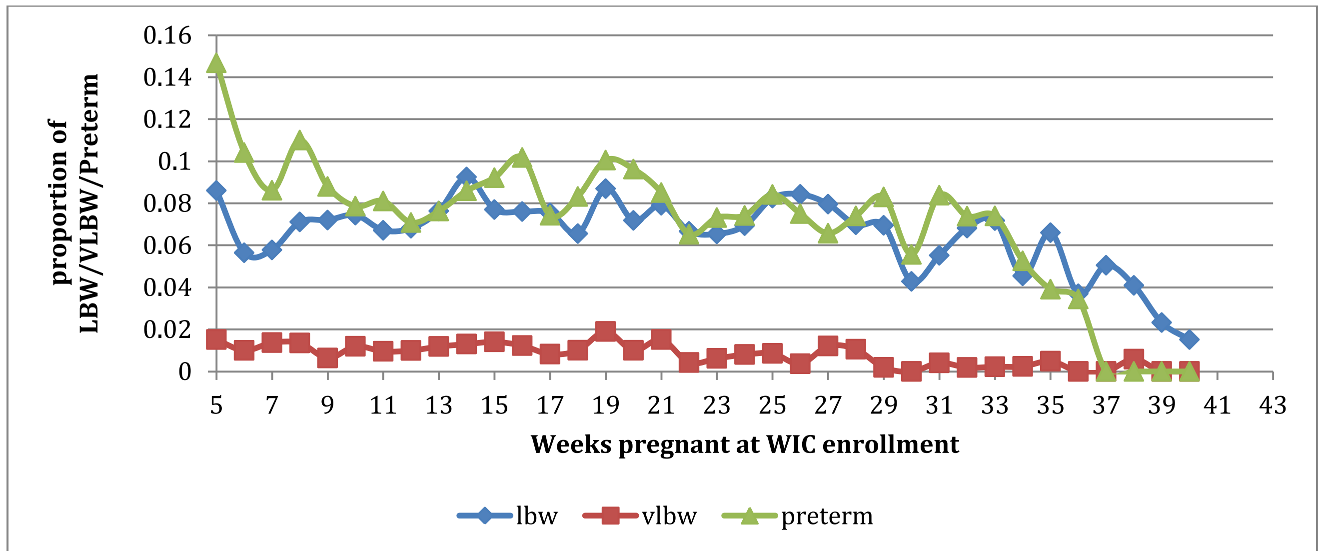
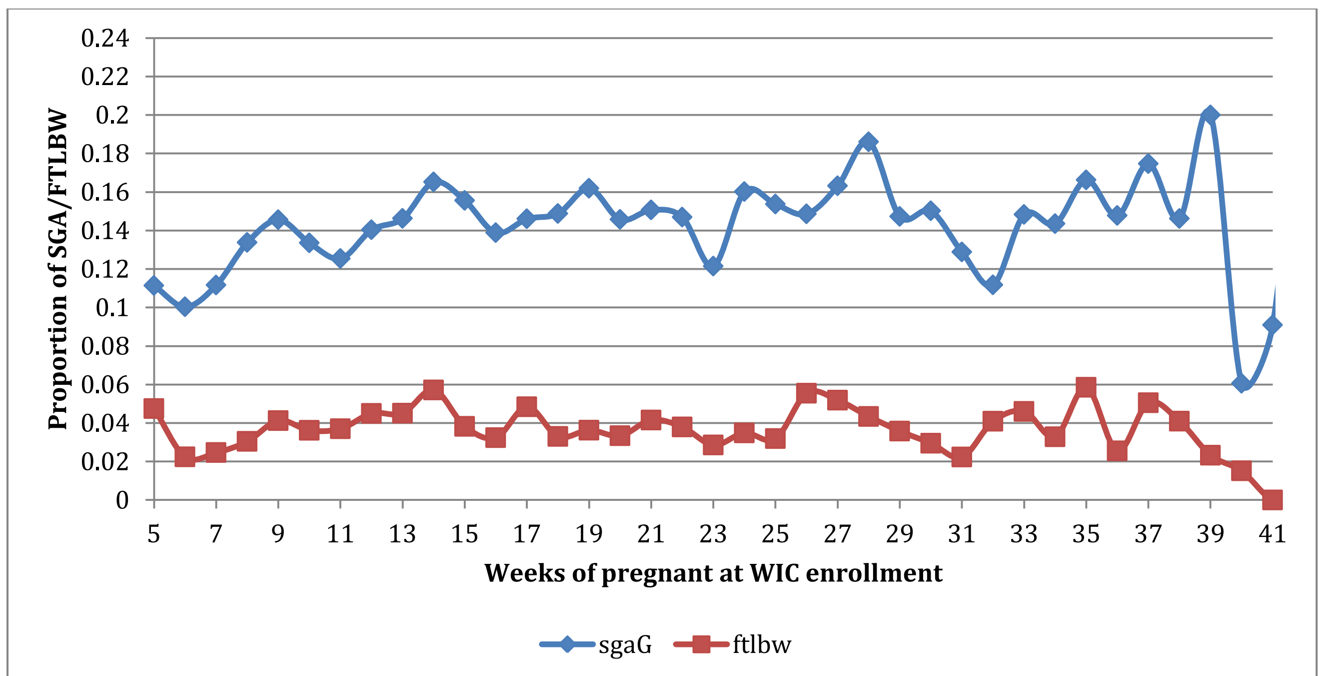


Figure A2: Proportion SGA and FTLBW by timing of WIC enrollment (PNSS)



Appendix B: ECLS-B data

Table B1: Characteristics by WIC participation status among singleton births (ECLS-B)

	Prenatal participants	*Postpartum entrants*	*Eligible non-WIC*	*Ineligible non-WIC*
Mother's characteristics				
Non-Hispanic white	0.385	0.396	0.566	0.799
Non-Hispanic black	0.228	0.222	0.0986	0.0550
Hispanic	0.338	0.321	0.271	0.0952
Other race	0.0481	0.0615	0.0653	0.0503
Less than high school	0.485	0.423	0.270	0.0645
High school graduate	0.288	0.256	0.243	0.144
Some college or vocational degree	0.206	0.278	0.326	0.364
College graduate	0.0207	0.0423	0.161	0.428
younger than 20	0.139	0.132	0.0641	0.00485
Age 20-34	0.781	0.745	0.769	0.738
Age 35 or older	0.0796	0.123	0.167	0.257
Mother is a U.S. citizen	0.788	0.768	0.825	0.949
Married	0.411	0.474	0.712	0.957
Birth is mother's first	0.366	0.350	0.263	0.211
Region and urbanicity				
Northeast	0.128	0.214	0.124	0.163
Midwest	0.200	0.188	0.199	0.255
South	0.422	0.389	0.349	0.366
West	0.249	0.210	0.328	0.217
Population at least 50,000 (City)	0.667	0.758	0.714	0.734
Population of 2500-49,999 (Town)	0.153	0.120	0.122	0.123
Population less than 2500 (Rural)	0.180	0.122	0.164	0.143
Income/assets/employment				
Household income below poverty level	0.497	0.423	0.257	0
Household income between poverty level and 185% poverty	0.385	0.446	0.540	0
Household income above 185% poverty level	0.118	0.132	0.203	1
Other program participation since birth of child	0.784	0.647	0.342	0.0119
Owns home	0.209	0.226	0.449	0.779
Mother employed during year before birth	0.640	0.707	0.657	0.795
Mother did not work anytime after birth	0.316	0.330	0.358	0.263

Table B1: Characteristics by WIC participation status among singleton births (ECLS-B) (cont'd)

Prenatal care and health				
Prenatal care paid by private insurance	0.196	0.371	0.603	0.958
Prenatal care paid by Medicaid	0.697	0.504	0.281	0
Prenatal care paid by neither Medicaid nor private insurance	0.0943	0.0810	0.103	0.0348
Mother smoked at least 100 cigarettes in lifetime	0.385	0.349	0.346	0.297
Observations	2750	650	750	650

Notes: Sample excludes: non-biological mothers, observations with missing child's age at assessment, missing information on WIC participation and eligibility, all relevant variables with no more than 40 missing values, and missing weights. Mothers with multiple births were included as a single observation. Estimates in column (1) show characteristics of prenatal participant who are women participated in both prenatal and postnatal periods. Estimates in column (2) show characteristics of women who entered into WIC at postpartum period. Estimates in column (3) show characteristics of women who were eligible for WIC but not on WIC. Estimates in column (4) show characteristics of women who were ineligible for WIC and not on WIC because income just above WIC threshold.

Table B2: Characteristics by WIC participation status among twin births (ECLS-B)

	Prenatal participants	*Postpartum entrants*	*Eligible non-WIC*	*Ineligible non-WIC*
Mother's characteristics				
Non-Hispanic white	0.433	0.477	0.672	0.883
Non-Hispanic black	0.259	0.115	0.0972	0.000
Hispanic	0.271	0.315	0.177	0.0520
Other race	0.0372	0.0923	0.000	0.0417
Less than high school	0.381	0.433	0.123	0.0331
High school graduate	0.350	0.231	0.267	0.0557
Some college or vocational degree	0.232	0.207	0.374	0.362
College graduate	0.0376	0.129	0.236	0.549
younger than 20	0.0808	0.000	0.0609	0
Age 20-34	0.840	0.817	0.762	0.707
Age 35 or older	0.0794	0.158	0.177	0.293
Mother is a U.S. citizen	0.856	0.787	0.891	0.971
Married	0.477	0.598	0.802	0.966
Birth is mother's first	0.273	0.301	0.225	0.422
Region and urbanicity				
Northeast	0.206	0.210	0.222	0.238
Midwest	0.209	0.146	0.209	0.256
South	0.374	0.352	0.325	0.282
West	0.211	0.292	0.244	0.224
Population at least 50,000 (City)	0.661	0.812	0.757	0.764
Population of 2500-49,999 (Town)	0.118	0.000	0.0850	0.102
Population less than 2500 (Rural)	0.221	0.139	0.158	0.134
Income/assets/employment				
Household income below poverty level	0.542	0.437	0.228	0
Household income between poverty level and 185% poverty	0.430	0.436	0.598	0
Household income above 185% poverty level	0.0275	0.127	0.174	1
Other program participation since birth of child	0.806	0.497	0.194	0.000
Owns home	0.233	0.488	0.505	0.852
Mother employed during year before birth	0.633	0.765	0.671	0.850
Mother did not work anytime after birth	0.365	0.453	0.482	0.244
Prenatal care and health				
Prenatal care paid by private insurance	0.224	0.523	0.736	0.977
Prenatal care paid by Medicaid	0.660	0.377	0.139	0
Prenatal care paid by neither Medicaid nor private insurance	0.0896	0.000	0.124	0.000
Mother smoked at least 100 cigarettes in lifetime	0.395	0.437	0.304	0.300
Observations	250	50	50	100

See notes under table B1. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Sample sizes were rounded to the nearest 50.

Table B3: Unadjusted birth outcomes by WIC participation status among singleton births (ECLS-B)

	BW (grams) (1)	*LBW (2)*	*VLBW (3)*	*Preterm (4)*	*Gestation(weeks) (5)*	*SGA (6)*	*FTLBW (7)*
Prenatal participants	3278.6	0.0933	0.0106	0.120	38.83	0.114	0.0331
N	2750	2750	2750	2750	2750	2750	2750
1st trimester	3270.8	0.102	0.0126	0.118	38.78	0.112	0.0353
N	1650	1650	1650	1650	1650	1650	1650
2nd trimester	3263.7	0.0847	0.00895	0.140	38.81	0.117	0.0295
N	850	850	850	850	850	850	850
3rd trimester	3381.8	0.0572	0.00372	0.0626	39.20	0.117	0.0315
N	250	250	250	250	250	250	250
Postpartum entrants	3303.7	0.121	0.0184	0.112	38.71	0.116	0.0393
N	650	650	650	650	650	650	650
Eligible non-WIC	3351.3	0.0852	0.0109	0.0894	38.90	0.0879	0.0238
N	750	750	750	750	750	750	750
Ineligible non-WIC	3447.5	0.0450	0.00494	0.0851	38.86	0.0578	0.0185
N	650	650	650	650	650	650	650

Notes: Estimates in column (1) to (7) are unadjusted mean of seven measures of infant health by WIC participation statuses among singleton births. Estimates in the top row of each panel are means among prenatal WIC participants. The estimates in the next three rows are means among women who enrolled in WIC in either the first, second, or third trimester of pregnancy. The estimates in the next row are means among women who entered into WIC at postpartum period. The estimates in the second last row are means among women who were not on WIC but eligible. The estimates in the last row are means among women who were not on WIC and ineligible.

Table B4: Unadjusted birth outcomes by WIC participation status among twin births (ECLS-B)

	BW (grams) (1)	*LBW (2)*	*VLBW (3)*	*Preterm (4)*	*Gestation(weeks) (5)*	*SGA (6)*	*FTLBW (7)*
Prenatal participants	2384.2	0.517	0.0766	0.593	35.49	0.366	0.355
N	250	250	250	250	250	250	250
1st trimester	2372.9	0.524	0.0785	0.553	35.87	0.376	0.338
N	150	150	150	150	150	150	150
2nd trimester	2309.8	0.550	0.0933	0.671	34.54	0.359	0.416
N	100	100	100	100	100	100	100
3rd trimester	2650.5	0.395	0.0198	0.533	36.73	0.344	0.298
N	50	50	50	50	50	50	50
Postpartum entrants	2340.1	0.505	0.104	0.620	34.93	0.274	0.305
N	50	50	50	50	50	50	50
Eligible non-WIC	2324.3	0.541	0.119	0.527	35.35	0.448	0.210
N	50	50	50	50	50	50	50
Ineligible non-WIC	2488.5	0.484	0.0666	0.567	36.12	0.293	0.302
N	100	100	100	100	100	100	100

Notes: Estimates in column (1) to (7) are unadjusted mean of seven measures of infant health by WIC participation statuses among twin births.

Table B5: Differences in birth outcomes when compare prenatal WIC participants to three groups of women among singleton births (ECLS-B)

	Panel A: Postpartum entrants		*Panel B: Eligible non-WIC*		*Panel C: Ineligible non-WIC*	
	Full sample (1)	*Early prenatal care initiators (2)*	*Full sample (3)*	*Early prenatal care initiators (4)*	*Full sample (5)*	*Early prenatal care initiators (6)*
BW	-15.316	-29.692	-13.831	-47.376	-28.575	-56.096
	(29.405)	(30.131)	(32.319)	(36.502)	(54.333)	(60.333)
N	3350	2800	3500	2950	3400	2950
LBW	-0.014*	-0.018*	-0.001	0.001	0.013	0.020
	(0.008)	(0.010)	(0.010)	(0.011)	(0.018)	(0.018)
N	3350	2800	3500	2950	3400	2950
VLBW	-0.007***	-0.005***	-0.002	-0.001	0.003	0.004
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
N	3350	2800	3500	2950	3400	2950
Preterm	0.005	0.005	0.015	0.014	-0.041	-0.011
	(0.014)	(0.020)	(0.015)	(0.019)	(0.027)	(0.025)
N	3350	2800	3500	2950	3400	2950
BW|gest	-26.194	-27.227	-6.129	-30.514	-39.882	-51.012
	(29.381)	(34.211)	(28.597)	(33.132)	(57.857)	(64.920)
N	3350	2800	3500	2950	3400	2950
SGA	-0.003	-0.012	0.008	0.016	0.023	0.030
	(0.015)	(0.015)	(0.016)	(0.016)	(0.026)	(0.025)
N	3350	2800	3450	2900	3350	2900
FTLBW	-0.011**	-0.013*	0.001	0.002	-0.005	-0.006
	(0.005)	(0.007)	(0.006)	(0.007)	(0.013)	(0.012)
N	2600	2150	2750	2300	2700	2350

Notes: Estimates in odd numbered columns are among all singleton births and in even numbered columns are among singleton mothers who initiated prenatal care with the first four months. Results were estimated under equation $H = \alpha_0 + \alpha_1 WIC + \beta X + e$, where$WIC$=1 indicates that a woman is a prenatal participant. WIC=0 indicates that 1) a woman is a postpartum entrant; 2) a woman is eligible for WIC but not on WIC; 3) a woman is ineligible for WIC and not on WIC. Estimates for birth weight (BW) and birth weight adjusted for gestational weeks (BW|gest) were obtained by OLS. Estimates for all other birth outcomes are marginal effects obtained by maximum likelihood probits. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, region of residence, urbanicity, participation in Medicaid, AFDC and the Food Stamp Program, household income, assets, household income to poverty ratio, whether owns home, whether worked year before birth and anytime after birth, whether the survey child is the mother's first birth, how the mother paid for prenatal care, and whether smoked at least 100 cigarettes in lifetime. Standard errors (se) were adjusted at state level. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table B6: Differences in birth outcomes when compare prenatal WIC participants to three groups of women among twin births (ECLS-B)

	Panel A: Postpartum entrants		*Panel B: Eligible non-WIC*		*Panel C: Ineligible non-WIC*	
	Full sample (1)	*Early prenatal care initiators (2)*	*Full sample (3)*	*Early prenatal care initiators (4)*	*Full sample (5)*	*Early prenatal care initiators (6)*
BW	64.345	0.959	88.370	63.945	-439.273	-692.605**
	(88.883)	(76.837)	(155.682)	(168.440)	(302.451)	(282.934)
N	300	250	300	250	350	300
LBW	0.025	0.001	-0.122	-0.099	0.316	0.966***
	(0.068)	(0.077)	(0.108)	(0.112)	(0.246)	(0.005)
N	300	250	300	250	350	300
VLBW	-0.044	-0.010	-0.030	-0.033	0.047	0.072*
	(0.046)	(0.041)	(0.046)	(0.061)	(0.051)	(0.038)
N	300	250	300	250	350	300
Preterm	-0.093	-0.089	0.092	0.120	-0.013	0.145
	(0.061)	(0.072)	(0.117)	(0.124)	(0.285)	(0.309)
N	300	250	300	250	350	300
BW|gest	-74.178	-80.709	39.190	30.288	-295.413*	-409.378***
	(47.544)	(56.802)	(116.728)	(118.726)	(155.902)	(139.433)
N	300	250	300	250	350	300
SGA	0.130**	0.147**	-0.060	-0.045	0.280**	0.333***
	(0.062)	(0.065)	(0.101)	(0.108)	(0.133)	(0.123)
N	300	250	300	250	350	300
FTLBW	0.098	0.089	-0.093	-0.015	0.046	0.845***
	(0.087)	(0.074)	(0.165)	(0.106)	(0.281)	(0.027)
N	100	100	100	100	150	100

Notes: Estimates in odd numbered columns are among all twin births and in even numbered columns are among twin mothers who initiated prenatal care with the first four months.

Table B7: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all singleton births (ECLS-B)

Panel A: Postpartum entrants as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-26.831	-0.007	-0.003***	0.004	-31.854	-0.006	-0.008
	(30.812)	(0.008)	(0.001)	(0.018)	(31.117)	(0.015)	(0.005)
2nd trimester	-23.305	-0.019***	-0.006***	0.021	-33.517	-0.002	-0.013**
	(33.526)	(0.006)	(0.001)	(0.017)	(33.196)	(0.019)	(0.005)
3rd trimester	78.281	-0.026**	-0.009***	-0.052***	32.137	0.004	-0.009
	(51.068)	(0.012)	(0.001)	(0.019)	(45.813)	(0.027)	(0.008)
N	3350	3350	3350	3350	3350	3350	2600

Panel B: Women who were eligible for WIC but not on WIC as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-24.966	0.005	0.000	0.014	-11.786	0.004	0.003
	(32.426)	(0.010)	(0.002)	(0.017)	(27.212)	(0.016)	(0.007)
2nd trimester	-23.816	-0.008	-0.003**	0.033	-15.581	0.011	-0.002
	(40.821)	(0.012)	(0.002)	(0.025)	(36.766)	(0.022)	(0.007)
3rd trimester	79.435*	-0.016	-0.007***	-0.042**	54.482	0.017	0.002
	(44.442)	(0.013)	(0.001)	(0.019)	(45.992)	(0.028)	(0.009)
N	3500	3500	3500	3500	3500	3450	2750

Panel C: Women who were ineligible and not on WIC as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-42.044	0.020	0.005	-0.037	-47.094	0.021	-0.003
	(50.313)	(0.021)	(0.004)	(0.025)	(52.719)	(0.029)	(0.012)
2nd trimester	-42.014	0.008	0.002	-0.019	-51.387	0.028	-0.008
	(58.799)	(0.022)	(0.004)	(0.023)	(63.413)	(0.034)	(0.011)
3rd trimester	62.658	-0.000	-0.004	-0.073***	20.163	0.036	-0.005
	(72.606)	(0.020)	(0.002)	(0.018)	(76.578)	(0.042)	(0.011)
N	3400	3400	3400	3400	3400	3350	2700

Notes: Results were estimated under equation $\boldsymbol{H = \theta_0 + \theta_1 WIC_1 + \theta_2 WIC_2 + \theta_3 WIC_3 + \beta X + e}$, where $\boldsymbol{WIC_1}$=1, $\boldsymbol{WIC_2 = 1, or\ WIC_3 = 1}$ indicates that a woman is a prenatal participant who enrolled in WIC either in first trimester, second trimester, or third trimester. $\boldsymbol{WIC_1}$=0, $\boldsymbol{WIC_2 = 0, or\ WIC_3 = 0}$ indicates that 1) a woman is a postpartum entrant; 2) a woman is eligible for WIC but not on WIC; 3) a woman is ineligible for WIC and not on WIC. Estimates for birth weight (BW) and birth weight adjusted for gestational weeks (BW|gest) were obtained by OLS. Estimates for all other birth outcomes are marginal effects obtained by maximum likelihood probits. All estimates were adjusted for mother's race/ethnicity, education, age, marital status, region of residence, urbanicity, participation in Medicaid, AFDC and the Food Stamp Program, household income, assets, household income to poverty ratio, whether owns home, whether worked year before birth and anytime after birth, whether the survey child is the mother's first birth, how the mother paid for prenatal care, and whether smoked at least 100 cigarettes in lifetime. Standard errors (se) were adjusted at state level. All estimates were weighted using ECLS-B wave two weighting variable W2R0. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table B8: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all singleton mothers who initiated early prenatal care (ECLS-B)

Panel A: Postpartum entrants as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-44.941	-0.011	-0.003*	0.003	-39.249	-0.009	-0.009
	(30.810)	(0.009)	(0.002)	(0.023)	(35.040)	(0.014)	(0.006)
2nd trimester	-25.626	-0.020***	-0.005***	0.024	-21.955	-0.018	-0.011*
	(36.182)	(0.008)	(0.002)	(0.023)	(39.385)	(0.016)	(0.006)
3rd trimester	60.623	-0.034***	-0.009***	-0.053***	35.823	-0.008	-0.019***
	(59.237)	(0.013)	(0.001)	(0.021)	(56.737)	(0.030)	(0.006)
N	2800	2800	2800	2800	2800	2800	2200

Panel B: Women who were eligible for WIC but not on WIC as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-62.956	0.006	0.000	0.012	-43.177	0.019	0.004
	(37.949)	(0.012)	(0.002)	(0.019)	(31.939)	(0.018)	(0.008)
2nd trimester	-45.785	-0.003	-0.002	0.034	-27.630	0.012	0.002
	(41.583)	(0.012)	(0.002)	(0.029)	(40.805)	(0.022)	(0.009)
3rd trimester	45.467	-0.021	-0.007***	-0.045**	38.906	0.021	-0.008
	(57.124)	(0.014)	(0.002)	(0.020)	(56.786)	(0.033)	(0.008)
N	2950	2950	2950	2950	2950	2900	2300

Panel C: Women who were ineligible and not on WIC as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-75.479	0.028	0.006	-0.010	-65.976	0.035	-0.003
	(57.579)	(0.023)	(0.004)	(0.027)	(59.669)	(0.031)	(0.011)
2nd trimester	-59.413	0.021	0.004	0.009	-52.298	0.029	-0.005
	(61.191)	(0.024)	(0.005)	(0.025)	(68.807)	(0.034)	(0.010)
3rd trimester	30.827	0.001	-0.003	-0.057***	12.730	0.042	-0.013
	(85.623)	(0.025)	(0.003)	(0.022)	(90.200)	(0.044)	(0.008)
N	2950	2950	2950	2950	2950	2900	2350

See notes under table B7.

Table B9: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all twin births (ECLS-B)

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
Panel A: Postpartum entrants as the comparison group							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	78.849	-0.012	-0.035	-0.132**	-88.999**	0.125	0.057
	(82.046)	(0.075)	(0.032)	(0.066)	(42.137)	(0.092)	(0.113)
2nd trimester	-53.902	0.113	-0.020	-0.009	-67.991	0.146*	0.187
	(113.540)	(0.091)	(0.030)	(0.093)	(77.548)	(0.077)	(0.162)
3rd trimester	264.166*	-0.031	-0.061***	-0.145	-30.110	0.199**	0.255
	(137.428)	(0.119)	(0.018)	(0.131)	(99.480)	(0.090)	(0.205)
N	300	300	300	300	300	300	100
Panel B: Women who were eligible for WIC but not on WIC as the comparison group							
	BW	**LBW**	**VLBW**	**Preterm**	**BW|gest**	**SGA**	**FTLBW**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	105.102	-0.169	-0.027	0.038	15.732	-0.078	-0.153
	(148.042)	(0.111)	(0.037)	(0.111)	(113.425)	(0.116)	(0.144)
2nd trimester	-25.804	-0.037	-0.012	0.177	42.045	-0.049	-0.017
	(154.902)	(0.122)	(0.034)	(0.124)	(118.995)	(0.096)	(0.163)
3rd trimester	317.844	-0.209	-0.059***	0.038	107.731	-0.019	-0.044
	(193.183)	(0.140)	(0.023)	(0.155)	(167.326)	(0.121)	(0.176)
N	300	300	300	300	300	300	100
Panel C: Women who were ineligible and not on WIC as the comparison group							
	BW	**LBW**	**VLBW**	**Preterm**	**BW|gest**	**SGA**	**FTLBW**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-409.080	0.284	0.054	-0.073	-319.391**	0.322	0.007
	(284.971)	(0.256)	(0.080)	(0.270)	(154.413)	(0.200)	(0.294)
2nd trimester	-517.476*	0.371*	0.066	0.067	-277.073	0.328**	0.090
	(299.169)	(0.221)	(0.098)	(0.279)	(165.993)	(0.165)	(0.333)
3rd trimester	-185.906	0.241	-0.029	-0.051	-223.709	0.376**	0.144
	(320.942)	(0.249)	(0.059)	(0.290)	(188.322)	(0.189)	(0.382)
N	350	350	350	350	350	350	150

See notes under table B7.

Table B10: Differences in birth outcomes by trimester of WIC enrollment when compare prenatal WIC participants to three groups of women, among all twin mothers who initiated early prenatal care (ECLS-B)

Panel A: Postpartum entrants as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-9.284	-0.028	-0.004	-0.107	-116.515**	0.168*	0.082
	(75.490)	(0.094)	(0.040)	(0.081)	(52.406)	(0.092)	(0.102)
2nd trimester	-101.466	0.093	0.003	-0.015	-58.376	0.129	0.222
	(86.965)	(0.092)	(0.042)	(0.111)	(87.437)	(0.107)	(0.158)
3rd trimester	270.184*	-0.100	--	-0.205*	17.282	0.243**	0.025
	(140.777)	(0.133)	--	(0.110)	(123.261)	(0.101)	(0.174)
N	250	250	200	250	250	250	100

Panel B: Women who were eligible for WIC but not on WIC as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	30.154	-0.120	-0.024	0.097	-24.323	-0.041	-0.039
	(160.219)	(0.105)	(0.053)	(0.121)	(110.269)	(0.116)	(0.103)
2nd trimester	-40.592	-0.002	-0.017	0.206	64.756	-0.072	0.033
	(174.508)	(0.131)	(0.050)	(0.128)	(131.055)	(0.114)	(0.127)
3rd trimester	356.744*	-0.217	--	0.014	143.007	0.004	-0.019
	(210.136)	(0.161)	--	(0.155)	(182.662)	(0.126)	(0.129)
N	250	250	250	250	250	250	100

Panel C: Women who were ineligible and not on WIC as the comparison group

	BW	LBW	VLBW	Preterm	BW|gest	SGA	FTLBW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st trimester	-695.664**	0.994***	0.124	0.089	-468.136***	0.432**	0.996***
	(263.264)	(0.002)	(0.091)	(0.291)	(115.947)	(0.199)	(0.003)
2nd trimester	-764.420**	0.954***	0.139	0.209	-376.627**	0.386**	0.981***
	(284.625)	(0.011)	(0.124)	(0.262)	(141.314)	(0.171)	(0.007)
3rd trimester	-388.090	0.670***	--	0.018	-314.460*	0.498***	0.914***
	(297.403)	(0.028)	--	(0.309)	(182.528)	(0.171)	(0.018)
N	300	300	250	300	300	300	100

See notes under table B7.

Figure B 1: Proportion of LBW, VLBW, preterm births, SGA, and FTLBW by timing of WIC enrollment among singleton births

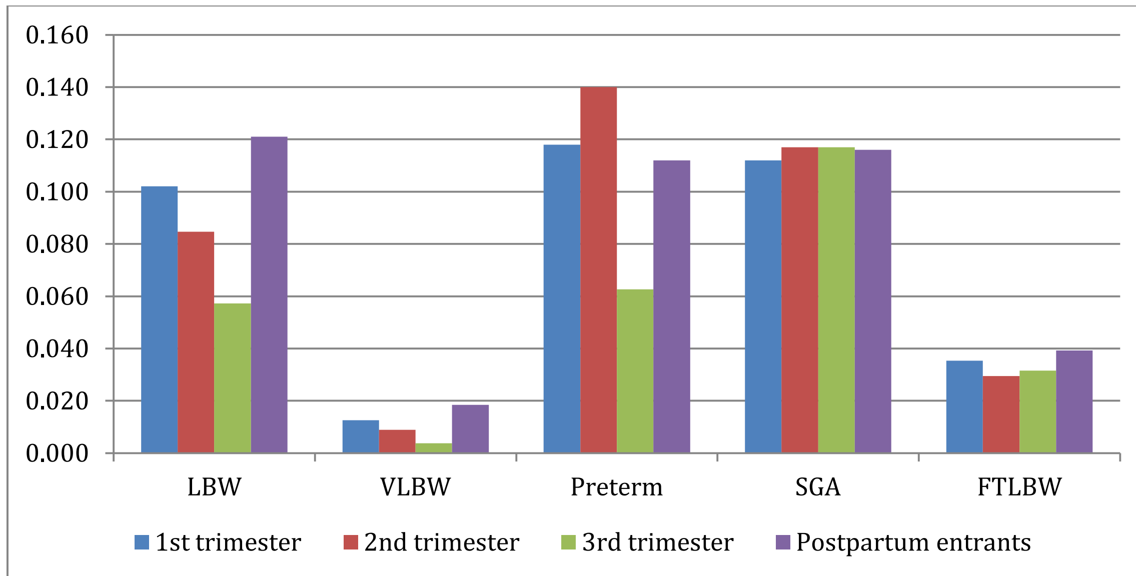
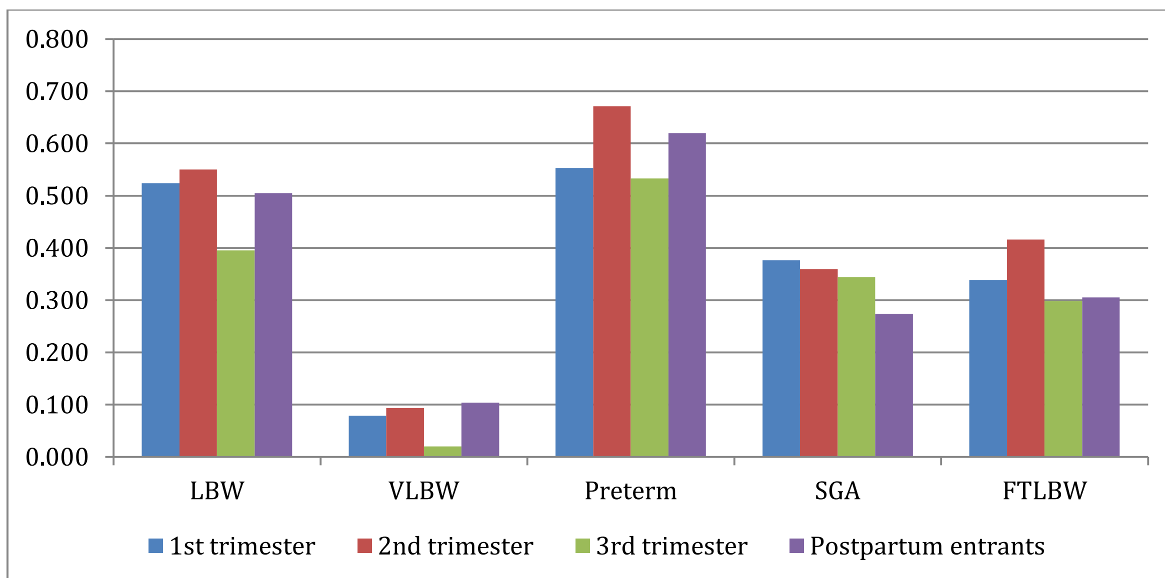


Figure B 2: Proportion of LBW, VLBW, preterm births, SGA, and FTLBW by timing of WIC enrollment among twin births



CHAPTER III: THE EFFECT OF RETIREMENT ON ALCOHOL CONSUMPTION

1. INTRODUCTION

Despite garnering much recent attention as a protective factor against ischaemic heart disease (Stampfer et al. 1988, Rodgers et al. 1993, Palomaki& Kaste 1993, Ralph et al. 1999), alcohol use has been found to be related to more than 60 different medical conditions, including neuropsychiatric disorders, certain cardiovascular problems, gestational diseases, and cancers, particularly liver, mouth and oropharynx, and esophageal cancers (Rehm et al. 2003). Drinking also raises the risk of both intentional and unintentional accidents. Twenty percent of motor vehicle accidents, 10% of drownings, 7% of falls, 18% of poisonings, 11% of self-inflicted injuries, and 24% homicides have been ascribed to drinking. Overall, alcohol accounts for as much of the global burden of disease as tobacco and hypertension (Room, Babor & Rehm 2005).

Age-related changes—among them declines in body fluid, increased sensitivity and decreased tolerance to alcohol, and compromised metabolism of alcohol in the gastrointestinal tract—make older individuals more vulnerable to the adverse effects of alcohol consumption (Smith, 1995; Vestal et al., 1977; Room R et al., 2005), and attendant effects have been documented. For example, research (Adams et al. 1990) has shown that 14% of people aged 65 and older who had hospital emergency visits had a history of problem drinking, and among those referred for in-home psychiatric assessment, 10% had severe alcohol-related problems (Malcolm 1984). A study using 1989 hospital claims data from the Health Care Financing Administration (HCFA) finds that the hospital-associated charges to Medicare for all admissions where the primary diagnosis was alcohol-related (N=33039) totaled $233,543,500. Median charge per hospital stay was $4514 (Adams et al. 1993). About one-third of older adults with drinking problem are late onset abusers (Liberto & Oslin 1995).

Theoretical research in social gerontology suggests that retirement is a life transition whose significance may provoke lifestyle and health behavioral alterations, including changes in alcohol consumption (Ekerdt 1989). As such, retirement has been investigated in relation to changes in alcohol use and onset of alcohol abuse. However, evidence on the effects of retirement on alcohol use is inconclusive. Several studies have suggested that retirement leads to increased drinking or problem drinking, while others have found declines or no retirement-related change. Research in this area is

nevertheless limited; a somewhat small assemblage of studies that differ substantially across samples and in measurement comprises the corpus of research.

The contradictory findings align, moreover, with conceptual justification for both positive and negative changes in alcohol consumption. Support for increased drinking after retirement derives from two somewhat disparate themes: loss and leisure (Ekerdt, De Labry et al. 1989). The first idea posits that retirement produces stress (Rosow 1974) that is occasioned by loss of status, professional position, workplace identity and role, and employment-based social support. Increased use of alcohol in retirement is therefore used as a means of coping with, or buffering against, the stress. The second idea suggests that retirement introduces unstructured leisure time and wider social liberties—with fewer consequences—which may encourage greater alcohol use. On the other hand, conceptual arguments for decreased alcohol use following retirement primarily relate to the severance of social ties with colleagues who encourage drinking, and to relief from work-related stress (Ekerdt, De Labry et al. 1989). Skeptics of the retirement-health association suggest that withdrawal from the labor force simply represents continuation of pre-retirement trajectories of behavior (Kasl & Jones, 2000), which supports studies that have found a null association.

2. LITERATURE REVIEW

Ekerdt and colleagues performed the seminal research in this area, assessing drinking behavior over a two-year period among 416 community-dwelling men as part of the 1989 Veterans Administration (V.A.) Normative Aging Study in Boston (Ekerdt, De Labry et al. 1989). This study compared regularity of alcohol consumption and markers of problem drinking at two time points, across retirement status, among retirees and study participants who remained employed. Its findings suggested that higher likelihood of periodic heavy episodic drinking and problem drinking at follow-up among retirees than individuals who continued to work.

Two subsequent studies of problem drinking (Neve, Lemmens et al. 2000; Bacharach, Bamberger et al. 2007), set in the Netherlands and the U.S., drew starkly different conclusions from the earlier V.A. study. The Dutch research, a 9-year cohort study of residents of the Limburg province (Neve, Lemmens et al. 2000), found a decrease in alcohol-related problems associated with retirement, as did an

analysis of male, blue-collar workers in the U.S. (Bacharach, Bamberger et al. 2007). The latter study also reported that the net decline in the severity of drinking problems among problem drinkers was partially mediated by changes in the breadth of social support.

Equivocal findings were also implied *within* an investigation of retirees sampled from Kaiser-Permanente, a California-based health maintenance organization (Midanik, Soghikian et al. 1995). This study, which explored an array of alcohol measures, found that whereas retirement was generally unrelated to changes in alcohol consumption and abuse indicators, it was associated with a nearly three-fold increase in alcohol problems among women, but not men. Quite in contrast, an investigation based on four waves of Health and Retirement Survey data (Perreira and Sloan 2002) found a considerably robust effect of retirement on alcohol use, but only among men. Retirement elevated the risk of increased drinking by 60% and lowered the risk of reduced drinking by 30% among men with a history of problem drinking, changes which persisted up to 4 years after the labor force exit. Similar results were suggested by a Dutch study (Henkens, van Solinge et al. 2008), which reported that retirement lowered by 53% the risk of reducing alcohol consumption.

Ambiguity in the salience, direction, and magnitude of the relationship between retirement and alcohol use is, at least partially, explained by design and measurement variation across studies. Whereas some of the studies are based on fairly small, selected, regional samples, others use national data. Moreover, while virtually all of the studies employ two-period panel designs, study frames differ considerably, so that any behavioral changes associated with retirement may not yet accrue (in short panels) or may dissipate (in long panels), reducing the comparability of the findings. Outcomes also vary, from self reports of daily use (e.g., *How many alcoholic drinks do you consume per day, on days when you drink?*) and problem drinking to simple measures of change (e.g., *Has your alcohol use increased, decreased, or stayed the same since we last interviewed you?*) In addition, the U.S. and Netherlands, the setting for the research, have different social norms around alcohol, labor market structure and retirement policies. The assumption that retirement would lead to analogous effects is likely naïve.

A more general limitation of the extant research is that it has not accounted for selection. Alcohol-related problems may adversely affect productivity and raise the risk of chronic diseases and accidental injuries, which may force individuals to retire early. Economists have addressed this type of endogeneity

in retirement studies that were focused on other outcomes (cite Dave and Rashad). Nevertheless, we should note that positive alcohol-related selection need not necessarily be the case; in fact, delayed retirement is also possible in this context. That is, alcohol-related health decrements may increase personal medical costs, whose payment would conceivably require a longer period in the labor force (Anderson and Burkhauser 1985; Dwyer and Mitchell 1999; McGarry 2004).

The goal of our research is to assess the relationship of retirement to daily alcohol use. Our study will address gaps in the research in the following ways. First, we use seven waves (14 years) of data, spanning from 1995 through 2008, from a national longitudinal survey—the U.S Health and Retirement Study (HRS). Our ultimate analysis sample has a size of more than 26,000 person-wave observations, the statistical power of which permits analysis of both secular (time) effects and sex strata. Second, our outcome variable, average daily alcohol consumption, is constructed by combining information on drinking frequency and intensity. This provides a more accurate measurement of drinking outcome than those of many previous studies. Third, we have taken into account the causality issue to obtain a less contaminated effect of retirement on post-retirement alcohol consumption.

3. DATA

3.1 Data Description

The Health and Retirement Study (HRS) is a nationally representative, longitudinal household survey data that was created with the support from National Institute on Aging (NIA) and the Social Security Administration (SSA). It was developed primarily to study health and economic well-being among individuals transitioning to retirement in the U.S. The survey provides rich information about demographics, health status, health behavior, job status and history, and income for individuals above age 50 and their spouses. HRS consists of five age cohorts: the initial HRS cohort; the Study of Assets and Health Dynamics among the Oldest Old (AHEAD) cohort; the Children of Depression (CODA) cohort; the War Babies (WB) cohort; and the Early Baby Boomers (EBB) cohort. The five cohorts together include individuals who were born from 1924 to 1953. Following a baseline assessment, whose timing varied by cohort, subsequent interviews take place every two years. The initial interview of the HRS cohort (born 1931-1941) took place in 1992, which is the earliest wave in the HRS file. The first interview of the

AHEAD cohort (born before 1924) was in 1993. The CODA (born 1924-1930) and WB (born 1942-1947) cohorts were first interviewed in 1998. Data were first taken from the EBB cohort (born 1948-1953) in 2004. With the first wave of data collected in 1992 until 2008 there are nine waves of data released in RAND HRS data file.

3.2 Analysis Sample

The analysis sample comprises respondents who participated in at least two surveys and provided valid data for working status. Our data are arrayed in multiple data records based on wave-pair, where each wave-pair combines data from adjacent survey waves. In this way, all data records contain pre-retirement data and a follow-up outcome assessment. We only included respondents who were working at the pre-retirement wave (baseline wave).

We used seven out of nine waves of HRS data for our study, spanning from 1995 to 2008. To maintain a consistent measurement of alcohol consumption, we excluded the first two waves of data from the analysis sample, because the measurement of alcohol consumption in the first two waves is different from those in the later waves. We only included individuals whose baseline age was 50 years old or above. Finally individuals who had missing information for all other relevant variables have been excluded from the analysis sample.

3.3 Variables Construction

Outcome Measure: Daily alcohol consumption

We constructed average daily alcohol consumption based on data from HRS wave 3 through wave 9. HRS respondents were first asked: *Do you ever drink alcoholic beverages?* Those who responded yes were then asked two follow-up questions about the frequency and intensity of alcohol consumption. In wave 3 and later waves, the questions were: *In the last three months, on average, how many days per week have you had any alcohol to drink?* Participants who did not respond "*none or less than one day*" were then asked: *In the last three months, on the days you drink, about how many drinks do you have?* We multiplied the weekly drinking frequency variable by the daily quantity, and then averaged over 7 days to obtain an average daily alcohol consumption measure. Once more, we exclude data from wave 1 and wave 2, which categorize daily alcohol consumption (less than one drink per day, 1-2 drinks per day, 3-4

drinks per day, or 5 or more drinks per day), to maintain continuous measurement of our outcome variable.

Independent Variables

Exposure: Retirement

Retirement is a dichotomous variable that indicates that a study participant who was working full-time or part-time at the previous wave has retired completely from the labor force. It is assessed at the follow-up wave of each two-wave pair. Individuals who were did not retire by follow-up comprise the comparison group, which includes full-time and part-time workers, the unemployed, and workers who are partly retired, disabled, or not in the labor force for reasons other than retirement.

Other explanatory variables:

Covariates included race/ethnicity, education, age, marital status, non-housing wealth, depression (CESD) score, number of medical conditions, and alcohol consumption at baseline. All variables were lagged, except time invariant variables such as race and education; that is, they were measured at the baseline wave in each wave-pair. Race/ethnicity was measured by three dummy variables (white (referent), black, other race). Education was dummy coded into five categories: less than a high school education (referent), GED, high school graduate, college degree, and more than college degree. Age is a continuous variable, range from 50 to 104. Marital status was measured by a dichotomous variable that indicates married or partnered (versus other marital status). Non-housing wealth is a continuous variable, with millions of dollars as the measurement unit.

CESD score is a mental health measure which was derived from responses to eight statements from a validated depression instrument. The eight items determine whether, in the past week, the respondent: felt depressed, everything an effort, sleep was restless, was happy, felt lonely, felt sad, could not get going and enjoyed life. After dichotomizing original Likert-scaled responses and reverse coding the positively framed statements, HRS summed item responses to create a CESD score, where higher scores reflect worsening mental health. Number of medical conditions (range: 0 – 8) was measured as doctor diagnosed health problems. It also has eight components and was constructed based on whether

the doctor ever told the respondent that she/he has 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, such as chronic bronchitis or emphysema; 5) heart attack, coronary heart disease, angina, congestive heart failure, or other heart problem; 6) stroke or transient ischemic attack (TIA); 7) emotional, nervous, or psychiatric problem; and 8) arthritis or rheumatism.

4. EMPIRICAL MODEL

Consider the following specification within a two period follow-up:

$$\boldsymbol{H_{it} = \alpha_0 + \alpha_1 R_{it} + \alpha_2 H_{it-1} + \alpha_3 X_{it-1} + e_{it}} \quad \textbf{\textit{(1)}}$$

where i denotes for individual; t denotes for wave.

Let $\boldsymbol{R_{it}}$ be a dichotomous variable which indicates the respondent's retirement status at time t, conditioned on time t-1 working status. $\boldsymbol{R_{it} = 1}$, which indicates the respondent was retired at time t but worked at time t-1. $\boldsymbol{R_{it} = 0}$, which indicates the respondent was not retired at time t and worked at time t-1. The dependent variable $\boldsymbol{H_{it}}$ denotes the respondent's daily alcohol consumption at time t. A person's past alcohol consumption is likely to affect his/her current alcohol consumption. We include respondent's alcohol consumption at time t-1 ($\boldsymbol{H_{it-1}}$) as one of explanatory variables. $\boldsymbol{X_{it-1}}$ is a vector of other time t-1 covariates including both time-invariant variables such as race and education level, and time-variant variables such as age, marital status, wealth, and health conditions. Let $\boldsymbol{e_{it}}$ be the error term which captures other unobservable characteristics may confound the relationship between retirement and drinking. To control for unobserved time-varying factors, we included control for time[7], and interaction time with retirement. There are five different survey cohorts in our full sample. To control for cohort effects, we also included cohort dummy.

The parameter of interest is $\boldsymbol{\alpha_1}$, the structural effect of retirement on alcohol consumption at the post-retirement period. Estimation of $\boldsymbol{\alpha_1}$ by ordinary least squares may be biased. If an individual's retirement choice and drinking behavior depend on a common set of unobserved factors, then such common factors will be correlated with retirement. This violates the assumption of unbiased Ordinary

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[7] We ran wave-pair specification regressions. The magnitude and statistical significance varies across time. Effective retirement we show crudely adjusted for macro level conditions.

Least Square estimate. To lessen this type of bias, besides controlling for respondent's race, age, education, marital status, wealth and health status, we included dummies for each wave and cohort, and the interaction term of wave dummies and retirement indicator to estimate equation (1). Even with the inclusion of these controls, the possibility of unobserved selection remains. There may be unobserved individual characteristics that may have impacted both the decision to retire and current alcohol consumption. The longitudinal aspect of the data allows for the estimate of individual fixed effects (FE) models that controls for all unobserved time-invariant heterogeneity across individuals.

The individual fixed effects can identify within-person differences, however, $\boldsymbol{\alpha_1}$ may still be biased if there is a reverse causality introduced by the effect of drinking on retirement.[8] Drinking, per se, does not have a direct effect on individual's retirement choice. However, alcohol is associated with significant risk of worsening in health conditions. Older adults are particularly vulnerable to the negative health consequences of alcohol consumption. The worsening health condition among older adults may force some individuals to retire early and others to work longer to pay medical bills. Thus drinking could impact individual's retirement decision through changes in health conditions.

To account for the reverse causality bias, we stratified our analysis sample across individuals who were aged between 62 to 66 and ever received social security benefit. In United States, the earliest age for one to receive Social Security benefits is 62. The full retirement age to receive full Social Security benefits was remaining at 65 until Social Security policies changed in 2003. The new polices remain 65 as the full retirement age for persons born in 1937 or earlier. For persons born between 1937 and 1942, the full retirement age increases successively by two months each time for every birth year after 1937[9]. Respondents in HRS were born before 1924 to 1953, therefore, the full retirement age ranges from 65 to 66 in our sample. We then limited our sample to respondents whose age between 62 and 66 at current wave, and ever received social security benefits. Stratifying our sample in this way, we likely to include

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[8] We ran logit regressions using retirement as dependent variable, alcohol consumption at time t-1 as explanatory variable. The negative significant estimator on time t-1 alcohol consumption indicates that the reverse causality does exist.

[9] For example, the full retirement age is 65 and 4 months for persons born in1939. For persons born between 1943 and 1954, the full retirement age is 66. From 1954 the full retirement age increases again successively by two months every time for birth year after 1954, until it reaches age 67 for everyone born in 1960 or after.

individuals who choose to retire because of entitlement to social security benefit. Within respondents whose age between 62 and 66 at current wave, there were about 44% of them retired in our sample.

5. RESULTS

4.1 Summary Statistics

Literature showed gender-specific difference on alcohol consumption. Studies on the ratio of male-to-female alcohol abusers usually found a substantial excess of men over women. Older men are more likely to drink and more likely to drink heavily than older women (Bucholz et al., 1995). Women generally are more vulnerable to social pressure than men. In terms of retirement, how to cope with the increased amounts of free time, socially isolated environment, loss of income as well as social support and self-esteem that work provided, women and men may react differently. Therefore, we stratified the sample by gender and test the retirement effect on alcohol consumption for men and women separately.

In Table 1, we show summary statistics for the sex-stratified sample by their retirement status. Characteristics of men are displayed in Panel A. In column (3) we show differences between retired and non-retired men. In Panel A, about 12% of men retired (1389 out of 11596) over the sample frame. The average baseline age for retired men is higher than for non-retired men (62.4 for retirees and 59.2 for non-retirees), which is expected. Male retirees drink less at both baseline and after retirement than non-retirees. There is also evidence that male retirees are in lower socioeconomic standing than male non-retirees. For instance, the proportion of male retirees who have attained less than a college degree among retirees is higher than among non-retirees, while the proportion having a more than college degree is lower among retirees than non-retirees. In addition, retirees are less likely to be married or living with partner, and have less non-housing wealth, on average, than male non-retirees. Higher depression scores (CESD) and number of medical conditions among retirees indicates that male retirees are generally in poorer health than male non-retirees. For example, retirees on average have 1.4 medical conditions compared to 1.1 for non-retirees in Table 1. The CESD score for retirees is 1.1 which is higher than 0.9 for non-retirees. Blacks and less white men choose to retire.

The summary statistics for women by retirement status are presented in Panel B of Table 1. The retirement rate among women is 11.4%, that is, 1668 out of the sample of 14591 women were retired.

The baseline age is higher for retirees (61.8) compared to non-retirees (58). Retirees drink less at baseline as well as after retirement compared to non-retirees. All the other characteristics difference, except for the wealth conditions, between retirees and non-retirees among women are consistent with those reported among men; that is, retirees are usually in lower social economic situations when compared to non-retirees among women as well. For example, retirees among women are less whites and more blacks, have a lower education level, less married, and in poorer health conditions. In addition, column (6) shows that the differences between retired and non-retired women are more significant than the differences among men,

4.2 Regression Results

Results of estimating equation (1) among men are reported in Table 2. Estimates in odd numbered columns are results by random effects (RE) model. Estimates in even numbered columns are results by fixed effects model (FE). All three random effects models control for respondent's characteristic including race, education, age, marital status, wealth, and health conditions. Time-invariant characteristic variables which are race and education are omitted in individual fixed effects model. Model one in column (1) controls for time effects by including wave dummies across wave 5 through wave 9 with wave 4 dummy as the basis. We see positive but insignificant effect of retirement on current alcohol consumption conditional on covariates. Model three in column (3) add controls for cohort effects by adding cohort dummies to model one. The effect of retirement on alcohol consumption is still positive and insignificant. In model (5), we add interaction terms of wave dummies and retirement indicator to model three. The estimate on retirement now is negative and is significant at 10% significance level although the results of other covariates do not vary much compared to the results of previous two models. The estimate on retirement in column (5) indicates that retirement will decrease current alcohol consumption by less than one drink a day among men. The change of results after adding time-retirement interaction provides us with evidence of within-wave effect. The effects of other covariates in fixed effects models are in expected direction and consistent with prior studies. For example, past alcohol consumption is significantly and positively related to current alcohol consumption. This could be explained by the reinforcement effect of drinking due to addictive nature of alcohol. Men who are blacks and other races

significantly drink less compared to white men. As age increases, alcohol consumption decline among older men. Poorer health (the higher number of medical conditions) also decreases alcohol consumption.

However, all three individual fixed effects models in Table 2 do not provide significant estimates of retirement. It suggests that within individual man, retirement do not have any effect on alcohol consumption. Individual fixed effects models also reverse the signs of baseline alcohol consumption estimates; that is, the increase in baseline alcohol consumption decreases current alcohol consumption within the same individual among men.

Estimations of equation (1) within women are shown in Table 3. We also run three models with controlling for time effects, then adding controls for cohort effects and interactions of time and retirement. We do not observe any significant effects of retirement on current alcohol consumption among women based on estimation by both random and individual fixed effects models. Race, education, marital status, wealth, and health conditions play important roles on women's drinking behavior in random effects models. Women who are non-white and have more health problem decrease alcohol consumption. However women who are in better social economic conditions, such as having a higher education, being wealthy and married, are likely to increase alcohol consumption.

In Table 5, we show estimation results of equation (1) within the sample of respondents whose age between 62 and 66 and ever received Social Security benefits. Estimates in column (1) and (2) are among men, and estimates in column (3) and (4) are among women. Results from random effects model and fixed effects model for men are in column (1) and (2). Estimation of random effects models for men and women, which is in column (1) and (3) respectively, includes all characteristic variables as well as time dummies, cohort dummies and time-retirement interaction dummies. The time-invariant variables such as race, education and cohort dummies are omitted in fixed-effects estimation.

Estimation within stratified sample has reduced the magnitude of the estimator on retirement from -0.084 (in column (5) in table 2) to -0.079 in column (1) in table 5. With significantly reduced sample size, the standard deviation is higher and the retirement estimator is insignificant anymore in table 5. However, estimate by individual fixed effects model in column (2) indicates that controlling for within-individual variation, retirement increases alcohol consumption significantly, by approximately 1.3 more drinks daily for men. The results among women remain insignificant by either random-effects or fixed-effects model.

5. DISCUSSION

This study examines the effect of retirement on alcohol consumption in subsequent period after retirement within a two period follow-up setting. We find some effects of retirement on alcohol consumption within men but not within women. The population average estimator for men shows that retirement decreases alcohol consumption after controlling for a set of characteristic covariates, especially time-retirement interactions. However, we also find that identifying off endogeneity of retirement and within-individual variations, retirement actually has been positively related to alcohol consumption by a significant level. Retirement could lead to consume 1.3 more alcoholic drinks per day for men. This could be a health threatening signal to older men. Low-risk drinking recommendations promoted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) states that "no more than one drink per day" for individuals over age 65.

There is a dose-response relation to volume of alcohol consumption for most diseases. Elderly are especially sensitive to the risk of alcohol related diseases. Understanding drinking behavior of the elderly after retirement is crucial to understand the relation between retirement and health outcomes. Life-time event like retirement will cause changes of individual's health behavior, such as drinking. Retirees may cope with retirement either positively or negatively. From negative perspective, retirement may cause depression due to loss of employment status and role, and employment based social support. More leisure time and change of life style along with depression after retirement could leads to more drinking. On the other hand, the less of social ties with colleagues who encourage drinking and relief from work-related stress may decrease alcohol use following retirement. If the overall effect of retirement is to increase drinking substantially, it will be highly likely to increase the risk of deterioration of health conditions among retirees. The expansion of aging population increases health care cost substantially. Promoting healthy aging has become a very important task to help reducing health care cost as well as increasing well-being of the elderly. If retirement causes negative health behaviors therefore adverse health outcomes, researchers have suggested that government may consider raise the retirement age (Dave & Rashad, 2008). Delay retirement at a higher age, it may postpone poor health outcomes, reduce the utilization of health care services and long-term growth in Medicare expenditure, as well as improve financial liability of Social Security system.

APPENDIX (Chapter III):

Table 1: Unadjusted breastfeeding outcomes by WIC participation status

	Panel A:	Men		Panel B:	Women	
	(1)	(2)	(3)	(4)	(5)	(6)
	Retired	Not-Retired	Differences	Retired	Not-Retired	Differences
Retired	1	0		1	0	
	(0)	(0)		(0)	(0)	
Current alcohol consumption	0.502	0.548	0.046	0.192	0.220	0.028*
	(1.061)	(1.061)	(0.030)	(0.527)	(0.539)	(0.014)
Baseline alcohol consumption	0.515	0.557	0.042	0.189	0.221	0.032*
	(0.999)	(1.054)	(0.030)	(0.480)	(0.526)	(0.014)
White	0.834	0.850	0.016	0.793	0.797	0.005
	(0.372)	(0.357)	(0.010)	(0.406)	(0.402)	(0.010)
Black	0.122	0.102	-0.020*	0.180	0.157	-0.023*
	(0.328)	(0.303)	(0.009)	(0.384)	(0.364)	(0.010)
Other race	0.0439	0.0480	0.004	0.0276	0.0460	0.018***
	(0.205)	(0.214)	(0.006)	(0.164)	(0.210)	(0.005)
Less than high school	0.191	0.136	-0.054***	0.169	0.134	-0.035***
	(0.393)	(0.343)	(0.010)	(0.375)	(0.341)	(0.009)
GED	0.0605	0.0421	-0.018**	0.0438	0.0421	-0.002
	(0.238)	(0.201)	(0.006)	(0.205)	(0.201)	(0.005)
High school graduate	0.311	0.258	-0.053***	0.363	0.331	-0.032**
	(0.463)	(0.438)	(0.013)	(0.481)	(0.471)	(0.012)
College degree	0.215	0.230	0.015	0.231	0.267	0.036**
	(0.411)	(0.421)	(0.012)	(0.421)	(0.442)	(0.011)
More than college degree	0.223	0.334	0.110***	0.193	0.225	0.032**
	(0.417)	(0.472)	(0.013)	(0.395)	(0.418)	(0.011)
Baseline age	62.38	59.17	-3.207***	61.77	57.95	-3.818***
	(5.706)	(5.991)	(0.170)	(6.005)	(5.610)	(0.147)
Baseline marital status	0.834	0.844	0.011	0.624	0.667	0.043***
	(0.372)	(0.363)	(0.010)	(0.485)	(0.471)	(0.012)
Baseline non-housing wealth($1m)	0.234	0.358	0.123*	0.228	0.214	-0.014
	(0.568)	(1.857)	(0.050)	(0.603)	(0.937)	(0.024)
Baseline CESD score	1.107	0.931	-0.176***	1.449	1.253	-0.196***
	(1.651)	(1.483)	(0.043)	(1.921)	(1.790)	(0.047)
Baseline number of medical conditions had	1.443	1.108	-0.335***	1.539	1.195	-0.344***
	(1.235)	(1.068)	(0.031)	(1.187)	(1.092)	(0.029)
Observations	1389	10207	11596	1668	12923	14591

Notes: Sample (full sample) includes individuals whose baseline age was 50 years old or above from wave 3 to 9 of the HRS. Characteristics among men are in Panel A and women in Panel B. Standard errors are in parentheses. Asterisks indicate significance level of the differences between retirees and non-retirees: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table 2: Estimation by random and fixed effects models within men

VARIABLES	(1) RE	(2) FE	(3) RE	(4) FE	(5) RE	(6) FE
Retired	0.007	-0.006	0.005	-0.006	-0.084*	-0.147
	(0.021)	(0.025)	(0.021)	(0.025)	(0.045)	(0.276)
Baseline alcohol consumption	0.555***	-0.131***	0.555***	-0.131***	0.555***	-0.131***
	(0.026)	(0.042)	(0.026)	(0.042)	(0.026)	(0.043)
Black	-0.128***		-0.128***		-0.128***	
	(0.022)		(0.021)		(0.021)	
Other race	-0.083*		-0.081*		-0.081*	
	(0.043)		(0.043)		(0.043)	
GED	0.039		0.038		0.039	
	(0.055)		(0.055)		(0.055)	
High school graduate	0.002		0.001		0.002	
	(0.032)		(0.033)		(0.033)	
College degree	-0.026		-0.025		-0.025	
	(0.032)		(0.032)		(0.032)	
More than college degree	0.016		0.018		0.017	
	(0.031)		(0.031)		(0.031)	
Baseline age	-0.005***	0.028	-0.007**	0.028	-0.006**	0.027
	(0.001)	(0.020)	(0.003)	(0.020)	(0.003)	(0.020)
Baseline marital status	-0.032	-0.007	-0.033	-0.007	-0.032	-0.010
	(0.026)	(0.064)	(0.027)	(0.064)	(0.027)	(0.064)
Baseline non-housing wealth($1m)	0.004	0.001	0.004	0.001	0.004	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Baseline CESD score	-0.006	0.001	-0.006	0.001	-0.006	0.001
	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.007)
Baseline number of medical conditions had	-0.013*	-0.041**	-0.014**	-0.041**	-0.014*	-0.040**
	(0.007)	(0.016)	(0.007)	(0.016)	(0.007)	(0.016)
Constant	0.545***	-0.871	0.651***	-0.871	0.633***	-0.839
	(0.092)	(1.103)	(0.199)	(1.103)	(0.198)	(1.103)
Wave dummies	Yes	Yes	Yes	Yes	Yes	Yes
Cohort dummies	No	No	Yes	No	Yes	No
Wave*Retirement	No	No	No	No	Yes	Yes
Observations	11,596	11,596	11,596	11,596	11,596	11,596
R-squared		0.018		0.018		0.018

Notes: Results were estimated within men from the full sample. RE and FE denotes random effects model and individual fixed effects model. Robust standard errors are in parentheses. Asterisks indicate significance level: ***significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table 3: Estimation by random and fixed effects models within women

VARIABLES	(1) RE	(2) FE	(3) RE	(4) FE	(5) RE	(6) FE
Retired	0.000	0.004	-0.000	0.004	0.002	-0.050
	(0.010)	(0.012)	(0.010)	(0.012)	(0.027)	(0.074)
Baseline alcohol consumption	0.611***	-0.048	0.611***	-0.048	0.611***	-0.048
	(0.026)	(0.037)	(0.026)	(0.037)	(0.026)	(0.037)
Black	-0.056***		-0.055***		-0.055***	
	(0.007)		(0.007)		(0.007)	
Other race	-0.069***		-0.070***		-0.070***	
	(0.012)		(0.012)		(0.012)	
GED	-0.022		-0.022		-0.021	
	(0.021)		(0.021)		(0.021)	
High school graduate	0.007		0.008		0.008	
	(0.011)		(0.011)		(0.011)	
College degree	0.031***		0.032***		0.032***	
	(0.011)		(0.012)		(0.012)	
More than college degree	0.060***		0.061***		0.061***	
	(0.013)		(0.013)		(0.013)	
Baseline age	-0.001	-0.007	-0.001	-0.007	-0.001	-0.007
	(0.001)	(0.008)	(0.001)	(0.008)	(0.001)	(0.009)
Baseline marital status	0.020***	0.008	0.020***	0.008	0.020***	0.008
	(0.007)	(0.018)	(0.008)	(0.018)	(0.008)	(0.018)
Baseline non-housing wealth($1m)	0.018***	0.003	0.018***	0.003	0.018***	0.003
	(0.003)	(0.006)	(0.003)	(0.006)	(0.003)	(0.006)
Baseline CESD score	0.000	-0.001	0.000	-0.001	0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Baseline number of medical conditions had	-0.008***	-0.012	-0.009***	-0.012	-0.009***	-0.012
	(0.003)	(0.009)	(0.003)	(0.009)	(0.003)	(0.009)
Constant	0.092**	0.601	0.155**	0.601	0.153**	0.598
	(0.037)	(0.459)	(0.075)	(0.459)	(0.076)	(0.461)
Wave dummies	Yes	Yes	Yes	Yes	Yes	Yes
Cohort dummies	No	No	Yes	No	Yes	No
Wave*Retirement	No	No	No	No	Yes	Yes
Observations	14,591	14,591	14,591	14,591	14,591	14,591
R-squared		0.006		0.006		0.006

Notes: Results were estimated within women form the full sample.

Table 4: Estimation by random and fixed effects models within individuals whose age between 62 and 66, and ever received Social Security benefits

	Panel A		Panel B	
	(1)	(2)	(3)	(4)
VARIABLES	RE-Men	FE-Men	RE-Women	FE-Women
Retired	-0.079	1.326***	-0.025	-0.052
	(0.072)	(0.129)	(0.030)	(0.087)
Baseline alcohol consumption	0.618***	-0.407***	0.705***	-0.373***
	(0.053)	(0.127)	(0.050)	(0.112)
Black	-0.129***		-0.046***	
	(0.044)		(0.014)	
Other race	-0.109**		-0.078***	
	(0.053)		(0.018)	
GED	0.095		-0.001	
	(0.120)		(0.026)	
High school graduate	-0.050		0.011	
	(0.053)		(0.017)	
College degree	-0.011		0.045**	
	(0.054)		(0.018)	
More than college degree	0.008		0.056**	
	(0.056)		(0.022)	
Baseline age	-0.006	0.038	0.003	0.002
	(0.011)	(0.047)	(0.005)	(0.025)
Baseline marital status	-0.059	-0.162	0.030**	0.011
	(0.065)	(0.311)	(0.013)	(0.030)
Baseline non-housing wealth($1m)	0.013	0.008	0.007	-0.025
	(0.011)	(0.008)	(0.009)	(0.020)
Baseline CESD score	-0.015	-0.027	-0.004	0.000
	(0.012)	(0.020)	(0.004)	(0.005)
Baseline number of medical conditions had	0.000	0.060	-0.004	0.049*
	(0.016)	(0.063)	(0.007)	(0.027)
Constant	0.000	-1.437	0.025	0.088
	(0.000)	(2.714)	(0.351)	(1.418)
Wave dummies	Yes	Yes	Yes	Yes
Cohort dummies	Yes	-	Yes	-
Wave*Retirement	Yes	Yes	Yes	Yes
Observations	2,669	2,669	2,953	2,953
R-squared		0.142		0.146
Observations	1,668	1,668	1,808	1,808

Notes: Results were estimated from sub-sample of individuals whose age between 62 and 66, and ever received Social Security benefits.

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