Does the Subsidy of Healthy Prenatal Nutrition Improve Birth Outcomes?†

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Abstract

To analyze the impact of healthier nutrition on birth outcomes we evaluate a reform of the Supplemental Nutrition Program for Women, Infants and Children (WIC). Since 2009 the program's food package content become healthier and cash vouchers on fruits and vegetables were implemented. To identify the intention-to-treat effect of this reform we use WIC non-participants as a control group within a difference-in-differences setting. Based on data from birth certificates we find that the reform decreased the probability of a high and very high birth weight significantly.

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1 Introduction

Healthier food and especially adequate intake of micronutrients is crucial during pregnancies. Inadequate micronutrient intake or lack of specific micronutrients leads to poor birth outcomes (Parul, 2010; Bloomfield, 2011). Micronutrients influence gestation age and higher risk of preterm birth (Bloomfield, 2011). The best solution for adequate micronutrient intake are fruits and vegetables (F&V) (Rolls et al., 2004; Bloomfield, 2011; Goletzke et al., 2015). The high density of micronutrients in F&V lowers energy intake which is essential to lower overweight. However, the average consumption of F&V of adults in America is only 1.1 fruits and 1.6 vegetables per day (Centers for Disease Control and Prevention, 2013). The consumption of F&V has been already an important public health strategy for weight management and risk reduction of chronic disease since 2009 (Kimmons et al., 2009). However, little is known how a subsidy increase on F&V would influence birth outcomes.

To answer this research question we use a natural experiment setting of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) composition change in 2009 to identify the average treatment effect of a healthier food subsidy on birth outcomes.

The WIC program addresses low income and under nutritional risk pregnant, breastfeeding women and normal parents as well as step, guardian and foster parents of infants and children under the age of five. The average subsidy per WIC participant was $ 42.4 per month in 2009.

In the last 40 years a large literature has developed suggesting that WIC has a positive effect on birth outcomes. The WIC program works despite its relatively small benefits to people's monthly food budget (Currie and Rossin-Slater, 2015). This is because on the one hand healthy food and diet counselling is offered, and on the other hand WIC benefits help to facilitate access to medical care.

Since the implementation of the WIC program it has been reformed only three times. On October 1, 2009 an interim rule was implemented as the first change of the WIC program. The interim rule was based on a revision of the WIC program to align more closely with updated nutrition science and the infant feeding practice guidelines of the IOM (2005). That revision did not only implement cash vouchers (CV) on F&V for WIC participants but also changed the content of all food packages to be healthier. At the beginning of 2010 a 25 percent increase of the implemented F&V-CV value for pregnant women was introduced. The composition change of the food package and the further increased F&V-CV value should increase participant's health without increasing state expenses (IOM, 2005). In the implementation year the new interim rule affected about 9 million participants including 10 percent pregnant women according to USDA data. The last change of the WIC program was in 2014. Based on the experience gained of the interim rule the

maximum allowance of food packages was changed and food choices of participants expanded in 2014. The food choice expatiation included yoghurt as a partial substitute for milk and more whole grain and fish options for women and children as well as additional fruits and vegetables for children.
Considering implementation dates the interim rule was supposed to be implemented between February 2008 and latest August 2009 at first. But on March 17, 2008 the Federal Register delayed the implementation date to October 1, 2009. Most states implemented the interim rule in October 2009 and some earlier such as New York which implemented the rule at the beginning of 2009 (Wilde et al., 2012).
The implementation date for the correction of F&V-CV for pregnant women was latest April 30, 2010.
The rule change of 2014 had many implementation dates depending on topics with the first implementation on Jun, 2015 and latest April, 2015.
To analyse the impact of the full implementation[1] of the interim rule we have defined four treatment periods because of the two implementation dates. The first treatment period is before the implementation of the interim rule (pre treatment period) two are between the first implementation date till nine months after the full implementation (interim treatment periods) and there after is the last treatment period (post treatment period).
The identification strategy of the following empirical analysis is a difference in differences approach, which uses WIC and WIC non-participants as cohorts within the previously described four treatment periods. The empirical analysis is based on *Vital Statistics* natality birth data of the time between 2009 and 2013.
The estimation analysis points into a positive direction of the the WIC composition change, but the estimated impacts are very small and not all results are robust. The main robust result is that the probability of high birth weight ($4,000\ gram <$ birth weight $\leq 4,500\ gram$) was decreased. Most results are either insignificant or not robust possibly due to data limitations.
The primary limitation is that the heterogeneity between states is unobserved. For instance we could not control for states with an implication dates before October 1, 2009. However the results are not biased as long as the mothers of early adopting states did not give birth before October 1, 2009.
This paper is organized as follows: First, we present the current literature on the effect of micronitrients and F&V during pregnancy on birth outcome and research evaluating the WIC program before and after the full interim rule implementation. The literature review is followed by the hypothesis and theory of change. Then we present the data and the institutional setting. In the next section we describe the econometric methodology and it's limitations. In the sixth section we discuss the estimation results and the sensitivity

[1] We define the full implementation of the interim rule as the introduction of the interim rule and the updated F&V-CV value.

analysis. In the last section we draw a conclusion of the empirical analysis. For a better overview all tables are placed in the appendix. Explanations of all abbreviations can be found in table A.1.

2 Literature review

Research about nutrition has rapidly increased in developing countries over the last decade (Nuijten and Lenoir-Wijnkoop, 2011). This led to a higher awareness of food composition and public health measures. On the one hand the social responsibility of countries to their inhabitants motivates the nutrition literature and on the other hand expected positive economic outcomes of a healthy population such as cost savings in medical care is a critical point. This is supported by Bitler and Currie's (2005) simple economic cost benefit analysis of the WIC program. The authors set direct cost of $280 for pregnant women against decreased average hospital night stays of infants by about one night and 14 percent lower probability of intensive care needs.

In this section at first the need and effect of micronutrient intake during pregnancy on health outcomes will be stated. Next the effects of fruits and vegetables during pregnancy on birth outcomes will be discussed. Finally the results of studies evaluating the WIC program before and after the full interim rule change will be reviewed.

2.1 Influence of micronutrients during pregnancy on birth outcomes

One-third of the world' s population suffers from micronutrient deficiencies (WHO et al., 2006). This is explained primarily due to inadequate dietary intake. Suboptimal intake of certain micronutrients has been linked with an increased risk of chronic diseases such as cardiovascular disease and cancer (Woodside et al., 2005).

During pregnancy women face much higher increased relative malnutrition requirements compared to energy requirements (Blumfield et al., 2012, 2013). Therefore micronutrient requirements might be even more difficult to achieve than energy requirements. To meet the micronutrient requirements of pregnancy the focus of health care should be on the dietary quality of pregnant women and not on increased food intake (Goletzke et al., 2015).

Supporting these results Parul (2010) describes high existing of maternal micronutrient deficiencies. These deficits have an effect on birth and newborn outcomes (Parul, 2010). Inadequate or lack of specific micronutrients influence gestation age and higher risk of preterm birth (Bloomfield, 2011).

To overcome the challenge of micronutrient deficite dietary intake of micronutrient-rich food or the use of supplements could be increased (Parul, 2010). However a diet high in fruits and vegetables may be more effective than large doses of a small number of micronutrients such as supplements (Woodside et al., 2005). Especially fruits and vegetables, nuts, dairy products, and legumes improve micronutrient intake (Goletzke et al., 2015).

2.2 Influence of fruits and vegetables during pregnancy on birth outcomes

An increased consumption of fruits and vegetables (F&V) could decrease the micronutrient deficit (Goletzke et al., 2015; Parul, 2010). The consumption of F&V has been already an important public health strategy for weight management and risk reduction of chronic disease since 2009 (Kimmons et al., 2009). Indeed a consumption increase of F&V is one of the most frequent messages of health agencies such as the "five-a-day" F&V campaign in the UK (Capacci and Mazzocchi, 2011). On the contrary to the high relevance of F&V the average consumption of F&V of adults in America is only 1.1 fruits and 1.6 vegetables per day (Centers for Disease Control and Prevention, 2013).

Several other studies such as Ford and Mokdad (2001); Rolls et al. (2004); He et al. (2006); Bao et al. (2014); Rugel and Carpiano (2015) analyse the effect of F&V on health outcomes. Adequate F&V intake may not only reduce energy density but also lower the risk of several chronic diseases such as reduced risk of stroke and lower probability for diabetes especially for women. A summary of F&V studies shows that the intake of F&V lowers the rate of cancer, decreases risk of chronic diseases, cardiovascular disease and depressions (Rugel and Carpiano, 2015).

Considering pregnant women F&V have long term impacts on post birth health and short term effect on pregnancy and birth outcome. Due to the lack of long term effect studies only impacts of F&V on pregnancy and birth outcome are discussed.
As the literature reveals an adequate intake of F&V can balance the disproportional increased of energy and micronutrient demand in pregnancy. The risk of bad birth outcomes is reduced by F&V intake (Rolls et al., 2004). The authors argue that F&V have higher density of micronutrients and therefore increases micronutrient intake with lower energy uptake which leads to the positive effect. Haugen et al. (2014) discuss the issue of energy intake in pregnancy. The authors analyse the risks caused by not meeting the IOM and NRC (2009) recommendations for nulliparous[2] and parous[3] normal weight women. Inadequate energy intake increased the risk of underweight and overweight birth, pregnancy hypertension, preeclampsia and emergency cesarean.

[2]Women which have never given birth to a child.
[3]Women which have already given birth to a child at least once.

2.3 Impact of the WIC before the full implementation of the interim rule

There is rich research available trying to determine the impact of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) since its implementation. This research suggests that WIC has a positive effect on birth outcomes (Currie and Rajani, 2014). Studying the literature such as Besharov and Germanis (2001) Bitler and Currie (2005); Hoynes et al. (2011) Bitler et al. (2003) Joyce et al. (2008) and Currie and Rajani (2014) it is outstanding that the main goal of these researches was to identify the effect of WIC due to the possible selection into the WIC program.

This selection occurs if WIC recipients differ from non-recipients. For instance, WIC recipients could be healthier, more motivated, or have better access to health care than other eligible women. If WIC and non WIC recipients differ in an unobserved characteristic then the WIC impact estimates are biased due to the selection bias.

Current literature suggests that WIC mothers are negatively selected from the eligible population (Bitler and Currie, 2005). For instance, mothers of New York are more likely to participate in WIC when they are young, unmarried, unemployed and more likely to have chronic conditions, such as diabetes (Currie and Rajani, 2014). These findings reveal that earlier research might be underestimating the impact of WIC.

Another bias in the WIC literature is the gestational bias. Women with longer pregnancy and therefore longer gestational age have more time to apply for the WIC program (Joyce et al., 2005). Longer gestational age leads to better birth outcome and if these mothers join the WIC program only at the end of their pregnancy the WIC impact is overestimated. However if gestational age is used as a control variable to overcome the bias the WIC impact is underestimated due to expected positive effect of the WIC program on gestational age. The only clear way of solving the gestational age bias issue would be information on the date of the mother's WIC enrollment.

Another issue in existing studies was that not all control variables of interest were available for the investigation of the WIC program. For instance, weight gain in pregnancy depends on the BMI of the mother. As mothers with higher BMI need to gain less weight during pregnancy as women with lower BMI studies such as Bitler and Currie (2005) have limited interpretation (IOM and NRC, 2009). On the contrary Joyce et al. (2008) results can be interpreted as a positive impact of increased weight gain due to WIC (Silve et al., 2012).

Considering birth outcomes in the WIC literature the direction of results are listed in table A.2. The samples and evaluation methods differ between these presented studies. For a detailed discussion of the evaluation method and results see Silve et al. (2012); Rossin-Slater (2013); Currie and Rossin-Slater (2015). The table states that the WIC program increases *pregnancy weight gain*, *gestation age*, *birth weight* and decreases *share/likelihood*

of low and very low birth weight and *pre term delivery*.
On the contrary to the clear direction of WIC on each dependent variable the research is not clear of the impact size. A 64 to 78 gram higher birth weights is estimated of WIC infants (Bitler and Currie, 2005). Results also show an average birth weight increase of 7 to 40 gram after adjusting for gestation age (Joyce et al., 2008). The availability of WIC increases birth weight by 7 gram among low-education mothers (Haugen et al., 2014). While earlier studies estimate a 22 to 32 gram increase of birth weight (Rossin-Slater, 2013). This derivation might be because the WIC operates on a much greater scale nowadays than it did at the time of its inception in the 1970is (Rossin-Slater, 2013). Next due to high standard errors the 7 gram are also included in the 95 per cent confidence interval of Rossin-Slater results.
Participating WIC decreases low birth weight by 10 to 43 percent and very low birth weight by 21 to 53 per cent (Bitler et al., 2003). Similar results show that infants are 30 percent less likely to be born with low birth weight (Bitler and Currie, 2005).
Despite different evaluation methods the current research has a clear conclusion that the WIC program has an positive outcome on participating women and children. The WIC program might work despite its relatively small benefits to people's monthly food budget as

"[...] the healthy WIC foods available or the nutritional counseling "nudge" people's diets in a healthier direction, or that the availability of WIC benefits helps to facilitate access to medical care." (Currie and Rajani, 2014, p. 6)

2.4 Impact of the WIC after the full implementation of the interim rule

Only few recent studies such as Whaley et al. (2012); Andreyeva et al. (2012); Langellier et al. (2013); Kong et al. (2014) examine the WIC change of 2009. A small but significant increase of F&V consumption was observed among Californian WIC pregnant or postpartum women and/or caregivers of children (Whaley et al., 2012). Furthermore the consumption of whole-grain food increased by 17.3 percentage points. On the contrary to decreased whole milk consumption, the lower fat milk consumption increased in March 2010 compared to September 2009 (Whaley et al., 2012). Access to healthy foods for WIC participants and society improved at large in terms of the availability, variety, quality and prices of WIC-approved foods before and after the implementation of the WIC package change (Andreyeva et al., 2012).
Kong et al. (2014); Langellier et al. (2013); Wilde et al. (2012) determine the impact of the interim rule on breastfeeding outcomes. Overall, food package assignments have changed. There were fewer partial breastfeeding packages but more full breastfeeding and full formula packages to WIC mothers (Wilde et al., 2012). However also other significant

changes of food package assignments were observed (Langellier et al., 2013). Exclusive breastfeeding at three and six months increased significantly after implementation of the new food package (Langellier et al., 2013). However these results do not match with current studies such as Wilde et al. (2012). This contradiction might be due to unobserved heterogeneity by region (Langellier et al., 2013). This unobserved heterogeneity might be a result of the differences in the implementation of the new policy, the characteristics of WIC participants, or other factors considering the breastfeeding package (Langellier et al., 2013). Further the dietary intake improved and obesity reduced of WIC participant after the change (Chiasson et al., 2013). Across Native American WIC children eating patterns become healthier and consumption of F&V, whole grains, and low-fat/fat-free milk increased(Ishdorj and Capps, 2013).
Besides current studies the report of the IOM (2005) describes possible impacts of the revised food package for all WIC package groups. The IOM (2005) was in charge to define guidelines for the interim rule change. To find an effective and cost neutral food package over all participants the IOM (2005) evaluated the food package of the year 2002. To do so they calculated cost and nutrition intakes of WIC participants. As a next step the food quality was analysed and some foods were deleted and others added to the package. This was followed by estimating cost and nutrients for the new food package. Referring to (IOM, 2005, p. 54ff) the revised food package had to meet the following six conditions at the end:

1. The package reduces the prevalence of inadequate and excessive nutrient intakes in participants.

2. The package contributes to an overall dietary pattern that is consistent with the Dietary Guidelines for Americans, for individuals 2 years of age and older.

3. The package contributes to an overall diet that is consistent with established dietary recommendations for infants and children younger than 2 years of age, including encouragement of and support for breastfeeding.

4. Foods in the package are available in forms suitable for low-income persons who may have limited transportation, storage, and cooking facilities.

5. Foods in the package are readily acceptable, widely available, and commonly consumed; take into account cultural food preferences; and provide incentives for families to participate in the WIC program.

6. Foods will be proposed giving consideration to the impacts that changes in the package will have on vendors and WIC agencies.

The calculated intake of malnutrition, vitamin, F&V by the IOM (2005) showed many inadequate intakes for all package groups for the year 2002. Due to the main interest to pregnant women only results considering this group will be presented in the following. More than 90 percent of pregnant women had inadequate intake for vitamin E. 40 percent of pregnant women appeared to have inadequate intakes of folate and about on third of vitamins A, C and B6 as well as a substantial proportion for zinc, thiamin and niacin. Iron, selenium, phosphorus and remaining B vitamins were low for less than 8 percent of pregnant women. The IOM (2005, p. 84ff) also stated that: *"Intakes of whole grains, vegetable subgroups excluding potatoes and other starchy vegetables, fruits, milk and milk products, and meat are all lower than recommended on average."*

The compared intakes before the composition change with estimates of the new food package lead to a more positive picture (IOM, 2005). The main conclusion was that the revised food package provided greater amounts of nearly all nutrients of concern with regard to inadequate intake. In addition less nutrients of concern regarding excessive intake are provided in the revised food package (IOM, 2005). However it is to mention that vitamin C and D are reduced for pregnant women.

Considering package costs the average cost per WIC participant over all packages was estimated as $34.76 for the year 2002 and $34.57 for the revised food package. On the contrary to the cost neutrality of the whole WIC program the estimated package value for pregnant increased by about $7. The average cost for each pregnant mother in the WIC program were $41.23 in 2002 and expected costs of $48.45 for the revised food package.

In their report the IOM (2005) points out that it was impossible to estimate a true and precise impact. This is because the estimates are based on a full prescription of the package and this is not always applicable. Furthermore not all foods obtained may be consumed by the WIC participants.

As the literature shows the WIC package change did not increase costs and led to positive health outcomes of certain WIC participants. Already before the IOM (2005) recommendations the effectiveness of the WIC program despite its already positive effect was doubt (Bitler and Currie, 2005; Besharov and Germanis, 2001). However the literature leaves an undiscovered and open question whether the WIC change had a positive effect on birth outcomes.

3 Theory/Hypothesis development

As the literature presents, healthy nutrition during pregnancy plays an important factor. Increased F&V intake in pregnancy leads to a higher density of micornutrients and results better birth outcomes. However it is unclear how a subsidy of healthier food effects birth outcomes.

I evaluate the interim rule change of the WIC program in 2009. The interim rule only changed the WIC packaged into a healthier direction such as including F&V and did not change other program characteristics. If the eligibility and characteristics of enrolment to the WIC program didn't change, then the difference in differences of WIC participants (treated) and WIC non-participants (control) outcome before (pre treatment period) and after the change (post treatment period) reflects the effect of the WIC package change. In this way we can observe the average treatment effect of the increased subsidy of healthier food (especially F&V) on their birth outcome.

Indeed due to this setting the external validity only refers to WIC participants and only the treatment effect of WIC participants is observable. However, the literature showed that the WIC program already has a positive impact on participants. Therefore if the changed increased the positive impact of WIC then it could be assumed that a clear subsidy for healthier food would also induce an effect in that direction.

To compare birth health outcomes pre and post treatment the outcome variables gestation length, birth weight and Apgar scores are used. Frimmel, Halla and Winter-Ebmer (2014) point out that most of these variables are the mainly used measures of health at birth.

Out of the literature the following hypothesis H_1 formulated hypotheses are developed:

$H1_1$ Shares of low Apgar score decreased by the subvention of healthier foods.

$H2_1$ Gestation length is increased by the subvention of healthier foods.

$H3_1$ Birth weight is increased by the subvention of healthier foods.

$H4_1$ Shares of very low birth weight decreased by the subvention of healthier foods.

$H5_1$ Shares of low birth weight decreased by the subvention of healthier foods.

$H6_1$ Shares of high birth weight decreased by the subvention of healthier foods.

$H7_1$ Shares of very high birth weight decreased by the subvention of healthier foods.

4 Data & Institutional setting

The empirical analysis is based on *US Vital Statistics* natality birth data of the time between 2009 and 2013. This data is derived of birth certificates collected by each state and are provided by the *National Center for Health Statistics*. Birth certificates are yearly recorded since 1968 and build cross section data for each year. Records include demographic variables of the parents and clinical information of mothers, births and infants. We use a 10 percent random sample conditioned on year with 2,000,773 observations. Since 2009, mother's participation of the WIC program is documented in the data. This variable reflects the cohort variable for treated and control. However, the available information the WIC participation record differs across years in the regression sample as table A.4 shows. Only 66 percent observations have data about the WIC participation. In 2012, 86 percent of the observations have information of the enrolment status of the mother. The high share of unobserved WIC status in the year 2009 might result a selection bias. Table A.5 states the average characteristics of mothers and births of WIC participants (treatment group), WIC non-participants (control group) and of the whole sample for 2009 till 2013. In line with the previous literature the WIC and WIC non-participants differ by mother's characteristics. The WIC sample is on average less educated, younger and has a higher share of migrants. Considering mother's education 30 percent of WIC participants did non graduate from high school nor completed a GED in each observational year. However, less than 10 percent of WIC non-participants have only such low education. About half of the WIC sample is younger than 25 years old in each year which is more than twice the share of non WIC mothers. Moreover, approximately 10 percent more WIC mothers are at least overweight. It is also to point out that more than 62 percent of WIC mothers are married compared to about 21 percent of not WIC mothers. The descriptive statistic also shows that characteristics do not differ much in time. This is important to see and diminishes the possible selection bias of not reported WIC status. However, this bias might occur on a different level such as across states. It is possible that in 2009 some states did not report the WIC status and therefore these states are not observed in this analysis.

Institutional Setting

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was introduced in 1974. The WIC program addresses low income and under nutritional risk pregnant, breastfeeding women and normal parents as well as step, guardian and foster parents of infants and children under the age of five. Families are stated of low income if their income is at or below 185 percent of the federal poverty income level. The program provides nutrition education, nutritious foods, referrals to health and human services and breastfeeding support.

For instance, the WIC nutrition education program offers topics such as "eating healthfully during pregnancy for mom and baby", "infant and child nutrition" or "tips for pregnant teens" are discussed. Nutrition benefits are provided each month and can be used to buy nutritious food in grocery stores. Depending on the classification of the participant one of the seven seven food package categories is supported to participants. Table A.6 illustrate the maximum allowance for pregnant and partially breastfeeding women of the current and the food package before October 2009.

Referrals serve as the third support to connect participants to medicaid, family planning, food stamps, food pantries as well as to housing services, drug and alcohol abuse programs or child care.

Since the implementation of the WIC program in the 1970s it has been reformed only three times. On December 6, 2007 an interim rule revised the program partially to align more closely with updated nutrition science and the infant feeding practice guidelines of the American Academys' Institute of Medicine IOM (2005). That revision did not only implement cash vouchers for WIC participants but also changed the content of all food packages, and redefined the food packages. USDA (2011) describes that the largest changes made by this interim rule were the inclusion of fruits and vegetables in the woman and child food packages, and updated food package quantities based on the breastfeeding status.

In 2009 the program was revised again to fully meet the recommendation of the IOM which refers to pregnant and partially breastfeeding woman. The only change in this food package was a raise of the maximum value of F&V CV by 25%.

The last and final rule revision of the WIC food package was published on March 4, 2014. The rule of 2014 is based on the gained experiences of the interim rule change and changed maximum allowance of food packages and expanded food choices of participants. These include yoghurt as a partial substitute for milk and more whole grain and fish options for women and children as well as additional fruits and vegetables for children.

Considering implementation dates the interim rule was supposed to be implemented between February 2008 and latest August 2009 at first. But on March 17, 2008 the Federal Register delayed the implementation date to October 1, 2009. Most states implemented the interim rule in October 2009 and some earlier such as NY which implemented the rule at the beginning of 2009 (Wilde et al., 2012)[4]. The implementation date for the correction of F&V-CV for pregnant women was latest April 30, 2010.

The rule change of 2014 had many implementation dates depending on topics with the first implementation on Jun, 2015 and latest April, 2015.

The composition change of the food package implemented in 2009 should increase participant's health without increasing state expenses (IOM, 2005). The IOM estimated that the total cost of the adapted WIC should not increase. This was due to the fact that some foods were added, others were reduced or omitted (see also section 2.3). Therefore, the estimated package costs of some packages decreased and other increased leaving a zero deficit. Nevertheless, the USDA argued on December 2006 not to able to provide all women participants with the suggested amount of cash value vouchers because of cost constrains and to ensure cost neutrality. However, as previously described the USDA decided in 2009 to cover the 25% higher expenses of F&V CV for pregnant and partially breastfeeding participants anyway. In the end there was no average monthly expense increase for WIC participants in the year 2010 as USDA reports ($ 42.4 in 2009 and $ 41.43 in 2010). In the implementation year the new interim rule was effected to about 9

[4]It is also to mention that referring to the US Department of Agriculture (USDA) all WIC participants began receiving the new food package by October 1, 2009. Therefore, it is assumed that all WIC participants which were already enrolled in the old WIC program switched to the new food package by October 1, 2009.

million participants including 10 per cent pregnant women according to USDA data.
Table A.7 gives an overview of the most important WIC implications dates till 2013 and their nine month lag. Assuming that pregnancies last on average nine months the lag can be used to define the first birth (output) after the implication. In this way the observed WIC pregnancies can be put into four treatment periods:

$$period(date) = \begin{cases} pre \text{ (pre treatment)} & \text{if} \quad date \leq \text{October 1, 2009} \\ interim^1 \text{ (interim treatment 1)} & \text{if} \quad \text{October 1, 2009} < date \leq \text{July 1, 2010} \\ interim^2 \text{ (interim treatment 2)} & \text{if} \quad \text{July 1, 2010} < date \leq \text{January 30, 2011} \\ post \text{ (post treatment)} & \text{if} \quad \text{January 30, 2011} < date \end{cases} \tag{1}$$

where *date* stands for the date of birth. This categorization is necessary because the output of each category is driven by a different available WIC program in the state at the time of pregnancy. For instance all WIC births before October 1, 2010 which are denoted as *pre* could be out of a pregnancy with the old or the WIC program which was changed by the interim rule. This mix of pregnancies is possible because depending on the state the interim rule was implemented between February 2008 and October 1, 2010 as previously explained. Nevertheless, to the existing early implication limitation[5] this period is denoted as the pre treatment period.
However, if the WIC composition change has a positive causal impact then the observed effect might be smaller due to this limitation. Table A.7 and figure A.1 illustrate and define the four treatment periods in more detail.

Summing up the implication of the WIC interim rule leads to a natural experiment imposed by a policy change. The implication variation of the interim rule leads to four time periods separated in pre, post and two interim treatment periods. The pre treatment period *pre* can have a possible bias of unobserved early implications. The main period of interest is the post treatment period denoted as *post*. The post treatment period stands for the time nine months after the full implementation of the new WIC package.

5 Econometric methodology

The difference in differences (DiD) identification strategy is used to analyse the repeated cross section dataset on a cohort level. For all birth outcomes the results are estimated by ordinary least squares. In the case of a binary outcome this gives a LPM.
The first estimation model (basic model) is a DiD model with four treatment periods and the inclusion of year and month dummies:

[5] The National Center for Health Statistics granted additional data do overcome this possible selection on November 27, 2017. On this data further analysis will be applied to improve our results.

$$
\begin{aligned}
Y_{it} = \alpha &+ \gamma WIC_i + \tau_1 interim_t^1 + \tau_2 interim_t^2 + \tau_3 post_t \\
&+ \delta_1 WIC_i * interim_t^1 + \delta_2 WIC_i * interim_t^2 \\
&+ \delta_3 WIC_i * post_t + \boldsymbol{\theta_t} + \boldsymbol{\kappa_t} + \epsilon_{it}
\end{aligned} \tag{2}
$$

where i represents each individual and t the observation time by year, month and day. Y_{it} is the birth health outcome. *WIC* is the enrolment in the WIC program and specifies the treatment and control group. $interim^1$, $interim^2$ and *post* refer to the defined treatment periods (see figure A.1 or section 4). The pre treatment period and the control group (WIC non-participants) deal as the reference categories and are included in the intercept α. The main coefficient of interest is δ_3. It represents the treatment effect of the full implementation of the WIC package on WIC participating mothers and births which were able to enrol the full WIC package during their whole pregnancy. In other words δ_3 stands for the average treatment effect. $\boldsymbol{\theta_t}$ and $\boldsymbol{\kappa_t}$ stand for year and month dummies.
To increase precision, decrease the omitted variable bias and control for possible characteristic changes of WIC participants X_{it} is added which contains mother and birth specific control variables. This leads to the main estimation model

$$
\begin{aligned}
Y_{it} = \alpha &+ \gamma WIC_i + \tau_1 interim_t^1 + \tau_2 interim_t^2 + \tau_3 post_t \\
&+ \delta_1 WIC_i * interim_t^1 + \delta_2 WIC_i * interim_t^2 \\
&+ \delta_3 WIC_i * post_t + \beta X_{it} + \boldsymbol{\theta_t} + \boldsymbol{\kappa_t} + \epsilon_{it}
\end{aligned} \tag{3}
$$

As an alternative check quarter specific cohort trends are added to create a more flexible DiD specification

$$
\begin{aligned}
Y_{it} = \alpha &+ \gamma WIC_i + \tau_1 interim_t^1 + \tau_2 interim_t^2 + \tau_3 post_t \\
&+ \delta_1 WIC_i * interim_t^1 + \delta_2 WIC_i * interim_t^2 \\
&+ \delta_3 WIC_i * post_t + \beta X_{it} + \boldsymbol{\theta_t} + \boldsymbol{\kappa_t} \\
&+ \iota_0 trend_t + \iota_1 WIC_i * trend_t + \epsilon_{it}
\end{aligned} \tag{4}
$$

In this way WIC and WIC non-participants are allowed to follow different trends over time. Standard errors of all estimations are clustered by cohort and time. Clustering standard errors reduces serial correlation but in this case might not work as strong due to small cohort size as Bertrand et al. (2004) point out.
Considering the results of these three models it is expected that the coefficients of the basic model are inconsistent with the main model due to the unobserved variable bias. On the contrary the results of the main model should not change after including time specific cohort trends. If estimates are changed then the results of the main estimation are not

robust and need to be interpreted with care. Estimates between the two coefficients δ_2 and δ_3 are expected to be quite similar and the effect of *post* larger. This is expected because the treatment between these two time periods only differs at most by $2 in the value of F&V CV. Nevertheless, the results could vary if the impact of the interim rule has a lag. This could for instance occur due to the learner effect of the new program or increased acceptance of new food in the WIC program over time. The coefficient δ_1 should either be not significant or point into the same direction and not to be lager than δ_2 and δ_3. δ_0 should be interpreted with care because of its classification described in figure A.1. Table A.8 presents a short description of all output variables and expected impact relation to the WIC package composition change. A descriptive statistic of all output variables is shown in table A.9 depending to each treatment period. The WIC sample (treatment group) has a lower share of births with *very low*, *high*, *very high birth weight*, low Apgar Scores compared to the not WIC sample (control group). WIC infants have also lower birth weight. For an overview of all output variables of each observation year see table A.10.

However, the descriptive statistics control variables were already discussed in chapter 4. The mean values of each treatment period for the control variables is presented in table A.11.

The DiD approach requires no selection change into the WIC program after the implication of the interim rule. Figure A.2 illustrates cumulative shares of characteristics for the variables *married*, *race*, *if hispanic*, mother's *education* and a *BMI*, *father's education*, mothers *age*, *birth order* on a monthly basis. Besides the known variation of WIC participants such as that WIC mothers are younger, less educated, with higher migration background no to little variation considering the selection is visible. This is also supported by figure A.3 which represents the average characteristics value of mothers over time on monthly basis. The blue line shows the mean values of WIC participants (treatment group) of each observed month. The red line represents WIC non-participants (control group). The first solid line represents the implication date of the interim rule, October 1, 2009. The area before that line is therefore the pre treatment period. The last solid line illustrates January 31, 2011. The time after this last solid line stands for the post treatment period as described in figure A.1. We clearly see that most characteristics behave similar and are parallel in the pre and post implementation period. This shows that the selection into the WIC program did not change. However, the IOM (2005) stated that the new package composition become much more attractive to different cultures and expected a higher incentive for these to participate. As the NCHS data doesn't include any variables for cultural background the only way to control for the variation of cultural differences between the time periods are the variables for race and origin. The figures for mother's race and if the mother is Hispanic show that trends of the WIC and WIC non-participants don't differ in each category. With this result the selection change of cultural differences in WIC participation between the pre treatment and post treatment period could have only occurred if other WIC participants in the same race category were crowded out. Another possibility could be that the increased culture is uniformly distribution between race variables and therefore not observed. All these scenarios are possible but rather unlikely. Notwithstanding a possible bias due to unobserved possible cultural variation might occur.

An another issue might be the gestation bias. The gestation bias was especially discussed by Joyce et al. (2008). The gestation bias is defined that mother's which have a long lasting pregnancy have more time to apply for the WIC program and if they didn't apply at the beginning of their pregnancy they may still apply at the end of it. If mothers apply at the end of their long lasting pregnancy to the WIC program then the data suggests that WIC led to a long gestation length which is biased. Another issue is that longer gestation length leads to better birth outcome such as higher birth weight and lower likelihood of low birth weight. For a clean identification of this bias information of the enrolment time would be necessary. Another precaution which was already mentioned in the literature review it to control for gestation length. This eliminates the positive effect of longer gestation length on birth outcome. In this way the estimations controls for the bias but might underestimate the treatment effect. The underestimation is due to the expected positive effect of WIC on gestation length. The gestation length bias might not be an issue if mothers with long gestation length behaved the same before the WIC composition change and after. If there was no behaviour change then the estimation results without controlling for the gestation bias should be still valid. The results are still valid because only the average treatment effect is estimated and not the whole impact of the new WIC program which would not eliminates the bias in that case. Despite to the possible elimination of the gestation bias robustness checks will be presented with controlling for gestation length.

In the following the parallel trend assumption of the DiD is discussed. The common trend assumption requires that birth outcomes of WIC (treatment group) and WIC non-participants (control group) follow parallel paths over time in in absence of the full interim rule implication. In order to show that the parallel trend assumption might be fulfilled the trends of all outcome variables of WIC and WIC non-participants are presented and discussed.

The plots of figure A.4 show that on the contrary to a different intercept almost all trends behave similar between treated and control before the interim rule change. Only birth weight and the share of very low birth weight has a different pattern in the WIC and not WIC sample.

As the parallel trend assumption is not testable it can only be assumed to hold due to the observed variable checks. However, it needs to be kept in mind that we can not control for a possible selection changes such as cultural or participation intention differences.

Summing up, our identification has some minor limitations. At first we can not controlled for the interim rule implication variation between states[6]. If some states introduced the interim rule before October 1, 2009 and the real effect of the WIC composition change is positive then the estimated effect will be smaller than the causal effect. Moreover, possible cultural changes of WIC participation are not eliminated. On the contrary the gestation bias might not be an issue but still occur if behaviour of mothers with long pregnancies has changed. Over all if unobserved behaviour has changed between mothers before and after the WIC composition change estimates might be biased.

6 Estimation results

At first results on birth outcome will be presented in this chapter. Next the sensitivity analysis is discussed.

With exception of the sensitivity analysis all outcomes were estimated as described by the equations in section 5. The estimation tables can be found in the appendix in section A.1. All regression result tables are presented as follows. The first column of each table represents the basic model (I) which stands for equation 2. In the second column (II) control variables were added as described in equation 3 and reflects the main model. The last regression of column (III) includes time specific cohort trends (see also equation 4). An overview and description of all outcome variables can be found in table A.8.

6.1 Birth outcomes

Table A.12 presents estimation results for the probability of low five-minute Apgar scores. According to the findings WIC participants had a lower share of low Apgar scores before the implication of the interim rule. The share of low Apgar scores decreased in the post treatment period compared to the pre treatment period. Looking at the main coefficient of interest δ_3 of the interaction term $WIC_i * post_t$ we see that the coefficient differs between the three regression models. The basic and main model(II) estimate a small but increased probability of low Apgar scores caused by the WIC change. This is surprising because healthier food should increase infants health and therefore the Apgar score and lower the probability of low Apgar scores. The inclusion of time specific WIC participation trends changes the sign of the coefficient. The last model leads to non significant impact with significant cohort specific time trends. The severe change of the effect between the second and third model might be because Apgar scores of the WIC sample increase in general over the observation time. This unobserved pattern in the main and basic model might have driven the wrong estimation results. In fact the first plot in figure A.4 shows that

[6] Note that detailed data on county and state level were granted by the National Center of Health Statistics on November 27, 2017. This data will improve our identification.

their is an overall decreasing trend of the Apgar score among the WIC sample that might be not due to the WIC change. It is also interesting that δ_2 has a positive sign which is consistent among models. These estimates show that the probability of low five-minute Apgar scores increased of pregnancies which might have participated in the new WIC program with \$8 or \$10 F&V CV value. The increased probability of low five-minute Apgar score could either be due to package change incontinence, the nutrition support of two different packages or only due to the new package. Either way it was expected to find similar and negative results for δ_2 and δ_3.

A similar but not such a strong pattern can be observed in the regression results for gestation age, birth weight, share of high birth weight, and very high birth weight. The results suggest that gestation age and birth weight increased over time which led to a underestimation by the basic and main model of the impact for these variables.

The basic and main model show that gestation age decreased due to the interim rule (see table A.13). The main model estimates a decrease by 0.03 and the third model by 0.05 months. However, the third model estimates a positive relationship. Not only the coefficient of δ_3 points in a different direction between the main and third model. This might be a results of the gestation selection bias which is captured by cohort specific time trends. The bias inherits that in the post treatment period less women with long lasting pregnancy enrolled the WIC program at the end of their pregnancy. This selection change might bias in the main model. However, in the third model the coefficients of δ_1 and δ_2 also behave in an unexpected pattern. All coefficients should point into the same direction with $\delta_1 < \delta_2 < \delta_3$. The further investigation of gestation age is necessary. The best solution would be controlling for WIC enrollment time during pregnancy.

Considering birth weight the results of the third model differ severely compared to the first two models (see table A.14). The WIC food package composition change decreased birth weigh by 6 gram referring to the main model. However, a not significant effect is estimated after including significant cohort trends. The third model shows that the estimation results of the first two model might suffer under a unobserved variable bias because the cohort trends partial out the high significant effect of the WIC food package composition change. In the following and to get a better picture of the birth weight change the regression results of the probabilities of very low, low, very high and high birth weight are presented.

Considering the probability of very low birth weight the estimation results are not consistent (see table A.15). The main models estimates an increased probability but the third model a decreased probability. Low birth weight estimates behave similar (see table A.16). As the included cohort specific time trends are in both estimations significant the third model is to favour. This leads to the result that the probability of births with very low and low birth weight decreased of WIC mothers due to the full implementation of the interim rule.

Much stronger and robust results are observed the probability of high birth weight (see table A.17). All models estimate a negative average treatment effect of the full implementation of the WIC package change. The main model and third model estimate a probability decrease by 0.4 and 0.3 percentage points of high birth weight births. Each cohort period specific interaction term behaves as assumed and the cohort specific time trend is not significant.
The probability of very high birth weight decreased of WIC births due to the treatment as well (see table A.18). However, δ_1 and δ_2 are insignificant or do not show into the same direction as δ_3.

Over all the birth outcome results show expected signs, imposing that the WIC food package composition change had a positive impact on birth outcomes of WIC participants. Unexpected signs of the main model are always followed by significant cohort specific time trends and a change of sign or significance. Especially the closer look on the changed birth weigh distribution shows a better picture. Checking probability changes of very low, low, high and very high birth weights reveals that the WIC composition change led mainly to a decreased probability of high and very high birth weights. This results are in line with the literature and the goals of the IOM while implementing the WIC interim rule.

6.2 Sensitivity analysis

The first robustness check was already presented in previous regression tables. Only the probability for high and very high birth weight were robust to time specific WIC trends. Two more robustness checks are discussed. At first the impact of the full implementation of the new WIC food package on prenatal pregnancy behaviour in analysed. Next the sensitivity of the coefficients is checked. Therefore gestation age and prenatal care variables were added as controls into the estimation models. All regression tables can be found in section A.2 and A.3 of the appendix.

Impact of the full implementation of the interim rule on prenatal behaviour

The interim rule only changed the food composition change and did not change any trainings and guidance of WIC participants. Therefore the interim rule change should not influence the timing of prenatal care nor the amount of prenatal care visits. To analyse whether there was a change of prenatal care we apply the same three estimation model as in the birth outcome analysis.
The estimation results show that prenatal care visits have slightly increased in the WIC sample in the post treatment period (see table A.19). Mothers didn't only visit the prenatal care more often, but the first mother's visit was also earlier after the interim rule implication (see table A.20). Prenatal care begun 0.06 months earlier referring to the third model (III) in the post treatment period of the WIC sample compared to the pre

treatment period.
These results suggest that the WIC program had an additional effect next to the food package composition change. However, no US wide training or guidance change is discussed in the literature after 2009. Therefore the results might be also due to a WIC participation selection change of early visiting prenatal care mothers. In other words either mother went earlier to prenatal care after enrolling in the WIC program or more mothers which went early to prenatal care enrolled in the WIC program. Unfortunately it is not identifiable which of these scenarios occurred because it is unknown if the WIC participant went to their first prenatal care before or after the enrolment in WIC.
The first scenario would inherit that the WIC program had an additional effect next to the food package composition change. This would violate the identification of the average treatment effect of a healthier food composition of birth outcomes as changed trainings might also influence birth outcomes. In this way all estimated effects might be overestimated. The second scenario is not that sever as it can be controlled for by adding prenatal care as a control variable.

Controlling for gestation age, amount and timing of first prenatal care visit

Adding gestation age and the amount and timing of first prenatal care visit as a control variable strengthens previous result validity. The included control variables are in all regressions highly significant and increase the adjusted R^2.
The treatment effect on low, high and very high birth weights is robust. The results of Apgar score changed only slightly (see table A.21). However, the coefficient for the average treatment effect for very low birth weight is no longer significant in the third model (see table A.22).
Further on the cohort specific time trends of birth weight are also no longer significant (see table A.23). This would imply that the main model is to favour which shows that the interim rule had a negative effect on birth weight. This would be unexpected but not that sever as the birth weight decrease occurred in the upper bound as the probability regressions of very low, low, high and very high birth weight show (see tables A.24, A.25 and A.26).

Summing up the estimated coefficients are especially in the disaggregated probability regressions of birth weight robust and imply a positive impact of the food composition change on birth outcomes.

7 Conclusions

We determine the impact of an increased subsidy of healthier foods during pregnancy on birth outcomes. The food package composition change of the WIC program which was caused by the interim rule in 2009 is used as a natural experiment to analyse the average treatment effect. The implementation setting of the interim rule led to four treatment periods with one pre and post treatment period and two interim treatment periods. However, the pre treatment period might be biased and decrease the impact due to unobserved earlier implications of the interim rule in certain states such as New York and Kentucky. The second period of main interest is the post treatment period which represents the time nine months after the full implementation of the WIC composition change in all US states. Due to the DiD setting the estimates of the average treatment effect are only applicable on WIC participants.

The estimation analysis points into a positive direction of the WIC composition change, but the estimated impacts are very small and not all results are robust. Clearly, only the results of the probability of very high and high birth weight were robust over all estimations. The WIC composition change decreased the probability of high birth weight by 0.4/0.3 percentage points of WIC participants depending on the estimation model. The regression results are not convincing if birth weight didn't change or decreased due to the full implication of the interim rule. These results emphasised a non or a negative effect of the interim rule on birth weight. However, disaggregated probability regressions of birth weight imply a positive impact. The probability of low birth weight slightly decreased. The probability of very low birth weight is not robust. The probability of very low birth weight either significantly decreased or did not change. As previously mentioned the probability of high and very high birth weights decreased. These findings show that a possible average birth weight decrease could only be due to a decreased birth weight of at least high weight births.

Out results can't be directly compared to previous WIC literature because non of them analysed the impact of the interim rule on birth outcome. Regardless the estimates of the WIC change are at least pointing into the same direction as previous studies. This imposes that the WIC program has not an adverse effect after the interim rule. Further on the small but significant estimated negative average treatment effect on the probabilities of high and very high birth weight supports the intention of the interim rule change. The first intention was to reduce excessive nutrient intakes because of the high prevalence of overweight and obesity (IOM, 2005). Studies of Gillean et al. (2005); Vidarsdottir et al. (2011) also illustrate that overweight babies cause negative morbidity for infants and adverse neonatal outcomes. These studies stress that the minor concern for overweight infants is shoulder dystocia and the main risk for mothers is an emergency section.

Summing up we show that the increased composition of F&V in the WIC package led to better birth outcome considering the share of high and very high birth weights. Other estimates need to be interpreted with care due to possible bias. However, the estimated impacts could be underestimated or overestimated due to data limitation and possible unobserved intervention changes next to the interim rule implementation. Our conclusion is that further investigation with data that contains information about participant's enrolment date and state would lead to much more credible results [7].

[7] The National Center for Health Statistics granted additional data on county and state level on November 27, 2017. We will apply further analysis on the new data to improve our results.

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A Appendix

Table A.1: Abbreviations and Explanations

Abbrevation	Meaning
CV	Cash voucher
DiD	Difference in differences
F&V	Fruits and vegetables
Full implementation of the interim rule	Is the introduction of the interim rule and the updated F&V-CV value.
IOM	Institute of Medicine
LPM	Linear probability model
NCHS	National Center for Health Statistics
NRC	National Research Council
postTP	Post treatment period
USDA	U.S. Department of Agriculture, Food and Nutrition Service
WIC	Special Supplemental Nutrition Program for Women, Infants and Children

Table A.2: Impact of WIC participation on variables of interest - adaptation of Silve et al. (2012, p. 24ff) table 2

Abbreviations: BC: Bitler and Currie (2005), Cox: Cox (2009),EIB: El-Bastawissi et al. (2007), Fif: Figlio et al. (2009), Fos: Foster et al. (2010), Joy5: Joyce et al. (2005), Joy8 1/2: Joyce et al. (2008) first and second trimester, Joy8 3: Joyce et al. (2008) third trimester, Riv: Rivera (2008)

	BC	Cox	ElB	Fif	Fos	Joy5	Joy8 1/2	Joy8 3	Riv
Pregnancy weight gain	+++						+++	+++	
Gestational age	+++			NS		+++			+++
Birth weight	+++			NS	+++	+++	NS, −−	− − −, +++	++
Nights spent in hospital by women at delivery	− − −								
Nights spent in hospital by women predelivery	NS								
Nights spent in hospital by infant	− − −								
Rate of preterm delivery	− − −	−−		NS	−−	− − −	+++	+++	−
Rate of very preterm delivery (< 32 weeks)	− − −								−−
Weight for gestation $< 10th$ percentile	− − −								
Weight-for-gestation $< 25th$ percentile	− − −								
Rate of very low birth weight $< 1,500$ grams	− − −		−−			− − −	NS	+++	−
Rate of low birth weight $< 2,500$ grams	− − −		−−	−−	− − −	− − −	−−	+++	NS
Moderate birth weight			−−						
Month started prenatal care									++
Number of prenatal visits									+++

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at $p< 0.01$, $p< 0.05$, and $p< 0.1$, respectively; "− − −", "−−", and "−" indicate a statistically significant negative association between WIC and the specific outcome at $p< 0.01$, $p< 0.05$, and $p< 0.1$, respectively; "NS" indicates a nonsignificant finding.

Table A.3: A.2 continued

Abbreviations: Hoy: Hoynes et al. (2011), Ros: Rossin-Slater (2013)

	Hoy*	Ros*
Pregnancy weight gain		
Gestational age		NS
Birth weight	++	++
Nights spent in hospital by women at delivery		
Nights spent in hospital by women predelivery		
Nights spent in hospital by infant		
Rate of preterm delivery		NS
Rate of very preterm delivery (<32 weeks)		
Weight for gestation $< 10th$ percentile		
Weight-for-gestation $< 25th$ percentile		
very low birth weight $< 1,500$ grams		
low birth weight $< 2,500$ grams	NS	+
moderate birth weight		
Month started prenatal care		
Number of prental visits		

Note: see note main table
* access to WIC was analyzed not participation in WIC

Table A.4: Share of data with available WIC enrollement status(in persent)

	2009	2010	2011	2012	2013
WIC status available	66.45	75.79	84.17	86.06	88.23
WIC status not available	33.55	24.21	15.83	13.94	11.77
Observations	413,784	400,711	396,122	396,080	394,076

Note: The characteristics of observations with available and unavailable WIC status differ slightly. Especially more white and Hispanic mothers are in the sample with unavailable WIC status. However, the characteristic difference is similar across observation years.

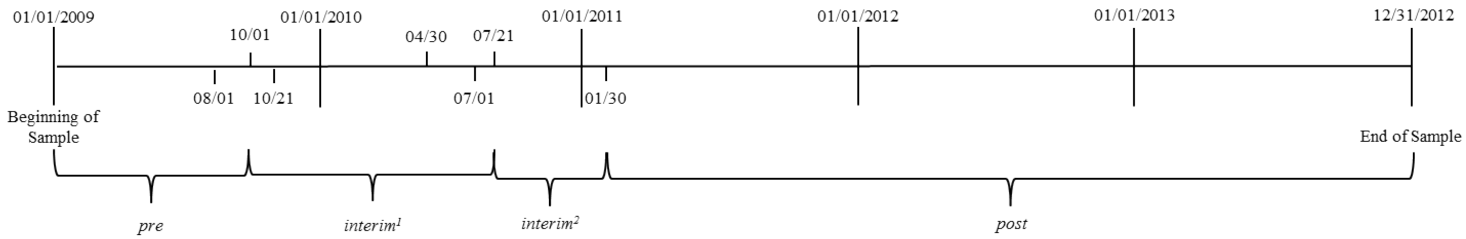
Table A.5: Descriptive statistic of control variables on observation year

	Treatment Group					Control Group					Full sample				
	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
Mother characteristics															
Mother white	74.83	73.9	71.92	71.5	70.56	81.9	81.49	81.69	81.08	80.95	76.75	76.71	76.33	75.95	76
African American	19.97	21.12	22.54	22.75	23.72	9.12	9.58	9.52	9.44	10.03	15.93	15.93	16.05	15.96	16.15
American Indian / Alaskan Native	1.37	1.38	1.46	1.45	1.51	0.71	0.63	0.67	0.65	0.75	1.19	1.15	1.18	1.16	1.18
Asian / Pacific Islander	3.83	3.59	4.08	4.3	4.21	8.27	8.31	8.13	8.83	8.27	6.12	6.21	6.44	6.93	6.67
Mother Hispanic	41.57	39.4	36.99	36.6	35.76	16.84	15.4	14.12	14.09	14.3	25.01	24.38	23.93	23.88	23.72
Mother married	62.16	62.47	62.76	62.86	63.39	21.29	21.04	20.92	20.84	21.84	41.06	40.82	40.67	40.57	40.54
Mother's age under 15 years	0.18	0.2	0.18	0.16	0.13	0.05	0.04	0.03	0.03	0.02	0.12	0.11	0.1	0.09	0.07
15–19 years	16.75	15.89	14.42	13.34	12.19	3.8	3.31	3.03	2.69	2.61	9.91	9.24	8.36	7.72	6.91
20–24 years	34.33	33.72	34.11	33.87	33.56	15.42	14.5	13.84	13.65	13.97	24.37	23.71	23.42	23.18	22.83
25–29 years	25.79	25.93	26.34	26.47	27.05	30.94	30.52	30.56	30.06	29.82	28.33	28.32	28.46	28.33	28.54
30–34 years	14.6	15.44	16.03	16.7	17.28	30.36	31.83	32.98	33.62	33.83	23.1	24.1	25.03	25.66	26.38
35–39 years	6.73	7.08	7.13	7.6	7.83	15.66	15.92	15.69	15.97	15.99	11.43	11.67	11.72	12.02	12.32
40–44 years	1.54	1.64	1.7	1.77	1.84	3.47	3.6	3.6	3.7	3.47	2.54	2.65	2.72	2.81	2.74
45–49 years	0.08	0.09	0.09	0.08	0.1	0.28	0.26	0.25	0.25	0.26	0.18	0.18	0.18	0.17	0.19
50–64 years	0	0.01	0.01	0	0.01	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.02	0.02	0.02
Mother's education 8th grade or less	8.73	7.82	7.37	6.78	6.43	2.36	2.09	1.95	1.76	1.8	5.47	4.88	4.52	4.14	3.89
9th through 12th grade with no diploma	25.73	24.4	22.8	21.82	20.64	6.47	5.91	5.41	5.02	4.95	15.83	14.81	13.61	12.83	11.97
High school graduate or GED completed	35.91	35.46	35.53	35.61	36.18	17.46	16.53	15.67	15.43	15.66	26.43	25.65	25.06	24.84	24.96
Some college credit, but not a degree	20.15	21.74	22.86	23.74	24.13	20.13	19.68	19.29	19.16	19.2	20.09	20.64	20.96	21.28	21.37
Associate degree (AA, AS)	4.45	4.82	5.29	5.42	5.93	9.31	9.32	9.62	9.61	9.84	6.94	7.15	7.57	7.64	8.06
at least Bachelor's degree	5.02	5.75	6.15	6.63	6.69	44.28	46.47	48.05	49.02	48.55	25.24	26.88	28.28	29.28	29.76
Mother Underweight $BMI < 18.5$	4.44	4.34	4.29	4.16	4.12	3.88	3.64	3.63	3.56	3.43	4.15	3.98	3.94	3.84	3.74
Normal 18.5-24.9	43.39	42.14	41.54	41.25	39.88	53.09	52.85	52.48	52.19	51.77	48.45	47.72	47.36	47.12	46.43
Overweight 25–29.9	25.97	26.23	26.15	26.17	26.59	24.26	24.43	24.62	24.74	24.78	25.08	25.3	25.34	25.41	25.59
Obesity we 30–34.9	14.62	14.91	15.21	15.31	15.7	11.03	11.25	11.31	11.36	11.61	12.74	12.99	13.14	13.19	13.45
Obesity II 35–39.9	6.85	7.2	7.37	7.56	7.81	4.87	4.84	4.93	5.02	5.18	5.81	5.97	6.07	6.2	6.36
Extreme Obesity III $BMI = 40$	4.74	5.18	5.42	5.54	5.9	2.87	3	3.03	3.13	3.23	3.77	4.03	4.15	4.24	4.43
Birth characteristics															
First in birth order	33.78	33.56	32.96	32.19	31.56	34	33.62	33.64	33.6	33.46	33.77	33.6	33.34	32.95	32.59
Second	26	25.97	26.23	26.13	25.94	30.26	30.34	30.23	30.57	30.53	28.43	28.46	28.36	28.47	28.45
Third	18.35	18.38	18.3	18.59	18.68	17.99	18.17	18.19	18.02	18.01	18.2	18.2	18.29	18.29	18.31
Fourth	10.64	10.69	10.75	10.88	11.1	9.08	9.09	9.13	9.17	9.02	9.8	9.79	9.84	9.95	9.99
Fifth or more	11.23	11.4	11.75	12.21	12.72	8.66	8.79	8.81	8.64	8.98	9.8	9.94	10.17	10.34	10.66
Single birth	97.22	97.17	97.23	97.22	97.07	96.06	95.98	96.01	95.96	96.04	96.52	96.53	96.54	96.55	96.5
Observations	132,833	145,725	157,349	158,863	156,296	142,145	157,957	176,060	182,021	191,392	413,784	400,711	396,122	396,080	394,076

Table A.6: Maximum WIC package allowance before and after the interim rule change

	Pregnant and Partially Breastfeeding	
	Before interim rule	After interim rule
Juice	288 fl oz concentrated liquid	144 fl oz single strength
Milk, fluid	28 qt	22 qt
Breakfast cereal	36 oz	36 oz
Chees		
Eggs	2-2.5	1 dozen
Fruits and vegetables		$10 in CV
Whole wheat bread or other whole grains		1 lb
Fish(canned)		
Legumes, dry and/or peanut butter	1 lb and 18 oz	1 lb and 18 oz

Figure A.1: Timeline of WIC package changes and nine months lag



Note: *pre*: All WIC mother which gave birth in that interval were either enrolled in the old or in the WIC program which was changed by the interim rule, depending on state of living. (pre treatment period)

$interim^1$: All WIC mother which gave birth in that interval were at least partly enrolled in the WIC program which was changed by the interim rule, depending on state of living. (first interim treatment period)

$interim^2$: All WIC mother which gave birth in that interval were either enrolled in the program changed by the interim with $8 or $ 10 maximum allowance of F&V CV, depending on state of living. (second interim treatment period)

post: All WIC mother which gave birth in that interval were enrolled in the program changed by the interim rule with $ 10 maximum allowance of F&V CV. (post treatment period)

Table A.7: Timetable of treatment periods depending on time of WIC package changes and nine months lag

	Date	Nine months lag	Treatment Period
Beginning of Sample	01/01/2009		*pre*: before 10/01/2009
First interim rule implication deadline (delayed)	08/01/2009		
Final interim rule implication deadline	10/01/2009	07/01/2010	$interim^1$
First possible aplication for 10$ subvention	10/21/2009	07/21/2010	
Final impication deadline for 10$ F&V CV	04/30/2010	01/30/2011	$interim^2$
End of Sample	12/31/2012		*post*: after 01/30/2011

Table A.8: Description of output variables

	Additional information	Expected effect of the interim Rule
Low five-minute Apgar Score	Stands for the share of AGP Scores below 8. In general the Apgar score is a summary measure of infant's condition and a better measure of infant mortality then birth weight. It ranges from 0 to 10. It is based on five infant health measures: heart rate, respiratory effort, muscle tone, reflex irritability and color. Each measure is given a score between 0 and 2. At the end the five scores are summed up to determine the APGAR score. Almond et al. (2005)	increase
Gestation age	The date of birth of the infant is subtracted from the last normal menses date to get the gestational age of the newborn. The gestation age is measured in weeks.	increase
Birth weight	Birth weight of infant measured in gram	increase
Very low birth weight	Share of birth weights < 1500 gram	decrease
Low birth weight	Share of birth weights ≥ 1500 and < 2500 gram	decrease
High birth weight	Share of birth weights > 4000 and ≤ 4500 gram	decrease
Very high birth weight	Share of birth weights > 4500 gram	decrease
IOM weight gain	Share of mother's weight gain in accordance with the IOM guidelines	increase
First prenatal care	Month of first prenatal visits ranging from first till tenth month.	decrease
Prenatal visits	Number of prenatal visits in categories. 0 for no visit, 1 for 1 to 2 visits, 2 for 3 to 4 visits and so on. The last category is 10 or more visits	increase

Table A.9: Descriptive statistic of output variables on treatment time

	Treatment Group				Control Group				Full sample			
	pre	$interim_1$	$interim_2$	*post treatment*	*pre*	$interim_1$	$interim_2$	*post treatment*	*pre*	$interim_1$	$interim_2$	*post treatment*
Birth Outcomes												
Low Apgar Score	3.94	3.94	3.97	4.09	4.01	3.96	3.68	3.80	3.59	3.63	3.63	3.81
Gestation length	38.58	38.57	38.61	38.61	38.58	38.58	38.59	38.66	38.57	38.57	38.60	38.63
Birth weight	3231	3231	3226	3232	3295	3294	3293	3305	3264	3262	3259	3270
very low	1.33	1.35	1.32	1.43	1.43	1.50	1.41	1.43	1.44	1.49	1.40	1.44
low	8.32	8.39	8.48	8.53	7.56	7.67	7.75	7.53	8.08	8.16	8.13	8.04
high	6.55	6.50	6.32	6.75	8.43	8.58	8.42	8.94	7.62	7.60	7.40	7.90
very high	0.90	0.92	0.87	0.94	1.15	1.14	1.11	1.21	1.04	1.05	1.00	1.08
Maternal Health Outcomes												
Prenatal visits	5.54	5.59	5.63	5.68	5.80	5.85	5.87	5.92	5.75	5.79	5.78	5.80
Prenatal care	7.66	7.41	7.30	6.33	6.80	6.74	6.64	5.78	7.77	7.49	7.30	6.57
Observations	99,145	103,338	76,253	445,935	107,655	111,664	80,989	520,363	206,800	215,002	157,242	966,298

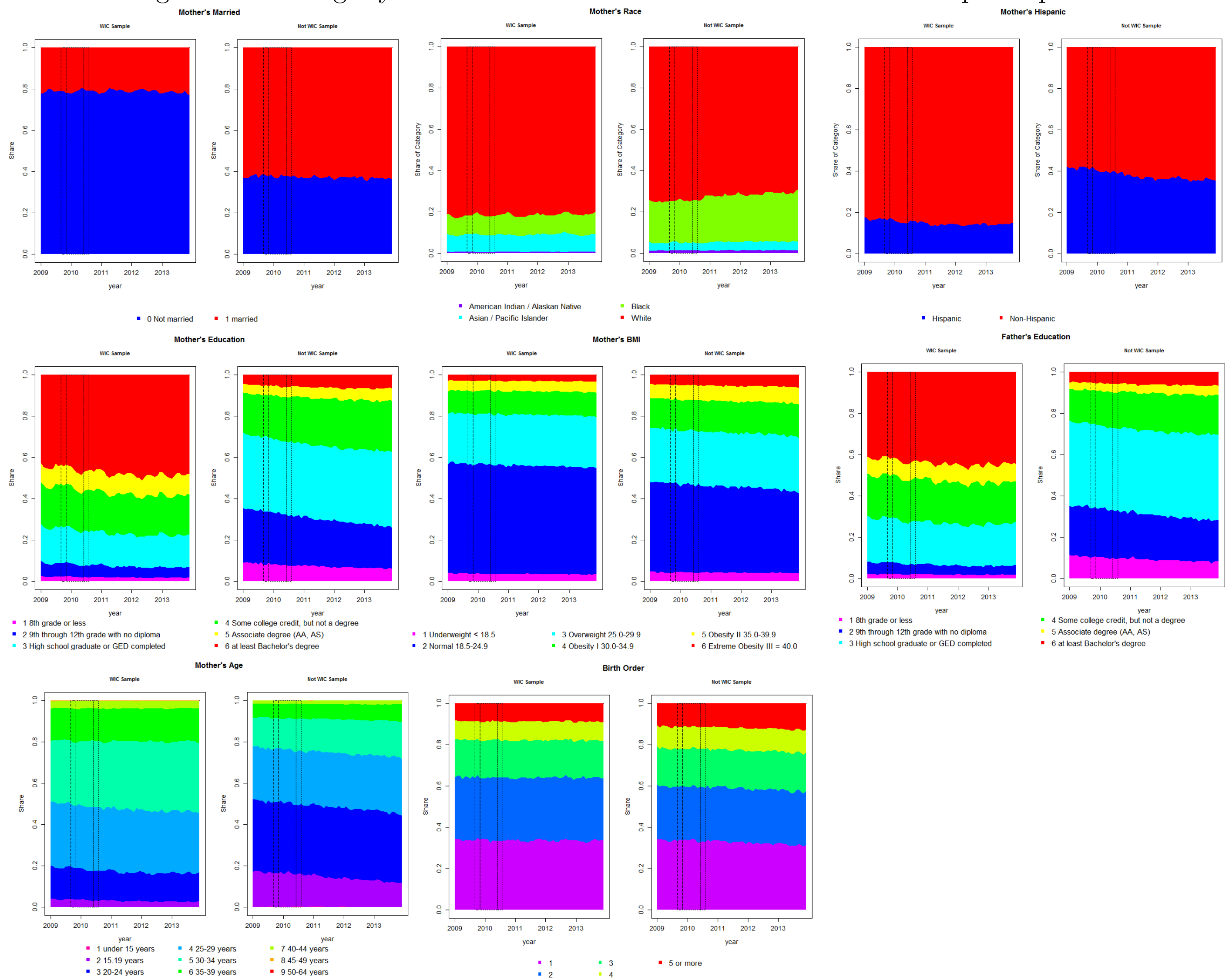
Table A.10: Descriptiv statistic of output variables on observation year

	Treatment Group					Control Group					Full sample				
Observation year	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
Birth Outcomes															
Low Apgar Score	3.91	3.98	3.93	4.03	4.27	4.02	3.80	3.73	3.71	3.97	3.59	3.64	3.67	3.75	3.98
Gestation length	38.57	38.59	38.60	38.62	38.61	38.58	38.59	38.63	38.66	38.68	38.57	38.59	38.61	38.64	38.65
Birth weight	3230	3229	3230	3235	3231	3293	3295	3301	3305	3306	3262	3262	3265	3270	3272
very low	1.34	1.34	1.41	1.41	1.45	1.44	1.46	1.46	1.44	1.41	1.46	1.44	1.45	1.44	1.44
low	8.32	8.45	8.49	8.38	8.69	7.59	7.71	7.65	7.56	7.48	8.12	8.13	8.12	8.01	8.04
high	6.50	6.44	6.62	6.82	6.83	8.44	8.53	8.86	8.97	8.94	7.58	7.53	7.76	7.94	7.98
very high	0.89	0.90	0.91	0.97	0.96	1.15	1.12	1.23	1.21	1.19	1.04	1.03	1.07	1.09	1.09
Maternal Health Outcomes															
Prenatal visits	5.55	5.62	5.67	5.68	5.68	5.80	5.87	5.92	5.92	5.92	5.76	5.79	5.80	5.80	5.79
Prenatal care	7.51	7.43	6.33	6.18	6.45	6.70	6.76	5.82	5.61	5.90	7.64	7.44	6.34	6.51	6.84
Observations	132,833	145,725	157,349	158,863	156,296	142,145	157,957	176,060	182,021	191,392	413,784	400,711	396,122	396,080	394,076

Table A.11: Descriptive statistic of controls on treatment time

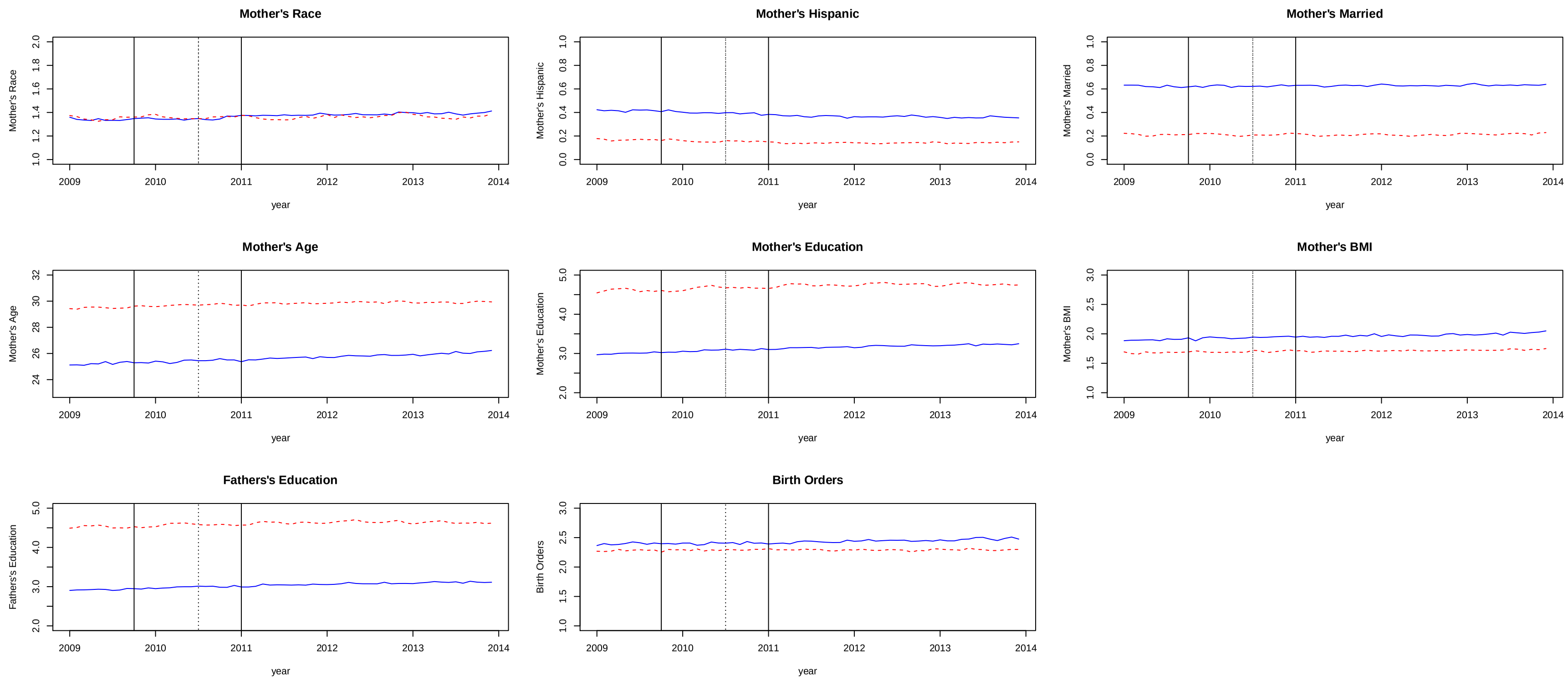
	Treatment Group				Control Group				Full sample			
	pre	$interim_1$	$interim_2$	*post treatment*	*pre*	$interim_1$	$interim_2$	*post treatment*	*pre*	$interim_1$	$interim_2$	*post treatment*
Mother characteristics												
Mother White	74.91	74.46	73.42	71.36	82.1	81.46	81.43	81.29	76.96	76.57	76.6	76.17
African American	20.02	20.33	21.65	22.97	9.05	9.48	9.61	9.63	15.81	16.01	16.02	16
American Indian / Alaskan Native	1.33	1.44	1.33	1.48	0.71	0.65	0.65	0.69	1.19	1.18	1.12	1.17
Asian / Pacific Islander	3.73	3.77	3.6	4.2	8.15	8.41	8.31	8.39	6.03	6.24	6.26	6.66
Mother Hispanic	41.69	40.16	39.17	36.47	16.85	15.66	15.66	14.16	25.03	24.19	24.96	23.86
Mother married	62.28	62.27	62.47	62.94	21.12	21.17	21.19	21.17	40.87	40.88	41.14	40.5
Mother's age under 15 years	0.19	0.18	0.2	0.16	0.05	0.04	0.04	0.03	0.12	0.11	0.11	0.09
15.19 years	16.82	16.33	15.58	13.3	3.83	3.46	3.25	2.77	9.91	9.48	9.2	7.64
20-24 years	34.3	34.05	33.59	33.86	15.47	14.78	14.46	13.78	24.33	23.97	23.7	23.1
25-29 years	25.76	25.76	26.13	26.64	31.12	30.56	30.41	30.15	28.43	28.28	28.25	28.46
30-34 years	14.63	15.02	15.6	16.67	30.38	31.39	31.8	33.53	23.14	23.72	24.11	25.73
35-39 years	6.71	6.95	7.12	7.52	15.49	15.89	16.07	15.9	11.38	11.64	11.68	12.03
40-44 years	1.51	1.62	1.67	1.76	3.37	3.58	3.7	3.57	2.49	2.61	2.74	2.74
45-49 years	0.07	0.09	0.09	0.09	0.27	0.27	0.26	0.25	0.17	0.18	0.18	0.18
50-64 years	0	0	0.01	0.01	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.02
Mother's education 8th grade or less	8.85	8.19	7.58	6.85	2.29	2.27	2.06	1.83	5.47	5.15	4.76	4.16
9th through 12th grade with no diploma	25.83	25.02	24.02	21.73	6.47	6.07	5.93	5.12	15.81	15.21	14.73	12.76
High school graduate or GED completed	35.89	35.51	35.63	35.79	17.4	16.91	16.47	15.54	26.32	25.9	25.78	24.92
Some college credit, but not a degree	20.04	21.09	22.09	23.58	20.11	19.68	19.89	19.19	20.02	20.32	20.92	21.2
Associate degree (AA, AS)	4.41	4.65	4.93	5.56	9.36	9.16	9.46	9.7	6.96	6.98	7.26	7.78
at least Bachelor's degree	4.98	5.55	5.75	6.49	44.37	45.91	46.2	48.61	25.42	26.44	26.54	29.19
Mother Underweight $BMI < 18.5$	4.43	4.41	4.29	4.2	3.92	3.71	3.57	3.54	4.16	4.06	3.92	3.84
Normal 18.5-24.9	43.49	42.65	41.88	40.87	53.23	52.98	52.6	52.13	48.6	48.04	47.41	46.96
Overweight 25.0-29.9	26.1	26.02	26.23	26.31	24.22	24.42	24.44	24.71	25.12	25.18	25.32	25.44
Obesity we 30.0-34.9	14.49	14.8	15.1	15.42	10.97	11.16	11.35	11.44	12.63	12.9	13.15	13.27
Obesity II 35.0-39.9	6.84	7.05	7.24	7.57	4.84	4.82	4.92	5.05	5.78	5.89	6.05	6.21
Extreme Obesity III $BMI = 40$	4.65	5.06	5.26	5.63	2.83	2.9	3.13	3.13	3.71	3.93	4.15	4.28
Birth characteristics												
First in birth order	33.69	33.8	33.43	32.22	33.86	33.79	33.75	33.54	33.66	33.72	33.69	32.93
Second	26.08	25.93	25.92	26.14	30.41	30.31	30.13	30.49	28.54	28.45	28.26	28.47
Third	18.41	18.32	18.37	18.51	18.04	18.16	18.03	18.07	18.25	18.2	18.13	18.29
Fourth	10.61	10.56	10.9	10.92	9.1	9.01	9.17	9.11	9.83	9.69	9.92	9.94
Fifth or more	11.21	11.38	11.38	12.21	8.6	8.72	8.91	8.79	9.71	9.94	10	10.37
Single birth	97.22	97.17	97.19	97.16	96.12	95.91	96.04	96.01	96.54	96.48	96.56	96.53
Observations	99,145	103,338	76,253	445,935	107,655	111,664	80,989	520,363	206,800	215,002	157,242	966,298

Figure A.2: Categoriy shares of characteristics of WIC and WIC non-participants



Note: Observations before the first solid line represent *post* treatment period. Between the first solid line and dotted line $interim^1$. $interim^2$ lies between the dotted and second solid line. The dashed line represents the end of the regression sample. The *post* treatment period is the time after the second solid. See also figure A.1 and table A.7.

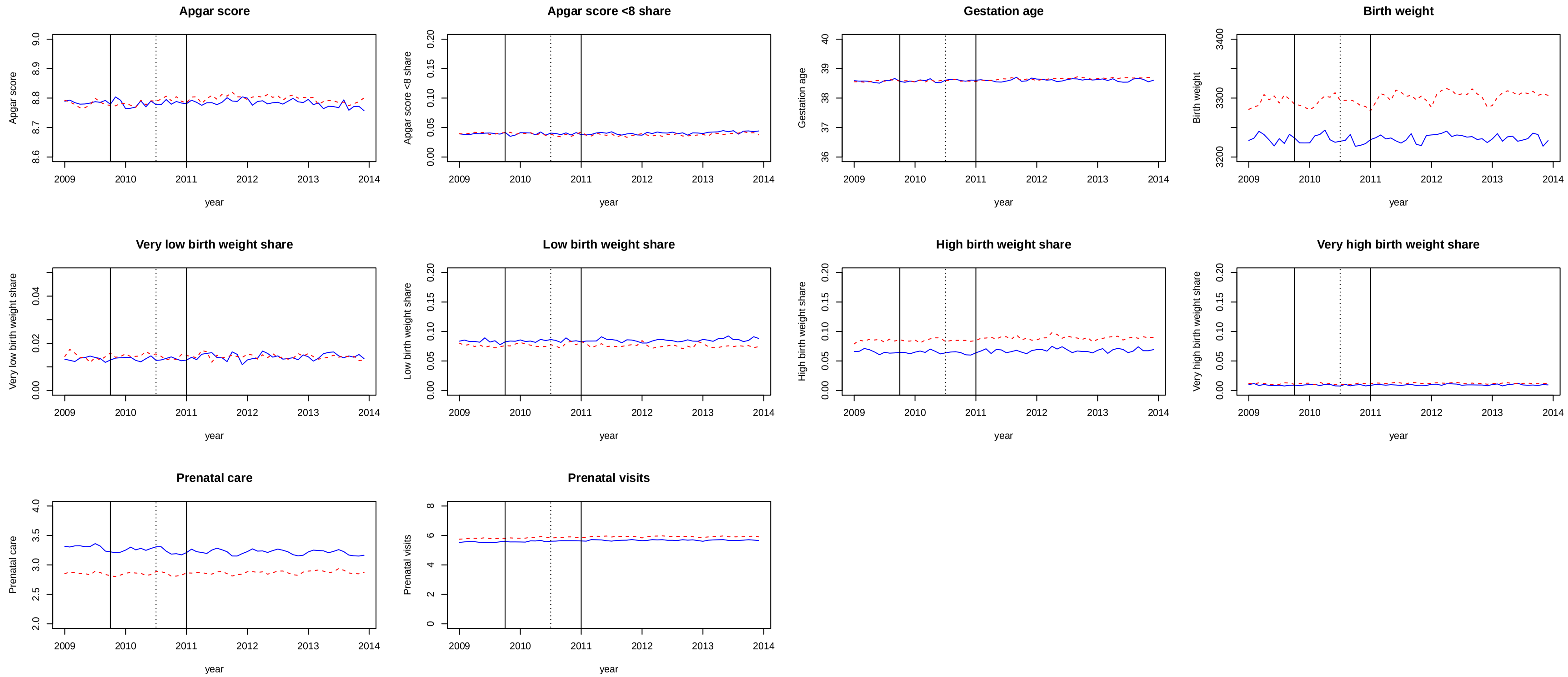
Figure A.3: Average characteristic value of WIC and WIC non-participant



Note: Blue line: WIC participants (treatment group); Red dashed line: WIC non-participants (control group).

Observations before the first solid line represent the *pre* treatment period. Between the first solid line and dotted line the fist interim treatment period. The second interim treatment period lies between the dotted and second solid line. The *post* treatment period is the time between the second solid line and the end of the regression sample in December 31, 2013. See also figure A.1 and table A.7.

Figure A.4: Average outcome value of WIC and WIC non-participants



Note: Blue line: WIC participants (treatment group); Red dashed line: WIC non-participants (control group).

Observations before the first solid line represent the *pre* treatment period. Between the first solid line and dotted line the fist interim treatment period. The second interim treatment period lies between the dotted and second solid line. The *post* treatment period is the time between the second solid line and the end of the regression sample in December 31, 2013. See also figure A.1 and table A.7.

A.1 Birth outcome regressions

Table A.12: Regression results: five minute apgar score below 8

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	−0.001***	−0.005***	−0.005***
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	−0.000	−0.001*	−0.000
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	−0.003***	−0.003***	−0.003***
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	−0.014***	−0.013***	−0.012***
	(0.001)	(0.001)	(0.001)
$\delta_1 : WIC_i * interim_t^1$	0.000***	0.000***	−0.000***
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	0.004***	0.004***	0.003***
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	0.004***	0.002***	0.000
	(0.000)	(0.000)	(0.000)
$trend_t$			*
$trend_t * WIC_i$			***
adj. R-squared	0.000	0.010	0.010
F	5.900	283.751	278.233
N	1,537,568	1,449,521	1,449,521
Mean of dep. var.		0.0372	
S.d. of dep. var.		0.1893	

Table A.13: Regression results: gestation age (continous)

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.000^{***}	0.142^{***}	0.150^{***}
	(0.000)	(0.005)	(0.006)
$\tau_1 : interim_t^1$	-0.004	-0.006^{*}	-0.012^{***}
	(0.003)	(0.003)	(0.003)
$\tau_2 : interim_t^2$	-0.023^{***}	-0.025^{***}	-0.035^{***}
	(0.003)	(0.003)	(0.003)
$\tau_3 : post_t$	-0.037^{**}	-0.034^{**}	-0.058^{***}
	(0.012)	(0.011)	(0.011)
$\delta_1 : WIC_i * interim_t^1$	-0.009^{***}	-0.017^{***}	-0.006^{***}
	(0.000)	(0.000)	(0.001)
$\delta_2 : WIC_i * interim_t^2$	0.016^{***}	0.014^{***}	0.036^{***}
	(0.000)	(0.000)	(0.002)
$\delta_3 : WIC_i * post_t$	-0.050^{***}	-0.030^{***}	0.019^{***}
	(0.000)	(0.000)	(0.004)
$trend_t$			***
$trend_t * WIC_i$			***
adj. R-squared	0.000	0.082	0.082
F	19.364	2591.089	2540.453
N	1,543,735	1,455,232	1455232
Mean of dep. var.		38.61	
S.d. of dep. var.		2.52	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.14: Regression results: birth weight (continous)

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-63.960^{***}	4.859^{***}	6.403^{***}
	(0.006)	(0.856)	(0.557)
$\tau_1 : interim_t^1$	-1.323^{*}	-0.572	-1.637^{***}
	(0.575)	(0.424)	(0.272)
$\tau_2 : interim_t^2$	-3.271^{***}	-3.331^{**}	-5.255^{***}
	(0.770)	(1.042)	(0.675)
$\tau_3 : post_t$	11.438^{***}	0.375	-4.057^{*}
	(1.885)	(2.469)	(1.858)
$\delta_1 : WIC_i * interim_t^1$	1.490^{***}	-0.545^{***}	1.695^{***}
	(0.011)	(0.061)	(0.514)
$\delta_2 : WIC_i * interim_t^2$	-3.087^{***}	-3.907^{***}	0.186
	(0.010)	(0.087)	(0.935)
$\delta_3 : WIC_i * post_t$	-8.938^{***}	-5.991^{***}	3.391
	(0.015)	(0.110)	(1.987)
$trend_t$			NS
$trend_t * WIC_i$			***
adj. R-squared	0.004	0.138	0.138
F	255.164	4654.986	4563.833
N	1,543,802	1,455,123	1,455,123
Mean of dep. var.		3266	
S.d. of dep. var.		592	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.15: Regression results: probability of very low birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.001^{***}	-0.005^{***}	-0.005^{***}
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	0.001^{***}	0.001^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.000^{***}	0.001^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	-0.001^{**}	-0.001^{**}	-0.001^{*}
	(0.000)	(0.000)	(0.000)
$\delta_1 : WIC_i * interim_t^1$	-0.001^{***}	-0.000^{***}	-0.001^{***}
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	0.000^{***}	0.000^{***}	-0.000
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	0.001^{***}	0.000^{***}	-0.000^{**}
	(0.000)	(0.000)	(0.000)
$trend_t$			***
$trend_t * WIC_i$			***
adj. R-squared	0.000	0.031	0.031
F	1.926	936.060	917.718
N	1,543,802	1,455,123	1,455,123
Mean of dep. var.		0.0145	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.16: Regression results: probability of low birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	0.008^{***}	-0.006^{***}	-0.006^{***}
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.001^{**}	0.002^{***}	0.003^{***}
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	0.007^{***}	0.013^{***}	0.015^{***}
	(0.001)	(0.001)	(0.001)
$\delta_1 : WIC_i * interim_t^1$	-0.000^{***}	0.001^{***}	-0.000^{***}
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	-0.000^{***}	0.000^{*}	-0.001^{***}
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	0.002^{***}	0.001^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$trend_t$			**
$trend_t * WIC_i$			***
adj. R-squared	0.000	0.131	0.131
F	21.784	4389.214	4303.228
N	1,543,802	1,455,123	1,455,123
Mean of dep. var.		0.0808	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.17: Regression results: probability of high birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.019^{***}	-0.001^{*}	-0.001^{**}
	(0.000)	(0.001)	(0.000)
$\tau_1 : interim_t^1$	0.002^{***}	0.002^{***}	0.002^{***}
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.002^{***}	0.001^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	0.008^{***}	0.007^{***}	0.006^{***}
	(0.001)	(0.001)	(0.001)
$\delta_1 : WIC_i * interim_t^1$	-0.002^{***}	-0.003^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	-0.002^{***}	-0.003^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	-0.003^{***}	-0.004^{***}	-0.003^{**}
	(0.000)	(0.000)	(0.001)
$trend_t$			NS
$trend_t * WIC_i$			NS
adj. R-squared	0.002	0.021	0.021
F	116.642	617.827	605.721
N	1,543,802	1,455,123	1,455,123
Mean of dep. var.		0.0776	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.18: Regression results: probability of very high birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.003^{***}	-0.000^{*}	-0.000^{**}
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	0.009^{***}	0.011^{***}	0.012^{***}
	(0.000)	(0.000)	(0.000)
$\delta_1 : WIC_i * interim_t^1$	0.000^{***}	0.000^{***}	0.000^{***}
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	0.000^{***}	0.000^{***}	-0.000
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	-0.000^{***}	-0.000^{***}	-0.001^{***}
	(0.000)	(0.000)	(0.000)
$trend_t$			***
$trend_t * WIC_i$			**
adj. R-squared	0.000	0.005	0.005
F	12.746	158.848	155.746
N	1,543,802	1,455,123	1,455,123
Mean of dep. var.		0.0106	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

A.2 Impact of the Full Implementation of the Interim Rule on Prenatal Behaviour

Table A.19: Regression results: number of prenatal care visit

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	−0.254***	0.232***	0.236***
	(0.000)	(0.004)	(0.005)
$\tau_1 : interim_t^1$	0.016***	0.017***	0.014*
	(0.005)	(0.005)	(0.006)
$\tau_2 : interim_t^2$	0.023***	0.025***	0.020*
	(0.006)	(0.007)	(0.008)
$\tau_3 : post_t$	0.144***	0.160***	0.149***
	(0.005)	(0.005)	(0.008)
$\delta_1 : WIC_i * interim_t^1$	−0.006***	−0.002***	0.004
	(0.000)	(0.000)	(0.002)
$\delta_2 : WIC_i * interim_t^2$	0.018***	0.012***	0.022***
	(0.000)	(0.000)	(0.003)
$\delta_3 : WIC_i * post_t$	0.011***	0.011***	0.035***
	(0.000)	(0.000)	(0.007)
$trend_t$			***
$trend_t * WIC_i$			**
adj. R-squared	0.005	0.053	0.053
F	354.430	1569.981	1539.259
N	1,487,717	1,412,786	1,412,786
Mean of dep. var.		3.04	
S.d. of dep. var.		1.55	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.20: Regression results: first prenatal care visit

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	0.452***	0.124***	0.131***
	(0.000)	(0.009)	(0.010)
$\tau_1 : interim_t^1$	0.006	0.008	0.003
	(0.005)	(0.006)	(0.006)
$\tau_2 : interim_t^2$	0.018*	0.020*	0.011
	(0.008)	(0.009)	(0.009)
$\tau_3 : post_t$	−0.075***	−0.043**	−0.064***
	(0.012)	(0.014)	(0.014)
$\delta_1 : WIC_i * interim_t^1$	−0.040***	−0.046***	−0.036***
	(0.000)	(0.000)	(0.001)
$\delta_2 : WIC_i * interim_t^2$	−0.066***	−0.067***	−0.048***
	(0.000)	(0.000)	(0.001)
$\delta_3 : WIC_i * post_t$	−0.106***	−0.105***	−0.062***
	(0.000)	(0.000)	(0.003)
$trend_t$			*
$trend_t * WIC_i$			***
adj. R-squared	0.015	0.044	0.044
F	1038.215	1316.447	1290.940
N	1,490,711	1,417,678	1,417,678
Mean of dep. var.		5.79	
S.d. of dep. var.		1.86	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

A.3 Robustness Ckecks: Birth outcome regressions

Table A.21: Robustness ckeck: five minute apgar score below 8

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.002^{***}	-0.003^{***}	-0.003^{***}
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	-0.001^{*}	-0.001^{***}	-0.001^{**}
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	-0.004^{***}	-0.004^{***}	-0.004^{***}
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	-0.019^{***}	-0.017^{***}	-0.016^{***}
	(0.001)	(0.001)	(0.001)
$\delta_1 : WIC_i * interim_t^1$	0.001^{***}	0.000^{***}	0.000
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	0.004^{***}	0.004^{***}	0.004^{***}
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	0.003^{***}	0.002^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
Gestation length	-0.017^{***}	-0.017^{***}	-0.017^{***}
	(0.000)	(0.000)	(0.000)
First prenatal care	0.002^{***}	0.001^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
Prenatal visits	-0.001^{***}	-0.002^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$trend_t$			NS
$trend_t * WIC_i$			***
adj. R-squared	0.050	0.052	0.052
F	3063.418	1441.827	1415.137
N	1,459,597	1,390,750	1,390,750
Mean of dep. var.		0.0372	
S.d. of dep. var.		0.1893	

Table A.22: Robustness ckeck: probability of very low birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.002^{***}	-0.002^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	0.001^{***}	0.001^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	-0.005^{***}	-0.004^{***}	-0.005^{***}
	(0.000)	(0.000)	(0.001)
$\delta_1 :$	-0.001^{***}	-0.001^{***}	-0.001^{***}
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	0.001^{***}	0.000^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	-0.000^{***}	-0.001^{***}	0.000
	(0.000)	(0.000)	(0.000)
Gestation length	-0.023^{***}	-0.022^{***}	-0.022^{***}
	(0.000)	(0.000)	(0.000)
First prenatal care	0.001^{***}	0.001^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
previs_rec	-0.002^{***}	-0.002^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$trend_t$			NS
$trend_t * WIC_i$			**
adj. R-squared	0.250	0.248	0.248
F	19576.750	8667.775	8507.272
N	1,465,097	1,395,899	1,395,899
Mean of dep. var.		0.0145	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.23: Robustness ckeck: birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-54.111^{***}	-14.429^{***}	-13.951^{***}
	(0.256)	(0.331)	(0.210)
$\tau_1 : interim_t^1$	-0.426^{**}	0.041	-0.287^{**}
	(0.141)	(0.216)	(0.105)
$\tau_2 : interim_t^2$	-1.393^{**}	-1.696	-2.290^{***}
	(0.487)	(1.058)	(0.628)
$\tau_3 : post_t$	25.719^{***}	18.761^{***}	17.393^{***}
	(0.645)	(1.711)	(0.746)
$\delta_1 : WIC_i * interim_t^1$	1.505^{***}	0.477^{***}	1.168^{*}
	(0.014)	(0.052)	(0.566)
$\delta_2 : WIC_i * interim_t^2$	-6.608^{***}	-5.929^{***}	-4.665^{***}
	(0.044)	(0.104)	(1.077)
$\delta_3 : WIC_i * post_t$	-4.279^{***}	-3.015^{***}	-0.117
	(0.012)	(0.132)	(2.283)
Gestation length	127.693^{***}	114.061^{***}	114.060^{***}
	(1.214)	(1.240)	(1.240)
First prenatal care	-12.781^{***}	-7.903^{***}	-7.904^{***}
	(0.465)	(0.480)	(0.479)
Prenatal visits	14.656^{***}	15.295^{***}	15.294^{***}
	(0.235)	(0.134)	(0.134)
$trend_t$			***
$trend_t * WIC_i$			NS
adj. R-squared	0.299	0.354	0.354
F	24973.121	14441.231	14173.810
N	1,465,097	1,395,899	1,395,899
Mean of dep. var.		3266	
S.d. of dep. var.		592	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.24: Robustness ckeck: probability of low birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	0.004***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	−0.001**	−0.001***	−0.001*
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.000	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	0.010***	0.011***	0.012***
	(0.001)	(0.000)	(0.000)
$\delta_1 : WIC_i * interim_t^1$	−0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	0.002***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	0.000***	−0.000	−0.001***
	(0.000)	(0.000)	(0.000)
Gestation length	−0.054***	−0.046***	−0.046***
	(0.001)	(0.001)	(0.001)
First prenatal care	0.004***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
Prenatal visits	−0.003***	−0.005***	−0.005***
	(0.000)	(0.000)	(0.000)
$trend_t$			NS
$trend_t * WIC_i$			***
adj. R-squared	0.243	0.298	0.298
F	18850.731	11154.971	10948.399
N	1,465,097	1,395,899	1,395,899
Mean of dep. var.		0.0808	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.25: Robustness ckeck: probability of high birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.017^{***}	-0.004^{***}	-0.004^{***}
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	0.002^{***}	0.002^{***}	0.002^{***}
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.001^{***}	0.001^{*}	0.001^{**}
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	0.012^{***}	0.009^{***}	0.009^{***}
	(0.001)	(0.001)	(0.001)
$\delta_1 : WIC_i * interim_t^1$	-0.002^{***}	-0.002^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	-0.002^{***}	-0.003^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	-0.003^{***}	-0.003^{***}	-0.003^{**}
	(0.000)	(0.000)	(0.001)
Gestation length	0.012^{***}	0.011^{***}	0.011^{***}
	(0.000)	(0.000)	(0.000)
First prenatal care	-0.002^{***}	-0.001^{***}	-0.001^{***}
	(0.000)	(0.000)	(0.000)
Prenatal visits	0.004^{***}	0.003^{***}	0.003^{***}
	(0.000)	(0.000)	(0.000)
$trend_t$			NS
$trend_t * WIC_i$			NS
adj. R-squared	0.015	0.031	0.031
F	917.201	844.584	828.944
N	1,465,097	1,395,899	1,395,899
Mean of dep. var.		0.0776	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.

Table A.26: Robustness ckeck: probability of very high birth weight

	(I) Basic Model	(II) + control variables	(III) + time specific cohort trends
$\gamma : WIC_i$	-0.002^{***}	-0.001^{***}	-0.001^{***}
	(0.000)	(0.000)	(0.000)
$\tau_1 : interim_t^1$	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
$\tau_2 : interim_t^2$	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)
$\tau_3 : post_t$	0.009^{***}	0.012^{***}	0.012^{***}
	(0.000)	(0.000)	(0.000)
$\delta_1 : WIC_i * interim_t^1$	0.000^{***}	0.000^{***}	0.000^{**}
	(0.000)	(0.000)	(0.000)
$\delta_2 : WIC_i * interim_t^2$	-0.000^{*}	0.000^{***}	-0.000^{***}
	(0.000)	(0.000)	(0.000)
$\delta_3 : WIC_i * post_t$	-0.000^{***}	-0.000^{***}	-0.001^{***}
	(0.000)	(0.000)	(0.000)
Gestation length	0.002^{***}	0.001^{***}	0.001^{***}
	(0.000)	(0.000)	(0.000)
First prenatal care	-0.000^{***}	-0.000^{**}	-0.000^{**}
	(0.000)	(0.000)	(0.000)
Prenatal visits	0.001^{***}	0.000^{***}	0.000^{***}
	(0.000)	(0.000)	(0.000)
$trend_t$			***
$trend_t * WIC_i$			***
adj. R-squared	0.002	0.007	0.007
F	113.142	178.445	175.161
N	1,465,097	1,395,899	1,395,899
Mean of dep. var.		0.0106	
S.d. of dep. var.		–	

Note: All models include year and month dummies. Robust standard errors are clustered by year and WIC participation. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent level, respectively.