

WIC in Your Neighborhood: New Evidence on the Impacts of Geographic Access to Clinics

Maya Rossin-Slater*

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Abstract

A large body of evidence indicates that conditions *in-utero* and health at birth matter for individuals' long-run outcomes, suggesting potential value in programs aimed at pregnant women and young children. This paper uses a novel identification strategy and data from birth and administrative records over 2005-2009 to provide causal estimates of the effects of geographic access to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). My empirical approach uses within-zip-code variation in WIC clinic presence together with maternal fixed effects, and accounts for the potential endogeneity of mobility, gestational-age bias, and measurement error in gestation. I find that access to WIC increases food benefit take-up, pregnancy weight gain, birth weight, and the probability of breastfeeding initiation at the time of hospital discharge. The estimated effects are strongest for mothers with a high school education or less, who are most likely eligible for WIC services.

Keywords: WIC; health at birth; pregnancy; public programs; low-income women and children

*Columbia University, Department of Economics. 1022 International Affairs Building, 420 West 118th Street, New York, NY 10027. Contact e-mail: mr2856@columbia.edu. Contact phone: 650-906-0158.

1 Introduction

A growing body of evidence suggests that *in-utero* conditions and health at birth matter for individuals' later-life well-being (Almond and Currie, 2011a,b). The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is the major program in the United States that aims to improve the health and nutritional well-being of low-income pregnant and postpartum women and children under age five, and thus has potential to improve the life chances of the children who benefit from it. Program participants receive free nutritional food packages, as well as education about health, nutrition, and the benefits of breastfeeding. In recent years, there has also been a particular emphasis on the importance of coordination of WIC with other social programs and services. WIC clinics can thus serve as gateways for clients to receive other services, and WIC staff can make referrals to other agencies such as public health clinics, Medicaid, Food Stamps (also currently known as the Supplemental Nutrition Assistance Program), housing services, and job banks, among others.

In 2011, Congress appropriated \$6.7 billion to fund WIC, and the program serves approximately 2 million women and 7 million children per month.¹ Yet despite the continued growth of the program from its inception in 1974, the debate on the effectiveness of WIC has not been settled. This paper seeks to inform this debate in two ways. First, I analyze whether geographic access to WIC clinics affects WIC food benefit take-up, a question that has not been previously thoroughly addressed. Then, I use a novel identification strategy that relies on within-zip-code variation in WIC clinic openings and closings in Texas over 2005-2009 with maternal fixed effects, and accounts for the potential endogeneity of mobility, gestational-age bias, and measurement error in gestation, to provide plausibly causal estimates of the effects of access to WIC clinics on pregnancy behaviors, birth outcomes and breastfeeding.

While many studies have attempted to estimate the effects of the receipt of WIC food benefits on infant health (e.g. Bitler and Currie, 2005; Joyce *et al.*, 2005; Joyce *et al.*, 2008; Figlio *et al.*, 2009; Hoynes *et al.*, 2011), fewer have considered the determinants of WIC benefit take-up. A large literature documents less-than-full take-up rates for public programs

¹Information about the WIC program is available at <http://www.fns.usda.gov/wic/WIC-Fact-Sheet.pdf>

among eligible individuals (see Currie, 2006 for a review), and the problem with pregnant women’s WIC take-up is similarly substantial (Bitler *et al.*, 2003). One hypothesis is that geographic access to WIC clinics may affect WIC participation. However, no past studies have rigorously tested this hypothesis.² In fact, in a recent review of the literature on WIC, Ludwig and Miller (2005) write that “...more evidence on what drives WIC participation would be extremely valuable for both research and policy.” Past research does find that distance to social service agencies that administer the childcare subsidy process affects the likelihood of childcare subsidy take-up (Herbst and Tekin, 2010).³ Further, evidence from psychology and behavioral economics suggests that proximity to program offices may be particularly salient for take-up because it can lead to more awareness of program existence, more frequent reminders to sign up, and reduced “hassle” costs (Bertrand *et al.*, 2006). It is therefore conceivable that geographic access to WIC clinics determines pregnant women’s likelihood of signing up for and receiving WIC benefits.

Additionally, whether WIC actually affects infant health and breastfeeding remains an open question. Many of the existing studies on WIC rely on comparisons between WIC participants and non-participants and likely suffer from omitted variables bias due to non-random selection into WIC participation.⁴ Recent work has attempted to deal with this issue by using more narrowly defined comparison groups (Bitler and Currie, 2005; Joyce *et al.*, 2005, 2008; Figlio *et al.*, 2009), employing propensity score matching methods (Gueorguieva *et al.*, 2009), including maternal fixed effects (Brien and Swann, 2001; Chatterji *et al.*, 2002; Kowaleski-Jones and Duncan, 2002), and using variation in state program parameters as

²It is important to note that Bitler *et al.* (2003) do include a measure of geographic access — the number of WIC agencies per capita in each state — in their study of the determinants of WIC benefit take-up. However, this variable may be correlated with other state time-varying characteristics that affect benefit take-up such as shocks to labor market conditions or demographic shifts that might affect the demand for WIC services. In my study, I exploit a much finer level of variation in geographic access at the zip code level, and include maternal fixed effects to limit the possibility of omitted variables bias.

³Past research has also considered distance to sites for health and educational services. For example, Kane and Rouse (1993) and Card (1993) use distance to the nearest college as an instrument for educational attainment, while Currie and Reagan (2003) estimate the impacts of distance to the nearest hospital on access to care.

⁴An additional issue is that many of these studies measure WIC participation with an indicator for receipt of food benefits. However, as discussed in more detail throughout this paper, WIC clinic access confers a variety of other benefits to clients such as health check-ups, health education, and referrals to other services. Studies that focus on the effects of food benefit receipt cannot speak to the possible additional impacts of the other aspects of the WIC program.

instruments (Chatterji *et al.*, 2002). Yet the findings from these studies are mixed, arguably in part because they are still plagued by identification issues.⁵ Studies that rely on narrowly defined comparison groups and propensity score matching may still suffer from bias due to selection on unobservable variables (such as knowledge about the program, access to transportation, and the ability to navigate bureaucratic application processes), while studies that include maternal fixed effects may be confounded by other time-varying within-family changes between sibling births (such as parental marriage or divorce and changes in family wealth). Additionally, variation in WIC parameters across states is not large, and thus these variables create poor instruments for WIC participation (Bitler and Currie, 2005).

Hoynes *et al.* (2011) present a notable improvement upon the existing literature. They rely on county-year variation in the initial roll-out of the WIC program in the 1970s for identification, and provide substantial evidence that program implementation was uncorrelated with other determinants of birth outcomes. They find that county-level access to WIC services leads to modest improvements in birth weight. However, despite the important methodological contributions of this study to the literature, it is limited in three dimensions. First, the authors are unable to observe actual WIC participation or food receipt in their data, so their estimates represent intent-to-treat reduced-form effects of county-level access to WIC on birth weight, and cannot address a crucial question of the extent to which having a WIC clinic in one’s county of residence affects WIC food benefit take-up.⁶ Second, the analysis relies on older birth records data which do not contain information on either breastfeeding or various pregnancy behaviors that may be affected by WIC. Third, the analysis presents estimates of the effects of access to WIC in the 1970s, when the program was first implemented and therefore operated on a much smaller scale than it does today. Understanding the causal effects of WIC in the current context, with its emphasis on coordination of social service programs, and especially during the time of the Great Recession, is critical for policy implications today.

⁵Estimates of the effect of WIC on the likelihood of low birth weight range from no effect for the whole sample (Joyce *et al.*, 2005) to a 30 percent reduction (Bitler and Currie, 2005) to an over 100 percent reduction (Figlio *et al.*, 2009).

⁶Hoynes *et al.* (2011) do calculate “treatment-on-the-treated” effects by scaling their coefficients by estimates of WIC participation rates from other data sources. However, as discussed in more detail in Section 5, it is difficult to interpret these effects without a “first-stage” estimate of the effect of county-level WIC access on WIC participation.

This paper uses restricted data from the universe of Texas birth records over 2005-2009 together with administrative data on the locations and dates of openings and closings of all WIC clinics that operated in Texas over this time period. The births data contain information on mothers' full maiden names, exact dates of birth, states or countries of birth, and zip codes of residence, which allows me to link siblings born to the same mother and determine whether mothers had an operating WIC clinic in their zip codes of residence during their pregnancies.⁷ Additionally, unlike older birth records data, these data contain information on WIC food receipt during pregnancy, a wide range of pregnancy behaviors, as well as on breastfeeding at the time of hospital discharge.

My data allow me to compare births by mothers who did and did not have a WIC clinic in their zip code of residence during pregnancy, and to include maternal fixed effects to control for all time-invariant characteristics of mothers that may be correlated with residential location, WIC participation, and birth outcomes. However, there are several potential issues with this approach. First, a mother's residential location during pregnancy is possibly endogenous as her decision to move between pregnancies may be correlated with determinants of WIC clinic openings and closings (for example, unemployment shocks may lead to increased mobility following job loss and greater demand for WIC services). A second problem is that the use of maternal fixed effects may exacerbate biases due to measurement error. A third issue, which has been pointed out by other researchers (e.g., Joyce *et al.*, 2005; Ludwig and Miller, 2005; Joyce *et al.*, 2008), is that longer gestation periods are mechanically correlated with a higher likelihood of WIC use as women with longer pregnancies have more time to receive WIC services. In the above design, since women with longer pregnancies are more likely to experience a clinic opening, there should be a positive correlation between WIC clinic presence and gestation. Since gestation is correlated with other birth outcomes such as birth weight, the estimates of access to WIC on infant health will be biased upward as a result of this issue.

To account for the potential endogeneity of maternal residence, measurement error, and the mechanical correlation between gestation and WIC, I implement a maternal fixed effects-

⁷As discussed briefly in Section 5, I also use mothers' exact residence addresses in some alternative specifications that estimate the effect of distance to the nearest WIC clinic.

instrumental variables strategy. My instrument is an indicator for whether the mother would have had an open WIC clinic during the current pregnancy *assuming she continued to live in the first zip code in which I observe her, and assuming her pregnancy lasted 39 weeks following her estimated week of conception*.⁸ Since the first zip code is a fixed characteristic of the mother, the first zip code itself does not have an independent effect on WIC use or birth outcomes in models that include maternal fixed effects. This instrument is highly correlated with whether the mother had an open WIC clinic during the actual gestation length of her current pregnancy and in her actual zip code of residence, but should have no independent effect on prenatal WIC food benefit receipt, other pregnancy behaviors, birth outcomes, or breastfeeding. I provide empirical evidence demonstrating that within-zip-code variation in WIC clinic presence is generally uncorrelated with changes in observable maternal characteristics, which reinforces the validity of my identification strategy. Importantly, unlike previous studies on WIC that use maternal fixed effects, my approach relies on variation in WIC access stemming only from WIC clinic openings and closings, rather than from other factors that may affect a woman’s decision to participate in WIC during one pregnancy and not during another.

My results suggest that geographic access to WIC is fairly important. The presence of a WIC clinic in a mother’s zip code of residence during pregnancy increases her likelihood of WIC food receipt by about 6 percent at the sample mean. The estimated coefficients are higher for mothers with a high school education or less and mothers whose first births were paid by Medicaid, who are most likely to be eligible for WIC.

Additionally, I explore differences in effects of access by the type of clinic location. I find that the effect on WIC food benefit take-up is concentrated among mothers in urban areas, where distances to WIC clinics are relatively short. This disparity in estimated effects between urban and rural areas suggests that physical distance can have distinct implications in different contexts. In particular, while a distance of a few miles may generate substantial costs for urban residents (especially those who do not drive), it may be trivial to rural

⁸The first zip code of observation is the mother’s zip code of residence at the time of her first birth occurring between January 2005 and December 2009. The mother may have had children born prior to 2005, but those children are not included in the analysis. The week of conception is calculated by subtracting gestation length in weeks from the child’s exact birth date.

residents who are accustomed to traveling long distances by car. Further, I find that the effects are driven by access to WIC clinics located in non-health-department facilities such as community centers, schools, churches, and mobile vehicles. These clinics are more likely to have visible advertisements for WIC than those located inside county health departments or large hospitals.⁹ My results may suggest that proximity to WIC clinics affects take-up through dimensions other than travel cost savings — for example, women with WIC clinics in their (urban) zip codes may be more likely to physically see them on a regular basis and thus become aware of the program and be reminded to sign up.

I also find that WIC clinic access affects pregnancy weight gain: while it reduces the likelihood of gaining too little weight (defined as less than 16 lbs), it also increases the likelihood of gaining too much weight (defined as more than 40 lbs). These results point to a possible unintended consequence of WIC for maternal health and suggest that more emphasis on nutrition education may be needed in the program.

Despite the potentially adverse effect on maternal weight gain, I find that WIC clinic presence is associated with a 27 gram increase in average birth weight (a 0.8 percent increase at the sample mean). This increase is mostly concentrated in the middle of the birth weight distribution; while there is a marginally significant decline in low-birth-weight (less than 2,500 grams) births among low-educated mothers, there are no effects on the likelihood of high-birth-weight (above 4,500 grams) births. For mothers with a high school degree or less, I further document a positive effect on breastfeeding — the likelihood that a child is being breastfed at the time of discharge from the hospital increases by about 6 percent. This result is a novel estimate of the causal effect of access to WIC on breastfeeding, as most of the recent studies have not had this outcome available in their data (e.g. Hoynes *et al.*, 2011; Figlio *et al.*, 2009). Importantly, I find no placebo effects of having an open WIC clinic either 3-6 months or 6-9 months following childbirth or before conception (and no open WIC clinic during pregnancy), which yields further support for my identification strategy.

Note that while I show that WIC clinic presence is a determinant of WIC food receipt, WIC clinics can affect birth outcomes and breastfeeding through other channels, such as the health check-ups, the provision of educational materials about maternal and child health,

⁹See, for example, the mobile WIC clinic in Figure 1.

and referrals to other social services. In fact, I find some evidence that suggests that aspects of WIC clinics other than the food benefits matter. For instance, there are positive effects on the likelihood of less-educated women recorded as having diabetes or hypertension during pregnancy, which could be driven by higher diagnosis rates of such conditions at WIC clinics or through referrals from WIC.¹⁰ Additionally, I provide suggestive evidence that WIC clinic access may increase Medicaid coverage and receipt of prenatal care from public clinics (the coefficients are positive and large relative to sample means, but statistically insignificant). Unfortunately, I cannot investigate the referral channel more thoroughly as my data provide no information on the take-up of any other public benefits or programs.

Consequently, my estimates represent the overall effects of geographic access to WIC clinics on WIC food receipt, pregnancy behaviors, birth outcomes, and breastfeeding, but cannot solely identify the causal effects of receiving WIC food benefits on infant health. However, these estimates are arguably more policy-relevant as they can help inform the debate on the costs and benefits of operating WIC clinics in the current policy context.

This paper proceeds as follows. I discuss the WIC program and the related literature in more detail in Section 2, and provide information on the data and sample in Section 3. Section 4 presents the empirical methods, while Section 5 discusses the results and some robustness checks. Section 6 concludes.

2 Background

The WIC program was first established as a pilot program in 1972, implemented in 1974, and then permanently expanded to most U.S. counties by the end of the 1970s (Hoynes *et al.*, 2011). The goal of the program is to improve the health and nutritional well-being of low-income pregnant and post-partum women, infants, and young children by providing them with nutritious food packages and health education. In Texas, as well as in other states, eligibility rules require participants to live in households with incomes below 185% of the poverty line and to be “at nutritional risk”.¹¹ Participating pregnant and post-partum

¹⁰It is also possible that these effects are driven by an increase in the likelihood of gaining too much weight during pregnancy. I cannot distinguish between these two possible channels in the data.

¹¹In Texas, WIC clients receive an initial health and diet screening at a WIC clinic to determine nutritional risk. WIC uses two main categories of nutritional risk: (1) medically-based risks such as a history of poor

women, as well as parents and guardians of children under age five, receive monthly benefits from WIC that can be taken to grocery stores and used to buy nutritious foods. WIC foods include iron-fortified infant formula and infant cereal, iron-fortified adult cereal, vitamin C-rich fruit and vegetable juice, milk, eggs, cheese, beans, and peanut butter.

For pregnant and post-partum women, another important component of WIC is education about nutrition, health, and breastfeeding. In fact, according to the Texas Department of State Health Services website, “clients receive encouragement and instruction in breastfeeding. In many cases, breastfeeding women are provided breast pumps free of charge. WIC helps clients learn why breastfeeding is the best start for their baby, how to breastfeed while still working, Dad’s role in supporting breastfeeding, tips for teens who breastfeed, how to pump and store breastmilk, and much more.”¹² The specific emphasis on the importance of breastfeeding provides motivation for rigorously evaluating the extent to which WIC affects breastfeeding rates of new mothers. This is particularly interesting given that WIC participants can also obtain free infant formula, so the effects of WIC on breastfeeding are *a priori* ambiguous. The existing literature on the relationship between WIC participation and breastfeeding is limited to studies that rely on comparisons between participants and non-participants (e.g., Bitler and Currie, 2005; Jacknowitz *et al.*, 2007), and on methods using maternal fixed effects and variation in state program parameters as instruments (Chatterji *et al.*, 2002). These studies find mixed results on the association between WIC use and breastfeeding, and likely suffer from bias due to non-random selection into WIC participation and weak instrument problems.¹³ More recent studies that use more rigorous identification methods do not have data on breastfeeding, and thus cannot address this question (Hoynes *et al.*, 2011; Figlio *et al.*, 2009). This paper attempts to fill this gap by using recent data with breastfeeding information together with an identification strategy that can

pregnancy outcome, underweight status, or iron-deficiency anemia, and (2) diet-based risks such as poor eating habits that can lead to poor nutritional and health status. Clients are counseled at WIC about these risks and the outcomes influenced by nutrition education and nutritious foods provided by WIC. (Information from the Texas Department of State Health Services: <http://www.dshs.state.tx.us/wichd/gi/eligible.shtm>).

¹²See <http://www.dshs.state.tx.us/wichd/gi/eligible.shtm> for more information.

¹³Bitler and Currie (2005) find a positive relationship between WIC and breastfeeding, while Jacknowitz *et al.* (2007) and Chatterji *et al.* (2002) find a negative association. Bitler and Currie (2005) also show that variation in WIC program characteristics across states makes for poor instruments for WIC participation because of the low explanatory power of these variables.

arguably isolate the effects of access to WIC from other determinants of breastfeeding.¹⁴

Another important component of WIC in more recent years has been the coordination with other social services. The promotion of coordination efforts stems from the national level. For example, in 2000, the U.S. Department of Agriculture distributed a handbook to all WIC state and local agencies that outlines twelve “model coordination sites”.¹⁵ In Texas, the WIC Policy and Procedures Manual has a clause that WIC clinics must establish a “referral mechanism for the provision of health services to WIC participants in need of such services”, and develop concrete strategies to identify “high-risk conditions requiring referral and the procedures for follow-up”. WIC clinic staff are also instructed to provide referrals for clients to a number of other agencies including public health clinics, Medicaid, Food Stamps, Temporary Assistance for Needy Families (TANF), literacy services, job banks, housing services, child support enforcement, and drug and alcohol abuse programs, among others. The WIC Policy and Procedures Manual highlights that “posting information in a public area does not satisfy this requirement. Applicants must individually receive written information [about these services] at initial application.”¹⁶ Thus, WIC clinics can serve as gateways for low-income women and children to receive other social services. As a result, access to a WIC clinic may have impacts on their health and well-being through other channels than just WIC food receipt. This issue has not been explicitly addressed in much of the previous literature.¹⁷ This paper seeks to shed light on some mechanisms through which WIC may affect infant health by studying the effects of WIC clinic access on various pregnancy conditions and behaviors.

In Texas, geographic access to WIC clinics is likely important because clients must apply for WIC in person. Local WIC clinics are operated in a variety of facilities including county

¹⁴An important distinction between my study and the others that consider breastfeeding is that I measure the effects of *access* to WIC rather than WIC participation.

¹⁵See <http://www.fns.usda.gov/wic/resources/strategies.htm> for more information.

¹⁶See the WIC Policies and Procedures Manual available at:
<http://www.dshs.state.tx.us/wichd/policy/tocga.shtm> for more information.

¹⁷An important exception is the study by Bitler and Currie (2005), which estimates the relationship between WIC use and prenatal care initiation. However, their analysis relies on comparing WIC participants to other mothers on Medicaid. WIC participants may be more knowledgeable about the program or have greater access to transportation than WIC-eligible non-participants who receive Medicaid. If these unobserved variables are correlated with prenatal care initiation, then their analysis may be confounded by omitted variables bias.

and city health departments, hospitals, schools, community centers, churches, and mobile vehicles, among others. Figure 1 shows an example of a mobile WIC clinic in McAllen, Texas, which is clearly labeled with an advertisement for offering WIC services. Prospective clients must schedule an appointment at a WIC clinic, and are required to bring documentation of their household income and Texas residence to the appointment.¹⁸ During the appointment, applicants undergo a health screening, and receive education and counseling, as well as referrals to other agencies as applicable. At the end of the appointment, WIC eligibility is determined, and food benefits are provided to those who are eligible in three-month increments. WIC participants must go to a WIC clinic at least once every three months to receive their next set of food benefits, and can receive additional health and referral services at those times. Thus, it seems that, especially for low-income women who are likely to be time- and transportation-constrained, living in proximity of a WIC clinic may be particularly advantageous.

Further, a growing literature in behavioral economics can speak to the importance of contextual factors in people’s decision-making processes. Bertrand *et al.* (2006) provide an overview of this literature and relate it to anti-poverty programs. They argue that small situational changes can have significant impacts on people’s behaviors — for example, in a well-known experiment by Leventhal *et al.* (1965), participants who received education about the risks of tetanus were much more likely to actually get a tetanus shot if they also were given a map with the infirmary circled and urged to decide on a particular time and route to get there. With regards to welfare programs, Bertrand *et al.* (2006) focus on three factors that can serve as considerable barriers to take-up: lack of knowledge about the program, hassle costs (such as tedious and complicated application forms or long wait times at program offices), and procrastination. In the context of WIC, all of these factors may be affected by geographic access to clinics. First, living in proximity of a WIC clinic likely increases the likelihood that a woman will see it on a regular basis, thus informing her of the existence of the program. Second, proximity to a clinic may reduce hassle costs if women can more easily stop by either on the way to or from work, for example. Third, physically seeing a WIC clinic on a regular basis may serve as a reminder to sign up for services and

¹⁸WIC clients must be Texas residents. U.S. citizenship is *not* a requirement for WIC eligibility.

combat procrastination.

My analysis uses variation in WIC clinic openings and closings to provide some of the first evidence on how geographic access to WIC clinics affects WIC food benefit receipt, pregnancy behaviors, birth outcomes, and breastfeeding rates. While the empirical literature on WIC dates back several decades, many studies focus on participation in WIC rather than access, and face difficulties in overcoming the challenge of non-random selection into WIC participation. Further, most of the existing studies equate participation with food benefit receipt, which prevents them from measuring any additional impacts of the other WIC services. Some of the earlier WIC studies do find a positive association between WIC food receipt and birth weight, as well as favorable relationships with other health outcomes like the probability of an infant being small-for-gestational-age (e.g., Devaney, 1992; Ahluwalia *et al.*, 1998). However, Besharov and Germanis (2001) argue that these studies generally do not account for non-random selection into WIC; if WIC participants tend to have characteristics associated with better birth outcomes relative to the comparison groups (for example, healthier behaviors or greater family support networks), then the benefits of WIC are likely to be overstated. To address this criticism, some researchers have attempted to use control groups that are more comparable to WIC participants. For example, Bitler and Currie (2005) compare women who receive WIC benefits to other women on Medicaid (who are also eligible for WIC), and find that WIC is associated with more prenatal care, higher birth weight, lower rates of premature births, greater breastfeeding rates, and a lower likelihood of an infant being admitted to the Intensive Care Unit (ICU). They also show that selection into WIC participation tends to be negative, at least on observable characteristics, suggesting that other studies on WIC may be actually underestimating the program's benefits.

In contrast, in two studies, Theodore Joyce and co-authors argue that the effect of WIC is more subtle than previously found (Joyce *et al.*, 2005, 2008). Both studies also use narrower comparison groups to deal with potential selection bias, and carefully address the issue of gestational-age bias resulting from the positive correlation between WIC enrollment and pregnancy length. They argue that the correlation between WIC and prematurity is spurious and driven by this gestational-age bias, but do find modest effects on fetal growth for some samples.

Two most recent studies on WIC have introduced novel identification strategies to account for the possibility of omitted variables bias in comparisons between WIC participants and non-participants, even in narrowly defined groups. Figlio *et al.* (2009) use data in which they can link Florida children who are born over 1997-2001 to their older siblings who are enrolled in elementary school. Their identification comes from the fact that the household income eligibility threshold for reduced-price lunches through the National School Lunch Program is the same as for WIC, at 185% of the poverty line. Their analysis compares outcomes of infants whose older siblings received reduced-price lunches in the same year to those of infants whose older siblings did not but received them in either the previous or following years. Their IV estimates suggest that while there is no effect of WIC participation on average birth weight, the likelihood of low birth weight is decreased by over 100 percent at the sample mean. However, a concern of omitted variables bias remains. In particular, it is impossible to separate out the effects of WIC from the effects of other factors (such as parental employment changes, for example) that are correlated with changes to the control families' eligibility status from year to year.

As discussed above, Hoynes *et al.* (2011) rely on county-year variation in initial WIC program roll-out in the 1970s for identification and, to my knowledge, present the only existing evidence on the impacts of *geographic access* to WIC rather than WIC participation. This paper builds on the work of Hoynes *et al.* (2011) by using finer variation in WIC clinic access within zip codes rather than counties, incorporating maternal fixed effects, and implementing an instrumental variables approach to address endogenous mobility and to account for the mechanical correlation between gestation length and WIC access. Further, this paper estimates the effects of WIC access on a wider range of outcomes including WIC food benefit receipt, pregnancy weight gain, pregnancy health conditions and behaviors, birth weight, and breastfeeding. Finally, estimates of access to WIC from a more current time period are arguably more valuable for policymaking purposes today.

3 Data and Sample

3.1 Data on WIC Clinics

My data on WIC clinic locations and opening and closing dates come from a public records request from the Texas Department of State Health Services. These data contain the names, addresses (including zip codes), and opening and closing dates for all WIC clinics in Texas that were either operating in 2010 or that were closed sometime over 1992-2010.¹⁹ WIC clinic opening dates were not consistently reported in the 1990s, but have been much more reliably recorded over the last decade. For the purposes of my main analysis, I only use information on WIC clinic openings and closings over 2005-2009. I extend the time period to 2003-2010 for the placebo analysis, which relies on information on WIC clinics 6-9 months before conception or after childbirth, as discussed in Section 5.

Figure 2 plots the number of operating WIC clinics by month in Texas from January 2005 to December 2009, the time period of my analysis. The number of WIC clinics has decreased from 614 clinics in January 2005 to 564 clinics in December 2009. In Texas, local WIC agencies have control over opening, closing, moving, and consolidating WIC clinics in their jurisdictions. These decisions are made for a variety of reasons, such as for space constraints (since many WIC clinics are operated at churches, community centers, and schools) and for cost-efficiency when multiple WIC clinics are located in proximity to one another. Additionally, WIC clinics may be closed when there is no longer a WIC approved grocery store or vendor operating in the area.²⁰ In recent work, Meckel (2012) shows that the introduction of the Electronic Benefit Transfer (EBT) system in 2004 has increased the surveillance of WIC vendors, and induced many vendors (who were likely previously engaged in fraudulent behavior) to exit the WIC program by either shutting down or no longer accepting WIC

¹⁹Theoretically, the information on WIC clinic addresses should allow me to measure WIC clinic access using distances from mothers' homes rather than simply at the zip code level. However, street addresses are poorly recorded in the WIC clinic data. Geocoding these addresses introduced substantial measurement error, and hand checking a random sample of 50 WIC clinic addresses suggested that a large fraction of WIC clinic street addresses were incorrectly recorded. On the other hand, zip codes are generally reliably recorded and can be cleanly merged to the birth records data. Therefore, I rely on zip-code-level measures in my main analysis. I have also estimated some alternative specifications using continuous distance to the nearest WIC clinic as the measure of access to WIC. These results are qualitatively similar to the main results and are discussed in Section 5.

²⁰Information on the determinants of WIC clinic openings and closings comes from personal communication with Ellen Larkin, the WIC state program specialist at the Texas DSHS (Larkin, 2012).

food benefits in Texas. Consequently, it may be the case that the decline in WIC clinics over 2005-2009 is at least in part driven by the decline in WIC grocery stores over the same time period.

In my data, 578 Texas zip codes have had at least one open WIC clinic sometime over 2005-2009. Only 65 zip codes have ever had more than one WIC clinic operating in any given month, so the relevant measure of access for most women is an indicator for having at least one open WIC clinic in their zip code of residence. Over 2005-2009, 114 Texas zip codes experienced either a WIC clinic opening or closing, providing substantial within-zip-code variation in WIC clinic access. Figure 3 provides some indication of this variation by showing a histogram of the distribution of the 87 zip codes that have had a non-zero change in the number of operating WIC clinics between January 2005 and December 2009. Note that this is an undercount of all zip codes that have had openings or closings since it just considers the difference in the number of WIC clinics between the first and last month in my data. Consistent with evidence on the decline in the number of WIC clinics from Figure 2, most zip codes with a change have had a one-clinic decrease over this time period.

3.2 Data on Births

I use restricted data from the universe of Texas birth records over 2005-2009, which are available through a special application process to the Texas Department of State Health Services. This data set contains 2,037,181 birth records. I limit the sample to singleton births with mothers who are Texas residents, with non-missing information on the child's date of birth, mother's date of birth, mother's full maiden name, mother's birth state or country, and mother's zip code of residence ($N=1,937,003$). The 8,431 births with missing gestation or gestation less than 26 weeks are also dropped.²¹ I match siblings to the same mother using information on her full maiden name, exact date of birth, and birth state or country. The resulting sibling sample consists of 612,694 births.

The births data are matched to WIC clinic data by the mother's zip code of residence.

²¹This results in less than 0.5 percent of the sample being dropped. Births with missing gestation are dropped because my analysis requires information on gestation to calculate the conception date. Births with gestation less than 26 weeks are dropped because they are extreme outliers in the data and have much worse outcomes than other births. For example, average birth weight among this group is 725.25 grams. Nevertheless, my results are not sensitive to this restriction.

WIC clinic access during pregnancy is calculated by first estimating the conception date from information on the child’s birth date and gestation length and then creating an indicator variable equal to 1 if at least one WIC clinic was operating at any point during the pregnancy in the mother’s zip code of residence, and 0 otherwise.²² The instrument is calculated similarly, except that the relevant zip code considered is the zip code of the mother’s *first* pregnancy residence and gestation is assumed to be 39 weeks for all births.

Table 1 presents some summary statistics from the births data. Nearly 56 percent of all mothers report receiving WIC food benefits at some point during their pregnancies. Fifteen percent of mothers are aged less than 20 years at the time of childbirth, and 59 percent have a high school education or less. Fifty-nine percent of all mothers are married. Thirty-five percent of mothers are non-Hispanic white, 11 percent are black, while 51 percent are Hispanic. Average birth weight is around 3,300 grams, and 6 percent of births are low-birth-weight (<2,500g). Almost 75 percent of all mothers reported breastfeeding their infants at the time of discharge from the hospital.

When I split the sample by whether or not the mother ever had a WIC clinic in her zip code of residence during any pregnancy, or by whether she had one during the current pregnancy, some differences emerge. WIC food benefit receipt is substantially higher among mothers living in the same zip codes as open WIC clinics. These mothers also tend to be less educated, are less likely to be married, and more likely to be Hispanic rather than non-Hispanic white or black. They also tend to have children with somewhat lower birth weights and have lower breastfeeding rates. These differences suggest that WIC clinics tend to locate in relatively less advantaged neighborhoods, where perhaps their services are most needed. As a result, simple comparisons between WIC participants and non-participants or comparisons of areas with and without WIC clinics will likely yield downward-biased results because of this negative selection. These differences point to the importance of finding methods that can overcome such selection issues to estimate the true causal effects of access to WIC on infant health and breastfeeding.

²²Results using an indicator equal to 1 if a WIC clinic was operating during the entire pregnancy (rather than at any point during pregnancy) are similar. Results using a continuous variable that measures the fraction of time during pregnancy that a WIC clinic was open are also similar. These results are discussed in Section 5.

4 Empirical Methods

In an ideal research setting, one would conduct a randomized controlled trial to study the causal effects of WIC. One would randomly assign WIC access to women in a study population, and then compare the outcomes of the treatment and control groups.²³ However, absent such an experiment, researchers must develop identification strategies to overcome the issues resulting from non-random selection into WIC participation. In this study, I propose a novel identification strategy that relies on within-zip-code variation in WIC clinic openings and closings.

Without data on siblings, one could estimate the effects of access to WIC using the variation within zip codes over time. Specifically, one would use Ordinary Least Squares (OLS) to estimate an equation of the form:

$$Y_{iymzc} = \beta_0 + \beta_1 * WIC_{iymz} + \theta' X_{iymzc} + \alpha_z + \gamma_y + \delta_m + \rho_c * t + \epsilon_{iymzc} \quad (1)$$

for each child i born in year y , month m , with a mother residing in zip code z , and in county c . Y_{iymzc} is an outcome of interest such as an indicator for mother receiving WIC food benefits during pregnancy or birth weight. WIC_{iymz} is the key explanatory variable, which is equal to 1 if a WIC clinic was operating at any point during the time of the pregnancy in the mother's zip code of residence, and 0 otherwise. X_{iymzc} is a vector of maternal and child characteristics that includes indicators for mother's age (<20, 20-24, 25-34, 35-44, 45+), indicators for mother's race (non-Hispanic white, black, Hispanic, other), indicators for mother's education (less than high school, high school degree, some college, college or more), an indicator for the mother being married, and indicators for birth order. α_z are zip code fixed effects, γ_y are birth year fixed effects, δ_m are birth month fixed effects, while $\rho_c * t$ are county-specific linear time trends. ϵ_{iymzc} is a birth-specific error term. The key coefficient is β_1 , which measures the effect of having an open WIC clinic in a mother's zip

²³To my knowledge, only one study has conducted a randomized controlled trial to evaluate WIC. Metcalf *et al.* (1985) conducted a randomized study of WIC on 410 women in Oklahoma. Treatment women received WIC vouchers, while control women did not. They find that treatment group women had children with birth weights that were on average 91 grams higher than children of women in the control group. However, while these results are certainly supportive of a beneficial causal effect of WIC, external validity may be a problem due to the small, non-representative sample. Further, the study can only speak to the pure effects of WIC food receipt on birth weight in the 1980s, but cannot address the question of the effectiveness of other aspects of the WIC program, such as education and referrals, which are particularly prevalent today.

code of residence during her pregnancy on the outcome of interest.

Note that while zip codes with and without WIC clinics are likely different on a number of dimensions, time-invariant differences between them will be captured by zip code fixed effects. Additionally, county-specific linear time trends control for differences in linear trends in outcomes across counties. The identifying assumption for equation (1) is that the variation in WIC clinic openings and closings within zip codes is not correlated with other determinants of WIC participation or birth outcomes at the zip code level. This assumption may not be satisfied if common shocks lead to changes in the numbers of WIC clinics and also affect average zip-code-level birth outcomes. For example, if spells of foreclosures affect the characteristics of zip code populations, then they may change the demand for WIC services and also change average birth outcomes through selection effects and direct health effects.²⁴

To address this issue, I take advantage of the data on sibling births, and estimate models that include maternal fixed effects. This is an improvement over a model with zip code fixed effects, since I can then control for all time-invariant observed and unobserved maternal characteristics by comparing children borne by the same mother. Specifically, I estimate:

$$Y_{ikymz} = \beta_0 + \beta_1 * WIC_{ikymz} + \theta' X_{ikym} + \alpha_k + \gamma_y + \delta_m + \epsilon_{ikymz} \quad (2)$$

for each child i , borne by mother k , in year y , month m , with the mother residing in zip code z during pregnancy. Now, α_k are mother fixed effects, and the vector X_{ikym} only includes time-varying maternal and child characteristics: indicators for mother's age, mother's education, mother's marital status, and birth order.²⁵ The rest of the coefficients and variables are the same as before. Note that several past studies have used mother fixed effects methods to estimate the effects of WIC (e.g., Brien and Swann, 2001; Chatterji *et al.*, 2002; Kowaleski-Jones and Duncan, 2002). However, the difference in the design presented here is that the within-mother variation in WIC access is coming only from WIC clinic openings and closings, rather than from other (likely unobservable) factors that may influence whether a woman receives WIC services during one pregnancy and not during another.

²⁴Currie and Tekin (2011) find that foreclosures have adverse effects on adult health. It is likely that pregnant women and infants would also experience such health effects.

²⁵Note that for two-sibling families, a maternal fixed effects model is equivalent to a first-difference model, where maternal age is identified by the birth interval. I show below that in models with zip code fixed effects, WIC clinic access is uncorrelated with the number of births or with maternal age at childbirth. Consequently, it is reasonable to assume that maternal age is not endogenous, and can be included as a control.

In equation (2), the effect of WIC clinic access is identified using a sample of mothers who have at least one pregnancy in a zip code with an operating WIC clinic and at least one pregnancy in a zip code without a WIC clinic. These mothers are comprised of two groups: 1) mothers who always live in the same zip code but experience either a WIC clinic opening or closing between pregnancies, and 2) mothers who move zip codes between pregnancies and live in the same zip code as a WIC clinic during one pregnancy and not during another. However, the decision of whether to move or not may be correlated with other determinants of WIC clinic openings and closings, which could bias the estimates produced by equation (2). Additionally, fixed effects models may be biased towards zero in the presence of classical measurement error in the explanatory variable. The key explanatory variable in my analysis relies on information on gestational age to calculate exposure to a WIC clinic during the length of the pregnancy, and gestational age is likely to contain some measurement error.

A further issue with both equations (1) and (2) is gestational-age bias (Joyce *et al.*, 2005; Ludwig and Miller, 2005; Joyce *et al.*, 2008). In particular, women with longer gestation periods have more time to experience a WIC clinic opening or closing and to receive WIC services. Consequently, since women with longer pregnancies are more likely to experience a WIC clinic opening holding all else equal, we would expect to see a positive correlation between WIC clinic access and gestation, which in turn is correlated with better birth outcomes like higher birth weight. This would lead to an upward bias on the estimated effects of WIC access.

To address all of the above issues, I implement an instrumental variables - maternal fixed effects (IV-FE) approach. I consider the zip code in which I observe each mother during her *first* pregnancy. Then, for each subsequent pregnancy, I create a variable that is equal to 1 if a WIC clinic was operating at any point during the pregnancy in the mother's zip code *had she remained in her first zip code of residence and had her pregnancy lasted 39 weeks*.²⁶ In other words, this instrument measures the mother's hypothetical WIC clinic access if she never moved and if all of her pregnancies lasted the same length of time. This hypothetical variable is used to instrument the WIC_{ikymz} variable described above. Specifically, I estimate

²⁶The 39 weeks are counted forward from estimated conception week.

a second-stage equation of the form:

$$Y_{ikymz} = \beta_0 + \beta_1 * \widehat{WIC}_{ikymz} + \theta' X_{ikym} + \alpha_k + \gamma_y + \delta_m + \epsilon_{ikymz} \quad (3)$$

with the corresponding first-stage equation:

$$WIC_{ikymz} = \pi_0 + \pi_1 * FSTWIC_{iymk} + \phi' X_{ikym} + \psi_k + \sigma_y + \omega_m + u_{ikymz} \quad (4)$$

for each child i , borne by mother k , in year y , month m , with the mother residing in zip code z during pregnancy. Here, $FSTWIC_{iymk}$ is an indicator that is equal to 1 if a WIC clinic was operating at any point during the 39 weeks following conception in the mother's first-pregnancy zip code, and 0 otherwise. The other variables and coefficients are defined as before.

The idea behind this instrument is that although the mother's current pregnancy zip code is potentially endogenous, her first-pregnancy zip code of residence is controlled for by the inclusion of fixed effects. Consequently, identification comes only from variation in WIC clinic openings and closings in the mother's first-pregnancy zip code, which should be exogenous to any given mother. This instrument thus satisfies the conditions for being a valid instrument: it is highly predictive of WIC clinic presence in the mother's actual current zip code of residence and during the actual gestation length of the current pregnancy (since many mothers do not move and have gestations close to 39 weeks), but it should have no effect on the outcomes of interest except through its effect on true WIC clinic access.²⁷

5 Results

5.1 Relationship Between WIC Clinic Access and Maternal Characteristics

My identification strategy relies on within-zip-code variation in WIC clinic access over time. A crucial concern with this approach is that omitted variables are correlated with both WIC clinic access and pregnancy and birth outcomes. While I cannot directly test for all potential omitted variables, I can assess the degree to which the variation in WIC clinic access across space and time is correlated with maternal characteristics. Table 2 presents results

²⁷Other studies that use a very similar IV-FE design include Almond *et al.* (2011a) and Currie and Rossin-Slater (2012).

from estimating a variant of equation (1) with various maternal characteristics as dependent variables, controlling for birth year and birth month fixed effects, and with standard errors clustered on the zip code level. I estimate these regressions both with and without zip code fixed effects.

The results without zip code fixed effects in Panel A point to substantial differences across areas that do and do not have WIC clinics. In particular, WIC clinics tend to locate in zip codes that have more disadvantaged mothers — mothers who are less than 20 years old, have a high school education or less, are unmarried and are Hispanic. This is perhaps not surprising as these mothers are also most likely to be eligible for WIC services. However, these differences also point to the fact that simply comparing outcomes in areas with and without WIC clinics will likely lead to downward biased estimates of the effects of WIC access on birth outcomes because of selection of WIC clinics into areas with potential recipients.

Panel B of Table 2 suggests that zip code fixed effects do a fairly good job of controlling for these differences. These regressions now test whether within-zip-code changes in WIC clinic access are correlated with changes in maternal characteristics. Most of the coefficients become much smaller and statistically insignificant, suggesting that trends in WIC clinic openings and closings are generally uncorrelated with trends in maternal demographics. However, there is still some evidence of selection — WIC clinics tend to operate in zip codes when they have fewer college-educated mothers and more black mothers. Note that this selection would likely lead to a downward bias on the results, as less-educated and minority mothers tend to have worse pregnancy and birth outcomes. Consequently, one can argue that my estimates of the impacts of WIC clinic access on these outcomes represent lower bounds for the true effects. These results also point to the potential benefits of including maternal fixed effects to compare children borne by the *same* mother, rather than simply using the within-zip-code variation in WIC clinic access with average zip-code-level outcomes.

In Table 3, I examine the relationship between WIC clinic access and maternal mobility across zip codes. I estimate models of the form:

$$\begin{aligned}
 M_{ikymz} = & \beta_0 + \beta_1 * WICfstpreg_{ikym} + \pi' WICfstpreg_{ikym} * X_{ikym} + \theta' X_{ikym} \\
 & + \alpha_z + \gamma_y + \delta_m + \epsilon_{ikymz}
 \end{aligned} \tag{5}$$

for each child i , borne by mother k , in year y , month m , with the mother residing in zip code z during pregnancy. M_{ikymz} is an indicator that is equal to 1 if the mother moved zip codes between the current pregnancy and the first pregnancy, and 0 otherwise. $WICfstpreg_{ikym}$ is an indicator that is equal to 1 if a WIC clinic was operating in the mother's zip code of residence during her first pregnancy, and 0 otherwise. I estimate this equation with and without first zip code of residence fixed effects, α_z . The vector of coefficients on the interaction terms, π , allows me to assess whether moving likelihoods differ across maternal characteristics.

The results in Table 3 demonstrate that older, more educated, and married mothers with fewer children are more likely to move zip codes if there was a WIC clinic in their first zip code of residence. These findings suggest that women's decisions to move (or not) between pregnancies may be correlated with the determinants of WIC clinic openings and closings. In particular, less advantaged women tend to remain in the same zip codes if they had a WIC clinic during their first pregnancy, perhaps because common shocks lead both to increases in demand for WIC services and to decreases in mobility among these women. Consequently, implementing an IV-FE strategy to address endogenous mobility is essential for estimating the true causal effects of WIC clinic access on WIC food benefit receipt, pregnancy behaviors, birth outcomes, and breastfeeding.

5.2 WIC Clinic Access and Prenatal WIC Food Benefit Take-Up

Having provided some evidence for the validity of my empirical approach, I turn to the analysis of the effect of WIC clinic access on WIC food benefit take-up. Figure 4 provides some graphical representation of the relationship between WIC clinic access and the take-up of WIC food benefits during pregnancy among singleton births with mothers who reside in Texas.²⁸ I plot the average prenatal WIC food receipt by the number of months between conception and the time of at least one WIC clinic operating in the mother's zip code of residence. The sample is limited to conceptions in a 36-month period surrounding the time that each zip code experienced a first WIC clinic opening or a last WIC clinic closing.²⁹ To

²⁸The sample is *not* limited to siblings in Figure 4.

²⁹Mothers residing in zip codes that have experienced a first WIC clinic opening and a last WIC clinic closing within the same 36-month period are dropped (5 zip codes).

understand the timing on the x-axis, consider for example all conceptions in January 2006. Assuming a 9 month gestation period, conceptions in zip codes with first openings before January 2006 will have WIC clinic exposure during the entire pregnancy; conceptions in zip codes with first openings between January 2006 and September 2006 will have partial WIC clinic exposure during pregnancy; while conceptions in zip codes with first openings after September 2006 will have no WIC clinic exposure during pregnancy. On the other hand, conceptions in zip codes with last closings before January 2006 will have no WIC clinic exposure during pregnancy; conceptions in zip codes with last closings between January 2006 and September 2006 will have partial WIC clinic exposure during pregnancy; and conceptions in zip codes with last closings after September 2006 will have WIC clinic exposure during the entire pregnancy. To combine these openings and closings on the same graph, for conceptions in zip codes that experience a first WIC clinic opening, the x-axis variable is equal to “*year-month of the first WIC clinic opening – conception year-month*”, while for conceptions in zip codes that experience a last WIC clinic closing, the x-axis variable is equal to “*conception year-month – year-month of last WIC clinic closing + 9*”. Consequently, all x-axis values below 0 correspond to conceptions in zip codes with at least one WIC clinic operating during the entire pregnancy; x-axis values between 0 and 9 correspond to conceptions in zip codes where a WIC clinic opened or closed during pregnancy; and x-axis values above 9 correspond to conceptions in zip codes with no WIC clinics operating during pregnancy.³⁰

The figure suggests that prenatal WIC food benefit receipt tends to be higher when at least one WIC clinic is present in the mother’s zip code of residence. The same pattern holds true in Figure 5, which limits the sample to sibling births, the main sample of my analysis. These figures suggest that there may be a relationship between geographical access to WIC and WIC food benefit take-up, which I explore more rigorously using regression methods

³⁰Note that for first openings, if “*year-month of the first WIC clinic opening – conception year-month*” > 9 , there is no WIC clinic exposure, if “*year-month of the first WIC clinic opening – conception year-month*” is between 0 and 9, there is partial WIC clinic exposure, and if “*year-month of the first WIC clinic opening – conception year-month*” < 0 , there is WIC clinic exposure in the entire pregnancy. For last closings, if “*conception year-month – year-month of last WIC clinic closing*” > 0 , there is no WIC clinic exposure, if “*conception year-month – year-month of last WIC clinic closing*” is between -9 and 0, there is partial WIC clinic exposure, and if “*conception year-month – year-month of last WIC clinic closing*” < -9 , there is WIC clinic exposure in the entire pregnancy. To align the closing timing to the opening timing, I add 9 to the x-axis variable for closings.

next.

Table 4 presents the regression coefficients from estimating equations (1), (2), and (3) with an indicator for prenatal WIC food receipt as the outcome of interest. Appendix Table 1 shows the first stage and reduced-form results corresponding to the IV-FE estimates. The first stage estimates are very strong (the partial F-statistics are equal to 1934.99, 2712.84, 829.80, and 394.53 for the whole analysis sample, mothers with a high school degree or less at the time of the first birth, mothers whose first births were paid by Medicaid, and mothers with a college degree or more at the time of the first birth, respectively), while the reduced-form estimates are appropriately scaled down from the IV-FE coefficients. The first stage results suggest that the presence of a WIC clinic in the mother’s first zip code of residence during the 39 weeks post-conception is associated with a 76.2 percentage point increase in the likelihood of there being a WIC clinic in her current zip code of residence and during her actual pregnancy duration.

The first two columns of Table 4 use the universe of all singleton births in Texas, while the remaining columns use only the sibling sample. Further, the eighth column considers mothers who had a high school education or less at the time of the first birth, and the ninth column limits the sample to mothers whose first births were paid by Medicaid. These two groups of mothers are most likely to be eligible for WIC services.³¹ The tenth column limits the sample to mothers with a college degree or more at the time of the first birth, who are less likely to be eligible for WIC than low-educated mothers (as evidenced by their lower rate of WIC food benefit receipt relative to mothers with a high school degree or less — 0.07 versus 0.74). Comparing results across these two education groups serves as a useful check of the identification strategy, as we expect access to WIC services to have a greater effect on the outcomes of low-educated mothers than the outcomes of high-educated mothers.³² Except for column 6, all regressions include time-varying controls for mother’s

³¹For all other outcomes, I no longer present results using the subsample of mothers whose first births were paid by Medicaid. The reason for this is that Texas experienced changes to the Medicaid system as many counties switched from fee-for-service to managed care plans over the time period of analysis. Mothers in counties with managed care are less likely to report being on Medicaid, perhaps because they now carry insurance cards from private HMOs. Consequently, I instead focus on results that split the sample by the mother’s education level at the time of the first birth as education is a more consistent proxy for WIC eligibility.

³²In supplementary analyses, I have estimated regressions for mothers residing in zip codes with average

age, mother’s education, mother’s marital status, child birth order, as well as birth year and birth month fixed effects. The regressions in the first four columns additionally include controls for maternal race and zip code fixed effects. The regressions in columns 2 and 4 also include county-specific linear time trends. The regressions in columns 5-10 include mother fixed effects. The IV-FE specification in column 6 omits the time-varying mother and child demographic variables to test the sensitivity of the preferred model to the inclusion of control variables. To account for serial correlation at the level of variation in the key explanatory variable, in columns 1-5, standard errors are clustered on the zip code level, while in all of the IV-FE specifications (columns 6-10), standard errors are clustered on the mother’s first zip code of residence. Finally, to create consistent sample sizes across specifications within the sibling sample, for each outcome, births by mothers who have at most one child with non-missing data for that outcome are omitted.

The results suggest that having an operating WIC clinic in the mother’s zip code of residence during any point of her pregnancy increases her likelihood of WIC food benefit receipt. The key coefficient of interest is positive and statistically significant across all specifications. Importantly, the coefficient in the mother FE specification (column 5) is considerably smaller than the coefficients in the IV-FE specifications (column 6 and 7), suggesting that endogenous mobility and measurement error create substantial downward bias on the estimated effects. Additionally, the key coefficient of interest in the IV-FE model does not seem to be sensitive to the inclusion of controls for maternal and child demographics (column 6 versus column 7). According to the IV-FE estimate for the whole sibling sample, the magnitude of the effect is about 3 percentage points, corresponding to a 6 percent increase in WIC food benefit take-up at the sample mean of 0.56. As expected, the estimated coefficients are larger for mothers with a high school education or less and for mothers whose first births were paid by Medicaid (corresponding to 6 and 5 percent increases at sub-sample means of 0.74 and 0.76, respectively). In contrast, the estimated coefficient for mothers with a college degree or more is insignificant and close to zero. These results imply that geographic access to WIC clinics does matter, and seems to matter more for less

adjusted gross incomes for 2004 above and below the sample median of \$35,891. The results split by average gross income in zip code of residence are similar to those split by mother’s education, and are available upon request.

advantaged women.

Table 5 presents additional results in which the sample is split by the type of WIC clinic location — urban versus rural zip codes, and “health-center” versus “non-health-center” facilities.³³ The results suggest that geographic access to WIC clinics is more salient for mothers in urban areas than in rural areas. This finding is interesting since zip-code-level access to WIC clinics in rural areas presents greater travel distance savings than in urban areas. In fact, in urban zip codes, the average Texan woman with a WIC clinic in her zip code of residence must travel approximately 1.64 miles to the closest clinic, whereas the average woman without a WIC clinic in her zip code lives approximately 3.96 miles from the nearest clinic. On the other hand, in rural zip codes, women with WIC clinics in their zip codes travel an average of 2.12 miles, while women without WIC clinics in their zip codes travel an average of 9.18 miles to the nearest clinic.³⁴ Consequently, zip-code-level WIC clinic access represents decreases of 4.64 miles and 14.12 miles in round-trip travel distances for urban and rural mothers, respectively. However, it may be that in rural areas, women are more accustomed to driving far distances and thus are less responsive to changes in geographic access to services. In contrast, in urban zip codes, proximity to WIC clinics may matter more as women can potentially pass by and physically see WIC clinics during the course of their daily activities.

Table 5 also suggests that the effects of access to WIC are driven by clinics located in “non-health-center” facilities such as community centers, schools, churches, and mobile vehicles. These clinics are more likely to have visible advertisements for WIC than those located inside county health departments or large hospitals. Indeed, my results suggest that despite the relatively small savings in travel times that arise from zip-code-level WIC clinic access, proximity to clinics is still important. Such a finding is supported by evidence

³³Data on urban and rural classification of zip codes comes from the WWAMI Rural Health Research Center at the University of Washington. The data contain Rural-Urban Commuting Area (RUCA) codes that classify zip codes into urban and rural areas. I follow their guidelines to classify zip codes with the following codes as urban: 1.0, 1.1, 2.0, 2.1, 3.0, 4.1, 5.1, 7.1, 8.1, 10.1. All other zip codes are classified as rural. More information is available here: <http://depts.washington.edu/uwruca/ruca-approx.php>. Health center WIC clinics are classified as those that contain one of the following strings in their name: “hospital”, “medical”, “health center”, “health ctr”, “health”, “clinic”.

³⁴These estimates are calculated by computing the average of the distances between mothers’ residence homes and the locations of the nearest WIC clinics. For WIC clinics with missing or incorrectly recorded street addresses, I use the zip code centroid instead.

from psychology and behavioral economics on the significance of contextual factors, and why seemingly minor situational changes may have large impacts (Bertrand *et al.*, 2006). For instance, physically seeing a WIC clinic on a regular basis may increase awareness of the program and serve as a needed reminder to sign up for services. Additionally, having a WIC clinic in very close proximity may reduce hassle costs, as women may be able to stop at a WIC clinic on their way to or from work, for example.

5.3 Effects on Pregnancy Behaviors

While receiving food benefits is an important aspect of the WIC program, access to a WIC clinic may affect mothers in several other ways. Women who come to a WIC clinic receive a health exam, which may increase the likelihood that they are diagnosed with various medical conditions such as hypertension or diabetes. They also receive information and education about nutrition and healthy behaviors. These services may encourage women to change their diet or exercise habits, or to stop smoking or drinking alcohol. Moreover, WIC clinics can serve as gateways to a range of other social services. For example, WIC staff can refer women to agencies that can help them enroll in other programs like Medicaid, Food Stamps, TANF, and housing assistance. They can also refer them to other services like counseling for substance abuse and job banks.

I test the extent to which some of these other mechanisms might matter in Table 6. This table shows the regression coefficients from the preferred IV-FE models, with various pregnancy behaviors and conditions as dependent variables. The controls and fixed effects are the same as described above, with standard errors clustered on the mother’s first zip code of residence. These results suggest that maternal weight gain is affected by WIC clinic access. In particular, women are 2 percentage points (12 percent at the sample mean) less likely to gain too little weight during pregnancy (defined as less than 16 lbs), and 3 percentage points (13 percent at the sample mean) more likely to gain too much weight during pregnancy (defined as more than 40 lbs).³⁵ The estimated coefficients are larger in magnitude and

³⁵Information on pregnancy weight gain guidelines comes from the Mayo Clinic. All women with a BMI of less than 30 are recommended to gain at least 16 lbs. The maximum recommended weight gain even for underweight women (BMI less than 18.5) is 40 lbs. See <http://www.mayoclinic.com/health/pregnancy-weight-gain/PR00111> for more details.

more statistically significant for mothers with a high school education or less. Appendix Table 2 suggests that the estimated increase in the likelihood of gaining too much weight is driven by mothers whose pre-pregnancy BMI for the first birth at which I observe them was 25 or greater (i.e., they would have been classified as overweight or obese).³⁶ These results point to the presence of opposing forces in the effect of access to WIC on pregnancy weight gain. On the one hand, the food benefits (and/or the nutrition education) may prevent some disadvantaged women from having an underweight pregnancy and putting themselves and their children at risk of various complications. On the other hand, the food benefits may lead to too much weight gain, especially among women who are overweight or obese. These findings suggest that more emphasis on nutrition education within the WIC program may be necessary.

I also find positive effects on low-educated mothers' likelihoods of having diabetes and gestational hypertension. These effects may be directly driven by the increase in excessive pregnancy weight gain. These could also be diagnosis effects, as women who show up at WIC clinics may be more likely to have these conditions be identified.³⁷ Note that there are no effects on the likelihood of experiencing eclampsia, a serious pregnancy condition that involves seizures and convulsions. Hypertension and diabetes are risk factors for eclampsia, and early diagnosis and treatment of these conditions may help prevent the onset of eclampsia. However, despite the increases in hypertension and diabetes diagnoses, I find no discernible effects on eclampsia. This is perhaps due to power issues that prevent me from detecting effects on low-frequency outcomes. It may also be that WIC clinic access only affects diagnoses of marginal (and therefore relatively mild) hypertension and diabetes cases, which are the least likely to develop into more serious conditions such as eclampsia.

Notably, as with the results on food benefit take-up, there are no statistically significant effects of WIC clinic access on college-educated mothers' pregnancy behaviors, who are less likely to be impacted by proximity to WIC services.

³⁶Pre-pregnancy BMI is calculated from information in the births data on the mother's height and pre-pregnancy weight.

³⁷Conditions such as hypertension and diabetes are generally reported at the hospital by either a doctor or a nurse. Consequently, some women may have these conditions recorded for their first births and not recorded for subsequent births, even if they did not actually "forget" that they had them. As a result, even women who had access to WIC during their first pregnancies and not during subsequent pregnancies may experience positive diagnosis effects.

Unfortunately, my results cannot conclusively speak to the degree to which WIC clinic access affects the take-up of other programs and services. Although the coefficients for the likelihoods of receiving prenatal care from a public clinic and of the birth being covered by Medicaid are positive and large relative to the sample means (especially for the low-educated sample), the standard errors are too large to draw conclusive inference from these results. My data do not have information on participation in other programs for which many WIC-eligible mothers are likely also eligible, such as Food Stamps, TANF, housing assistance, or child support enforcement.

Finally, there are some pregnancy behaviors and conditions which do not seem to be impacted by WIC. I have estimated regressions for the number of prenatal visits, prenatal care adequacy, and smoking during pregnancy, and found no statistically significant (or economically meaningful) results. Smoking is arguably expected to be most affected by the educational component of WIC, and my results suggest that this aspect of WIC may not have substantial influence on women’s behavior during pregnancy.

5.4 Effects on Birth Outcomes and Breastfeeding

Having shown that WIC clinic access impacts pregnant women’s food benefit take-up, weight gain, and diagnoses of some high-risk pregnancy conditions such as hypertension and diabetes, I next turn to the analysis of the effects on birth outcomes and breastfeeding. As mentioned before, these outcomes may be affected by WIC clinic access through a number of different channels including food benefit take-up, health exams, health education, and the receipt of other services through referrals from WIC.

Table 7 presents results from the IV-FE specification for six different outcomes: birth weight in grams, an indicator for low birth weight ($<2,500$ grams), gestation in weeks, an indicator for a premature birth (<37 weeks gestation), an indicator for the child being breastfed at the time of discharge from the hospital, and an indicator for child death.³⁸

³⁸In the Texas 2005-2009 birth certificate data, child death is recorded for children who could be matched to a death certificate by 2011. I have also estimated effects on child gender at birth to assess the relationship between WIC access and the likelihood of fetal death, since male fetuses are more susceptible to fetal death (Almond and Edlund, 2007). However, I find no statistically significant effects of WIC clinic access on the likelihood that a child is male. This may be due to the fact that the highest fetal death rates occur during the early part of the pregnancy, by which time many women may not have had time to visit a WIC clinic. Unfortunately, my data have no information on when the WIC benefits were received during pregnancy, so

The results demonstrate that there is a positive effect of WIC clinic access on birth weight. According to the IV-FE estimate, birth weight is increased by about 27 grams, a 0.8 percent increase at the sample mean of 3,274 grams. The lack of statistically significant effects on gestation and prematurity is consistent with studies that argue that any relationship between WIC and gestation is spurious because of a lack of medical evidence supporting a protective effect of WIC on prematurity (Joyce *et al.*, 2005, 2008).

Figure 6 investigates the effects of WIC clinic access throughout the birth weight distribution for the whole analysis sample, while Figure 7 limits the sample to mothers with a high school degree or less at the time of the first birth. The figures plot the coefficients and 95% confidence intervals from the IV-FE models with indicators for being above each specified number of grams (ranging from 1,500 grams to 4,500 grams in 500 gram increments) as outcomes. These results suggest that the effects on birth weight are concentrated in the middle of the birth weight distribution — WIC access leads to more children being born who weigh above 3,000 and 3,500 grams. For low-educated mothers, there is some evidence of movement across the low-birth-weight cutoff of 2,500 grams, although the effect is only marginally significant at the 10% level.³⁹ Importantly, despite the adverse effects on excessive maternal pregnancy weight gain, there is no effect on the likelihood of a child being born above 4,500 grams (the cutoff that classifies births as high-birth-weight). Additionally, consistent with the birth weight effects being concentrated in the middle of the distribution, I find no effect on child mortality (see the last column of Table 7). These findings imply that while WIC access improves average health at birth, children born at the very low end of the weight distribution, who are most likely to die within the first year of life, are unaffected.

Table 7 also shows a positive and statistically significant increase in breastfeeding among mothers with a high school education or less — the likelihood of the infant being breastfed

I cannot study this issue directly.

³⁹The marginal decrease in low-birth-weight births is also evident in Table 7. The magnitude of the decline in low-birth-weight further suggests that the average effect on birth weight is not perfectly uniform across the birth weight distribution. In particular, applying the 32.5-gram increase in average birth weight for low-educated mothers implies that children born between 2467.5 and 2500 grams would be moved above the low-birth-weight cutoff (0.006 of births among low-educated mothers). In my analysis, I find that 0.01 births are moved across the low-birth-weight cutoff. This finding suggests that the effect on birth weight may be larger around the low-birth-weight threshold. However, given that this estimate is only marginally significant at the 10% level, these findings should be interpreted with some caution.

at the time of discharge is increased by about 6 percent at the sub-sample mean of 0.682. This effect implies that WIC emphasis on breastfeeding is relatively successful. However, an important limitation is that I cannot observe the duration of breastfeeding in my data. Therefore, while it may be the case that WIC encourages women to initiate breastfeeding, the provision of free formula may disincentivize breastfeeding in the long-run, as some past studies have shown (Jacknowitz *et al.*, 2007; Chatterji *et al.*, 2002).

As with the results on WIC food benefit take-up and pregnancy conditions, the estimated coefficients for birth weight and breastfeeding are larger in magnitude for mothers with a high school degree or less relative to mothers with a college degree or more. Specifically, for birth weight, the estimated effect for less-educated mothers is a statistically significant 1 percent increase at the subsample mean of 3,236 grams while the estimated effect for college-educated mothers is a statistically insignificant 0.4 percent increase at the subsample mean of 3,381 grams. For breastfeeding, in contrast to the above-mentioned estimated effect for less-educated mothers of 6 percent, the estimated effect for college-educated mothers is a statistically insignificant 2 percent decline at the subsample mean of 0.91. These findings confirm the conjecture that less-advantaged women are more likely to be affected by WIC clinic access.

5.5 Additional Results and Robustness

The key identification assumption in the above analysis is that WIC clinic openings and closings in the mother’s first zip code of residence are uncorrelated with other time-varying variables that may affect WIC food receipt, pregnancy behaviors, birth outcomes, and breastfeeding. As an indirect test of this assumption, I check whether WIC clinic access either before the pregnancy or after childbirth is correlated with these outcomes. Since women have to be pregnant or post-partum to be eligible for WIC services, access to a WIC clinic before the start of the pregnancy should have no effect on the woman’s pregnancy behaviors or her child’s birth outcomes. Similarly, while women are eligible for WIC after giving birth, access to a WIC clinic after childbirth should have no effect on their behaviors during pregnancy or their children’s outcomes at birth. However, if there is a correlation between WIC clinic openings and closings and maternal (unobservable) time-varying characteristics that affect

these behaviors and outcomes, then we may detect some spurious placebo effects.

Table 8 presents the results from this placebo test. Here, the key explanatory variables are indicators for a WIC clinic operating in the mother’s zip code of residence either 3-6 or 6-9 months before the start of the pregnancy or after childbirth, but no open WIC clinic during the actual pregnancy.⁴⁰ Across all specifications, for all three main outcomes of interest (WIC food receipt, birth weight, and breastfeeding), and for both the whole sibling sample and the subsample of mothers with a high school education or less, only one out of the 60 coefficients on these placebo variables is statistically significant at the 5 percent level. This statistically significant coefficient and the few other marginally significant negative coefficients for birth weight and breastfeeding are opposite-signed than the coefficients on the main effects in Table 7. These findings are reassuring as they imply that trends in WIC clinic access are likely uncorrelated with other unobservable maternal time-varying characteristics, providing further support for the validity of the identification strategy used in this paper.

I next test whether my results are sensitive to the definition of WIC clinic access. In the main analysis, the key explanatory variable of interest is an indicator for a WIC clinic operating in the mother’s zip code of residence at any time during her pregnancy. In Appendix Table 3, I estimate regressions using two alternative definitions: an indicator for a WIC clinic operating in the mother’s zip code of residence for the entire duration of the pregnancy, and a continuous variable that ranges from 0 to 1 and denotes the fraction of pregnancy duration days that at least one WIC clinic was operating in the mother’s zip code of residence. The results for WIC food benefit receipt using these alternative definitions are very similar to the main results presented in Table 2.⁴¹ This is likely due to the fact that not many women experience a last WIC clinic closing or a first WIC clinic opening at some point during their pregnancies (rather than before or after), so these variables have equal values for most observations in the sample. It is nevertheless encouraging that the effects are consistent across several definitions of WIC clinic access.

I also explore whether there are differences in effects of WIC clinic access between clinic openings and closings. In Appendix Table 4, I show results for WIC food receipt separately

⁴⁰In the RF-FE models, the key explanatory variables refer to the mother’s *first* zip code of residence.

⁴¹Results for other outcomes are also similar and available upon request.

for mothers who ever have any WIC clinic in their zip code of residence (60 percent of the analysis sample), mothers who experience an increase in the number of WIC clinics between their first and last birth in the data (12 percent of the analysis sample), and mothers who experience a decrease in the number of WIC clinics between their first and last birth in the data (15 percent of the analysis sample). Since the identification of the effect of WIC clinic access in the IV-FE model comes from mothers who experience changes in the number of WIC clinics in their first zip codes, it is reassuring that the key coefficients are larger in magnitude for these mothers (although they are less significant because of reduced sample sizes). However, there are no meaningful or statistically significant differences in the coefficients between mothers who experience more openings and mothers who experience more closings, suggesting that combining the two sources of variation is a reasonable strategy.

Appendix Table 4 additionally addresses the concern that mothers with longer spacing between births are more likely to experience a change in WIC access. The last two columns show that the magnitude of the key coefficient is slightly larger and more significant for mothers with a space of two or more years between the first and last birth relative to mothers with shorter spacing. However, these coefficients are not statistically different from one another.

Another potential concern in my analysis relates to mis-specification of binary treatment. In particular, when a variable treatment is incorrectly parametrized as binary, the resulting estimate of the effect may be too large relative to the average per-unit effect along the length of the response function (Angrist and Imbens, 1995). In this context, this may be a problem because I determine access to WIC with an indicator for clinic presence in the mother’s zip code, whereas the underlying treatment may be a continuous measure of distance to the nearest WIC clinic. However, as noted above, calculating distances is problematic because of substantial measurement error in recorded WIC clinic street addresses in my data. Nevertheless, I have conducted some supplementary analyses using a continuous distance measure.⁴² I have estimated regression models as before, except with the key explanatory

⁴²To construct this measure, for each birth record with a non-missing mother’s full residence address, I calculated the distance between the mother’s home and the location of the nearest WIC clinic that is open during her pregnancy. For WIC clinics with missing or incorrectly recorded street addresses, I used the zip code centroid instead.

variable being the distance from the mother’s home to the nearest WIC clinic in miles, and the instrument referring to the distance from the mother’s first residence address (and assuming 39 weeks gestation). The results from this exercise are qualitatively consistent with the zip-code-level results, although they are not as precise.⁴³ In particular, scaling the IV-FE coefficients on the effect of each additional mile to the nearest WIC clinic by the average roundtrip travel distance savings that zip-code-level access to WIC represents yields estimates that are similar to (although generally somewhat smaller than) those presented in the main tables.⁴⁴ These results suggest that while the issue of mis-specification of binary treatment is a potentially relevant concern, it does not lead to substantial bias in my main estimates.

The presence of measurement error among WIC clinic street addresses may present concerns regarding the overall quality of the administrative data. Although numeric data fields for zip codes are likely less prone to be entered inaccurately than street address text fields, it may be the case that WIC clinics with wrong street addresses have other incorrectly recorded information as well (such as opening and closing dates). To address this concern, I have re-estimated the IV-FE models for the key outcomes (WIC food benefit receipt, birth weight, and breastfeeding) on a subset of the data that drops mothers residing in the 96 zip codes with at least one WIC clinic which could not be matched to longitude and latitude coordinates based on the street address provided in the raw data. The results from this exercise are presented in Appendix Table 5. Reassuringly, these results are quite similar to the main results described above, suggesting that poor data quality is not a significant shortcoming.

I have also estimated heterogeneous effects of WIC clinic access by maternal race. In results not shown, I find that Hispanic mothers experience the largest increases in WIC food benefit take-up relative to non-Hispanic white and black mothers. However, Hispanics have the smallest estimated effects on birth weight out of the three groups. This discrepancy

⁴³The results are available upon request.

⁴⁴For example, I find that each additional mile to the nearest WIC clinic reduces WIC food benefit take-up by 0.2-0.3 percentage points, and reduces birth weight by 4-5 grams. To put these magnitudes in context of the zip-code-level analysis, I note that the average distance to the nearest WIC clinic for mothers with a WIC clinic in their zip code is 1.7 miles, whereas the average distance to the nearest WIC clinic for mothers without a WIC clinic in their zip code is 4.3 miles. Consequently, zip-code-level access to WIC represents savings of an average of 5.2 miles in roundtrip travel distance. Multiplying these coefficients by 5.2 yields estimates that are similar to those presented in the main tables.

may exist because Hispanic mothers, who are less likely to be U.S. citizens relative to non-Hispanic white and black mothers, are less able to take advantage of referrals from WIC to other agencies that have restrictions for non-citizens.⁴⁵ However, sample size limitations prevent me from having the power to detect statistically significant differences across races, so these results are merely suggestive.⁴⁶

Another important issue to address is whether WIC clinic access has an effect on the total number of births. In particular, if WIC has an effect on fetal deaths, then there could be a selection effect on birth outcomes as more “marginal” babies survive. Further, it is possible that WIC may incentivize women to become pregnant in order to receive the benefits. As a result, WIC access may affect the composition of births, which could bias the estimates on birth outcomes. I investigate this possibility in Table 9. I collapse the data into zip-code/birth-year/birth-month cells, and estimate regressions with the number of births and log number of births as dependent variables. I consider all singleton births, as well as all sibling births that are part of my main sample of analysis. All regressions include birth year, birth month, and zip code fixed effects, with standard errors clustered on the zip code level.

Across all specifications in Table 9, the results suggest that WIC clinic access is not correlated with the total number of births. This may be because the effect of WIC on fetal deaths is likely very small, since the highest fetal mortality rates occur in the early stages of the pregnancy, before many women have a chance to visit a WIC clinic. Further, these results suggest that WIC benefits do not have large incentive effects on conception. These findings are reassuring because they suggest that my main results are not driven by changes in the composition of births.

5.6 Discussion

My results suggest that zip-code-level access to WIC services increases food benefit take-up by 2 to 5 percentage points, raises birth weight by 22-32 grams, and increases the likelihood of breastfeeding at the time of hospital discharge by 4 percentage points for mothers with

⁴⁵Following the enactment of the Personal Responsibility and Work Opportunity Act (PRWORA) in 1996, documented adult immigrants are subject to a five-year waiting period until they are eligible for Food Stamps, TANF, and Medicaid.

⁴⁶These results are available upon request.

a high school degree or less. How meaningful are these effects? It is useful to put these magnitudes in the context of the existing literature.

The evidence on the relationship between WIC participation and birth outcomes provides a range of estimates. Earlier studies summarized in Currie (2003) find that participation in WIC is associated with a 10-43% reduction in the probability of low-birth-weight. More recently, Bitler and Currie (2005) have found that WIC participation is associated with a 64-78 gram increase in average birth weight and a 30 percent decrease in the likelihood of a low-birth-weight birth. Joyce *et al.* (2008) find smaller effects once they control for gestation length — 7-40 gram increases in average birth weight depending on the subsample considered, and a 0.7 percentage point (9 percent at the sample mean) reduction in low-birth-weight births. Figlio *et al.* (2009) find no statistically significant effects of WIC participation on average birth weight, but do find a substantial 13 percentage point decline in low-birth-weight births (which translates to a 160% reduction at the sample mean).

In comparing my results to the existing literature on WIC, it is important to again highlight that I measure *access to* WIC, rather than WIC participation. Consequently, my results are most comparable to Hoynes *et al.* (2011), the only other study on the relationship between geographic access to WIC and birth outcomes. Hoynes *et al.* (2011) find that county-level access to WIC leads to a 7 gram increase in birth weight among low-education mothers. While my estimates of 22-32 gram increases are higher, the 95% confidence intervals of the coefficients do overlap. The larger estimate in my study may also be explained by the fact that the WIC program operates on a much greater scale than it did at the time of its inception in the 1970s (the time period analyzed by Hoynes *et al.* (2011)), and offers a wider range of services. Additionally, expansions in Medicaid and Food Stamps may have made referrals to these other programs more relevant for a larger proportion of WIC-eligible women.

Similar to Hoynes *et al.* (2011), this paper measures the intent-to-treat (ITT) estimate of the effect of WIC access on pregnancy and birth outcomes. Yet we may also be interested in the treatment-on-the-treated (TOT) effect on the population actually affected by WIC services as a result of geographic access. Hoynes *et al.* (2011) scale their ITT estimates by several different measures of WIC participation from other data sources over 1980-1988

to attain TOT effects on birth weight ranging from 18 to 37 grams. However, it is not clear how to interpret these calculations as they do not measure the “first-stage” impact of county-level access to WIC on WIC participation. In particular, these calculations assume that the 1980-1988 participation rates are equal to the percentage point increases in WIC participation resulting from county-level access in the year of pregnancy in the 1970s. If the increases in participation induced by county-level WIC clinic access in the 1970s are smaller than the participation rates measured in the 1980s, then the scaled TOT estimates should necessarily be larger.

In my data, I observe the effects of geographic access to WIC on food benefit take-up. Although one might argue that food benefit take-up is a reasonable proxy for participation, there is reason to believe that access to WIC affects several outcomes other than food benefit receipt. For example, in Texas, where women must physically go to a WIC clinic to determine their eligibility for benefits and to receive them, ineligible women may still benefit from WIC clinic access through the initial health screenings, educational services, and the referrals to other programs for which they may be eligible. Unfortunately, the Texas WIC program does not keep track of the number of applicants who are ineligible, but anecdotal evidence from state program specialists at the Texas DSHS suggests that this is a non-negligible population (Larkin, 2012).⁴⁷

Even if WIC clinic access only affected women who were eligible, scaling the estimates of effects on birth outcomes by the effects on benefit take-up would provide TOT estimates of the effects of participation in WIC *and* participation in any other programs to which clients may have been referred to. Growing evidence suggests that many programs aimed at the low-income population, such as Medicaid, Food Stamps, and the Earned Income Tax Credit (EITC), have impacts on birth outcomes (see, for example, Currie and Gruber, 1996,

⁴⁷In Texas, participation in the WIC program is actually measured through the voucher and EBT data. As a result, only individuals who have used their food benefits at a WIC grocery store are recorded as participants. However, data from the United Way Food Support Connections program, which provides eligibility screening and enrollment support for Food Stamps at local offices throughout New York City, provides a ballpark estimate of the fraction of individuals who show up at a benefits office but are determined to be ineligible — in 2009, approximately 16 percent of individuals who were screened for eligibility by the program were determined to be ineligible (see <http://unitedwaynyc.org/pages/food-card-access-project> for more information about the program). Clearly, this estimate may not be directly applicable to Texas’s WIC program. However, it at least provides some suggestive evidence that the number of women who could benefit from access to WIC clinics without actually receiving WIC food benefits is not trivial.

Almond *et al.*, 2011b, and Hoynes *et al.*, 2012, respectively). Consequently, the impacts of WIC clinic access on birth outcomes are plausibly larger than the effects of food benefit receipt alone.

Indeed, scaling the estimated 95% confidence interval of the effect of WIC clinic access on birth weight for the low-educated sample by 0.04 (the coefficient for food benefit take-up) gives large estimates ranging from 337 to 1131 grams. However, it is difficult to interpret these estimates since I do not observe the take-up of most other programs or the proportion of people who are affected by WIC clinic access but do not receive food benefits.

6 Conclusion

Increasing support for the notion that fetal and infant health are predictive of individuals' later-life outcomes highlights the value of programs and policies aimed at pregnant women and new mothers. Indeed, successful programs that improve the welfare of disadvantaged women during pregnancy and post-partum may play an important role in ameliorating inequalities at birth, and thereby potentially mitigating the intergenerational transmission of low socio-economic status. WIC is the major program in the United States whose goal is to enhance the health and nutrition of low-income pregnant and post-partum women, infants, and children under age 5. Consequently, rigorous evaluation of the program is necessary both for policy-making purposes and for providing new estimates of the determinants of fetal and infant health.

Although there are many studies that examine the relationship between WIC and birth outcomes, much less attention has been paid to the determinants of WIC food benefit take-up. Moreover, consensus on the effectiveness of WIC has not been reached. Some of the existing literature on WIC may be affected by omitted variables bias due to non-random selection into WIC participation. Other studies suffer from lack of data on important variables such as WIC food benefit take-up and breastfeeding. Additionally, the mechanical correlation between gestation and WIC participation is not always carefully addressed. Finally, thorough evaluation of WIC in the current policy context, with the emphasis on coordination of services and during the time of the Great Recession, has not been done.

This paper uses restricted data on the universe of sibling births in Texas over 2005-2009

together with administrative data on all WIC clinic openings and closings during this time period to analyze the relationship between WIC clinic access, food benefit take-up, pregnancy behaviors, birth outcomes, and breastfeeding. My identification strategy relies on within-zip-code variation in WIC clinic openings and closings, together with mother fixed effects. Additionally, I use an instrumental variables technique to account for endogenous mobility between pregnancies, measurement error in gestation, and the mechanical correlation between gestation and WIC clinic access.

My results suggest that geographic access to WIC is a determinant of WIC food benefit take-up. Specifically, the presence of a WIC clinic in the mother's zip code of residence during pregnancy increases the likelihood that she receives food benefits by about 6 percent. The effects are driven by mothers in urban zip codes where travel distance reductions from zip-code-level access are relatively low, and by access to WIC clinics located in non-health-department facilities that are more likely to have visible advertisements for services, implying that contextual factors of proximity to clinics may be influential. Further, WIC clinic access has two effects on pregnancy weight gain: although the likelihood of gaining too little weight is reduced, the likelihood of gaining too much weight is actually increased. These findings point to one potentially unintended consequence of WIC of an increase in the probability of excessive weight gain. The estimated effects on food benefit receipt and weight gain are larger in magnitude for mothers who have a high school education or less at the time of their first birth.

I also provide some suggestive evidence on the importance of other aspects of the WIC program such as health screenings, education, and referrals to other social services and programs. I show that access to a WIC clinic increases the likelihood that a mother with a high school education or less is recorded as having hypertension or diabetes, which may be either due to the effect on excessive weight gain or a result of an increase in the likelihood of diagnosis of such conditions at a WIC clinic and through a referrals.

Finally, I find that for mothers with a high school education or less, WIC clinic access increases average birth weight, and raises the likelihood of breastfeeding at the time of hospital discharge. The results on birth weight are concentrated in the middle of the distribution — there are no increases in high-birth-weight births despite the effects on excessive pregnancy

weight gain. My results suggest that WIC is successful at improving health at birth for children of disadvantaged mothers, and that the effect may operate through multiple channels including food benefit take-up, health exams at clinics, and referrals to other agencies.

My findings can help inform the cost-benefit analyses of programs and interventions aimed at the low-income population in the U.S. Existing work provides some estimates of the benefits of other programs in terms of birth weight: Currie and Gruber (1996) find that a 30 percent increase in Medicaid eligibility leads to an 8 percent reduction in low-birth-weight; Almond *et al.* (2011b) show that access to Food Stamps leads to 15-20 gram increases in birth weight for whites and 8-12 gram increases in birth weight for blacks; Hoynes *et al.* (2012) find that the 1993 EITC expansion led to a 10 gram increase in average birth weight, and that a \$1000 increase in EITC income leads to a 7-11 percent reduction in low-birth-weight. Although these estimates are not directly comparable with one another, this paper suggests that WIC clinic access leads to at least as much of an increase in birth weight as some of these other programs. Given that the costs of the WIC program are much lower than the costs of Medicaid, Food Stamps, and EITC, my results suggest that WIC, a program targeted at pregnant women and young children specifically, presents a relatively cost-effective way of improving child health at birth.⁴⁸ However, this comparison is of course very limited, as it does not factor in the potential adverse effects of excessive pregnancy weight gain for women or the benefits of breastfeeding, and does not account for the benefits of the other programs for any individuals except pregnant women and infants.

It is also possible to provide a sense of the value of the increase in birth weight in terms of other outcomes. For example, Almond *et al.* (2005) show that one standard deviation increase in birth weight leads to a 0.08 standard deviation reduction in hospital costs for delivery and initial care. Assuming that their findings are applicable to my sample, and assuming a linear relationship between birth weight and hospital costs, my estimate of a 0.05 standard deviation increase in birth weight would imply a 0.004 standard deviation reduction in costs.⁴⁹ Using an estimate of the standard deviation of approximately \$39,000

⁴⁸Ben-Shalom *et al.* (2011) show that monthly expenditures per recipient in 2007 dollars are \$482 for Medicaid, \$96 for Food Stamps, \$165 for EITC, and \$54 for WIC.

⁴⁹I attain the 0.05 standard deviation magnitude from dividing the coefficient for birth weight on the main analysis sample (27 grams) by the standard deviation in the sample of 517 grams.

in 2000 dollars from Almond *et al.* (2005), my findings suggest a \$156 reduction in average hospital costs. In terms of the long-run value, Black *et al.* (2007) find that a 10 percent increase in birth weight is associated with a 1 percent increase in annual full-time earnings. Applying their findings for cohorts born in 1967-1981 in Norway to my setting of Texas sibling births in 2005-2009 maps to a 0.08 percent increase in annual full-time earnings facilitated by WIC clinic access. Note that these value calculations likely represent lower bounds since they rely on the ITT (and not TOT) estimates of the effect of access to WIC.

An important limitation of this paper is that the findings presented may only be relevant for sibling births in Texas, and may not be generalizable to the rest of the U.S. population. Data from the 2009 March Current Population Survey (CPS) suggests that the WIC receipt rate is higher among mothers with youngest children less than one year old in Texas than in the rest of the country: the national rate is 0.27, while the Texas rate is 0.36.⁵⁰ However, infant health in Texas is comparable to the rest of the country: in 2009, the national rate of low-birth-weight was 8.2 percent, while the Texas rate of low-birth-weight was 8.5 percent. Clearly, further research on the effects of WIC access on the national level in recent years is necessary to assess the generalizability of my findings.

While this paper shows robust evidence on the effects of WIC clinic access on food benefit take-up, pregnancy behaviors, birth weight, and breastfeeding, my data do not allow me to follow children as they grow older. Understanding the long-run effects of WIC on children's outcomes should be the focus of future research.

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⁵⁰Note that the Texas take-up rate in the CPS is much lower than the food benefit receipt rate recorded in my data from Texas birth certificates. The substantial underreporting of WIC receipt in the CPS has been documented by other researchers like Bitler *et al.* (2003).

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Figure 1: Mobile WIC Clinic in McAllen, Texas



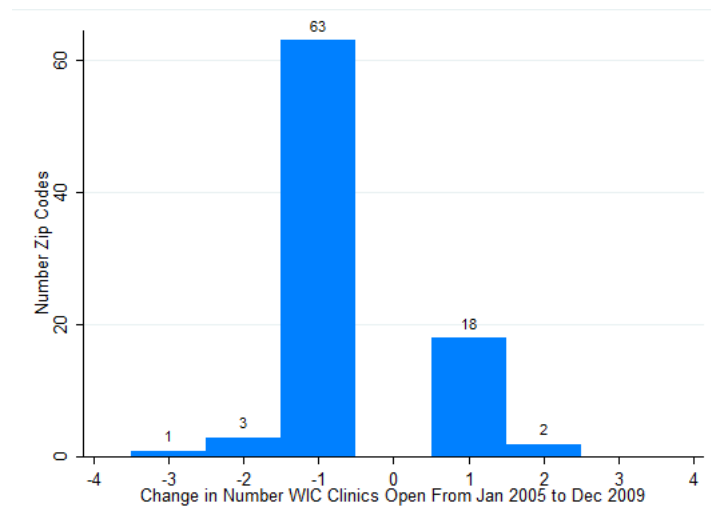
Source: United States Department of Agriculture Blog. Accessed at:
<http://blogs.usda.gov/2011/05/10/clinic-on-wheels-reaches-communities-once-isolated-from-wic-clinics/>.

Figure 2: Number Operating WIC Clinics in Texas: 2005-2009



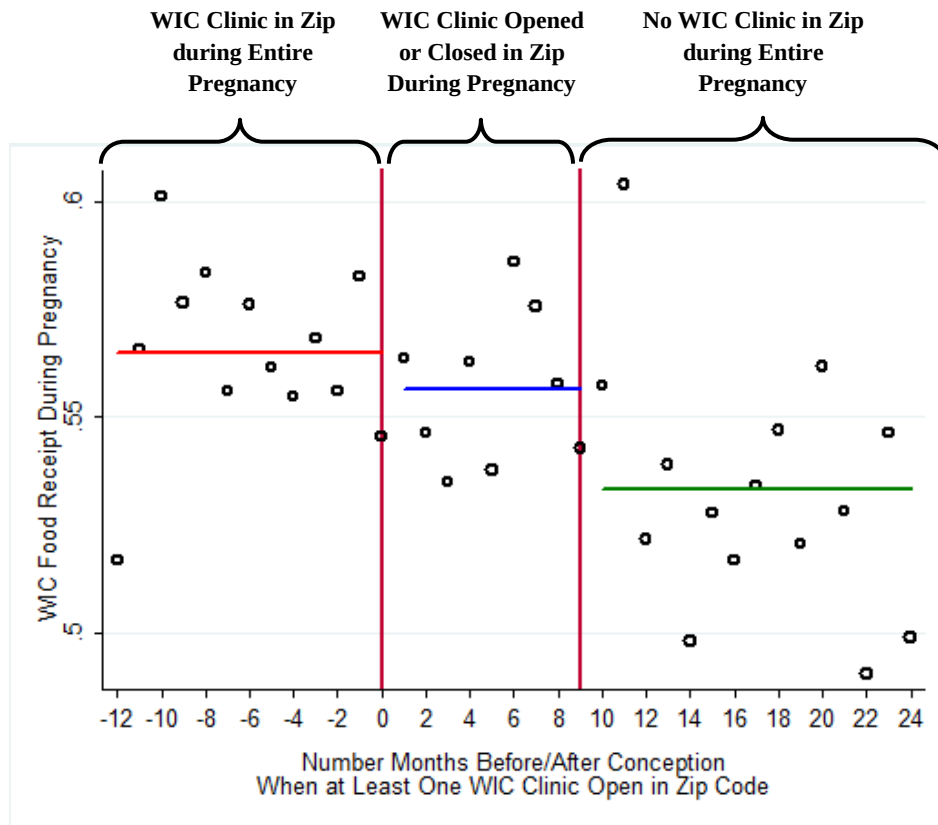
Notes: This figure plots the number of open WIC clinics in Texas by year-month from January 2005 to December 2009.

Figure 3: Variation in Within-Zip Code Number of WIC Clinics Over 2005-2009



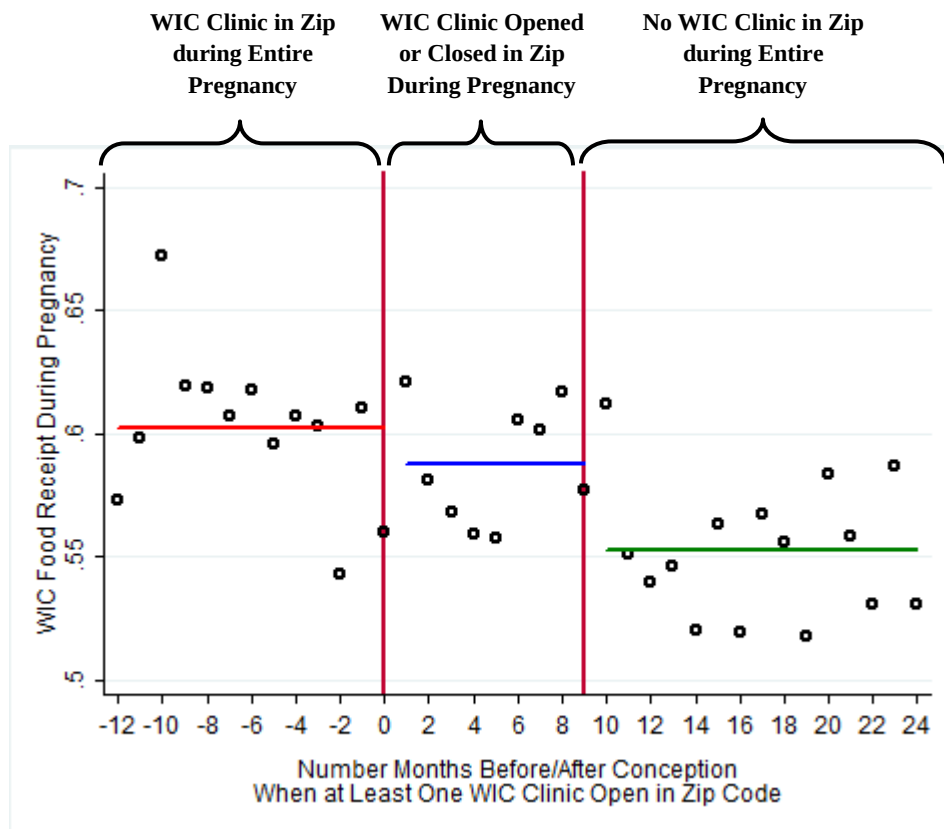
Notes: This figure is a histogram of zip codes that have had a non-zero change in the number of open WIC clinics between January 2005 and December 2009. There are 578 Texas zip codes that have ever had at least one WIC clinic operating between January 2005 and December 2009. Out of them, 114 zip codes had a non-zero change, while 464 zip codes experienced no change in the number of open WIC clinics over this time period. Note that 27 zip codes experienced a change in the number of open WIC clinics but had the same number of clinics in January 2005 and December 2009, and they are therefore excluded from the figure.

Figure 4: Prenatal WIC Food Receipt by Number Months Before/After Conception When At Least One WIC Clinic Was Operating in the Mother's Zip Code of Residence: TX Births 2005-2009



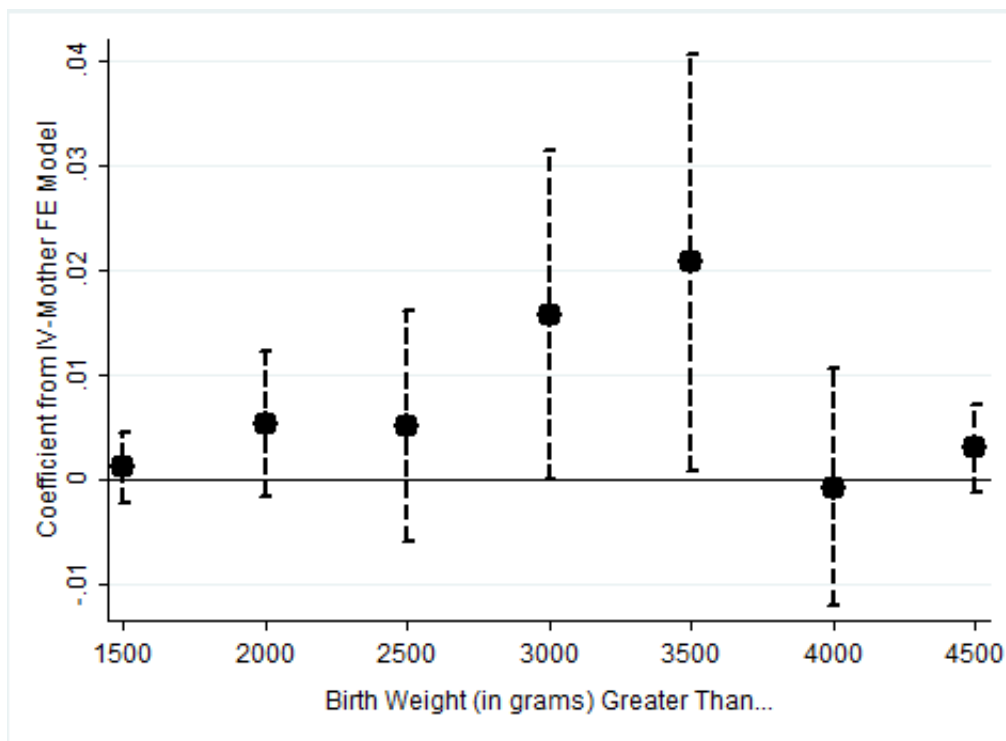
Notes: The sample of analysis consists of all singleton births in Texas over 2005-2009 with mothers who reside in Texas. The sample is limited to conceptions in a 36-month period surrounding the time that each zip code experienced a first WIC clinic opening or a last WIC clinic closing. Mothers residing in zip codes that have experienced a first WIC clinic opening and a last WIC clinic closing within the same 36-month period are dropped (5 zip codes). To understand the timing on the x-axis, consider for example all conceptions in January 2006. Assuming a 9 month gestation period, conceptions in zip codes with first openings before January 2006 will have WIC clinic exposure during the entire pregnancy; conceptions in zip codes with first openings between January 2006 and September 2006 will have partial WIC clinic exposure during pregnancy; while conceptions in zip codes with first openings after September 2006 will have no WIC clinic exposure during pregnancy. On the other hand, conceptions in zip codes with last closings before January 2006 will have no WIC clinic exposure during pregnancy; conceptions in zip codes with last closings between January 2006 and September 2006 will have partial WIC clinic exposure during pregnancy; and conceptions in zip codes with last closings after September 2006 will have WIC clinic exposure during the entire pregnancy. To combine these openings and closings on the same graph, for conceptions in zip codes that experience a first WIC clinic opening, the x-axis variable is equal to “year-month of the first WIC clinic opening – conception year-month”, while for conceptions in zip codes that experience a last WIC clinic closing, the x-axis variable is equal to “conception year-month – year-month of last WIC clinic closing + 9”. Consequently, all x-axis values below 0 correspond to conceptions in zip codes with at least one WIC clinic operating during the entire pregnancy; x-axis values between 0 and 9 correspond to conceptions in zip codes where a WIC clinic opened or closed during pregnancy; and x-axis values above 9 correspond to conceptions in zip codes with no WIC clinics operating during pregnancy. The horizontal lines depict the mean values of WIC food benefit receipt for each group of observations.

Figure 5: Prenatal WIC Food Receipt by Number Months Before/After Conception When At Least One WIC Clinic Was Operating in the Mother's Zip Code of Residence: TX Sibling Births 2005-2009



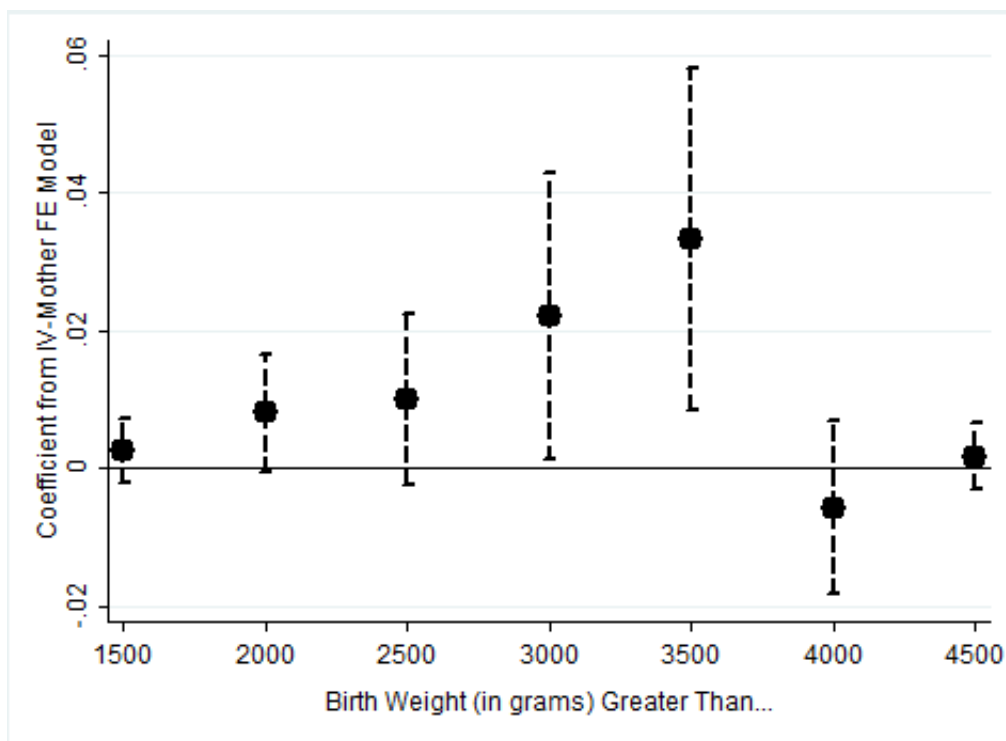
Notes: The sample of analysis consists of singleton sibling births in Texas over 2005-2009 with mothers who reside in Texas. See notes under Figure 4 for more information.

Figure 6: Effects of WIC Clinic Access in Zip Code of Residence on Birth Weight Throughout the Distribution



Notes: This figure plots the key coefficients and 95% confidence intervals from estimating equation (3) for indicators for being above each specified number of grams as outcomes.

Figure 7: Effects of WIC Clinic Access in Zip Code of Residence on Birth Weight Throughout the Distribution: Mothers with a High School Degree or Less at Time of First Birth



Notes: This figure plots the key coefficients and 95% confidence intervals from estimating equation (3) for indicators for being above each specified number of grams as outcomes. The sample is limited to births by mothers with a high school degree or less at the time of the first birth.

Table 1: Summary Statistics: Texas Sibling Births 2005-2009

	BIRTHS BY MOTHERS WITH WIC CLINIC IN ZIP CODE DURING ANY PREGNANCY					
	WHOLE SAMPLE (N=612,694)		BIRTHS WITH WIC CLINIC IN ZIP CODE DURING PREGNANCY (N=297,552)			
	Mean	SD	Mean	SD	Mean	SD
Mother Received WIC Food During Pregnancy	0.556	0.497	0.647	0.478	0.656	0.475
Mother's Age <20	0.150	0.357	0.178	0.383	0.179	0.384
Mother's Age 20-24	0.330	0.470	0.370	0.483	0.365	0.481
Mother's Age 25-34	0.447	0.497	0.399	0.490	0.401	0.490
Mother's Age 35-44	0.073	0.260	0.053	0.224	0.055	0.227
Mother's Ed: <HS	0.310	0.462	0.371	0.483	0.378	0.485
Mother's Ed: HS degree	0.281	0.449	0.305	0.460	0.303	0.460
Mother's Ed: Some College	0.220	0.415	0.207	0.405	0.203	0.402
Mother's Ed: College+	0.188	0.391	0.117	0.321	0.116	0.320
Mother is Married	0.587	0.492	0.525	0.499	0.529	0.499
Mother is Non-Hispanic White	0.353	0.478	0.276	0.447	0.263	0.440
Mother is Black	0.110	0.312	0.107	0.310	0.098	0.297
Mother is Hispanic	0.511	0.500	0.601	0.490	0.624	0.484
Child is Male	0.511	0.500	0.510	0.500	0.510	0.500
Mother's Pre-Pregnancy BMI	25.819	6.079	26.079	6.202	26.134	6.215
Pregnancy Weight Gain <16 lbs	0.146	0.354	0.159	0.366	0.161	0.368
Pregnancy Weight Gain >40 Lbs	0.191	0.393	0.186	0.389	0.183	0.387
Number Prenatal Visits	9.695	4.039	9.384	4.148	9.395	4.152
Prenatal Care Received from Public Clinic	0.092	0.289	0.106	0.308	0.109	0.311
Diabetes	0.035	0.183	0.034	0.180	0.034	0.181
Gestational Hypertension	0.043	0.202	0.041	0.199	0.041	0.199
Eclampsia	0.001	0.031	0.001	0.032	0.001	0.032
Birth Paid by Medicaid	0.480	0.500	0.554	0.497	0.553	0.497
Birth Weight (g)	3275.410	517.173	3254.084	517.108	3254.559	516.061
Low Birth Weight (<2500g)	0.060	0.238	0.064	0.245	0.063	0.244
Very Low Birth Weight (<1500g)	0.006	0.080	0.007	0.082	0.007	0.081
High Birth Weight (>4500g)	0.008	0.089	0.007	0.086	0.008	0.087
Gestation (weeks)	38.431	1.748	38.404	1.789	38.406	1.786
Premature (<37 weeks)	0.091	0.288	0.096	0.294	0.095	0.294
Child is Breastfed at Time of Discharge	0.745	0.436	0.710	0.454	0.709	0.454
Child Matched to Death Record	0.004	0.066	0.004	0.066	0.004	0.067

Notes: The sample is limited to singleton sibling births with mothers that reside in Texas over 2005-2009. Births with missing gestation length or gestation less than 26 weeks are omitted. Exposure to a WIC clinic is calculated by considering length of pregnancy from the time of conception (estimated using the child's birth date and gestation length).

Table 3: Effect of WIC Clinic Presence During First Pregnancy on Probability of Moving Zip Codes Before Next Pregnancy

	Outcome: Mother Moved Zip Codes Between Pregnancies			
	(1)	(2)	(3)	(4)
Any WIC Clinic in Zip Code of Residence	-0.0611***	0.0312+	-0.0122	0.0568**
During 1st Pregnancy	(0.0080)	(0.0179)	(0.0210)	(0.0196)
WIC Clinic * Mother is Non-Hispanic White			-0.0128	0.0102
			(0.0146)	(0.0148)
WIC Clinic * Mother is Black			-0.0163	-0.0228
			(0.0187)	(0.0178)
WIC Clinic * Mother is Hispanic			-0.0325+	-0.0256
			(0.0174)	(0.0182)
WIC Clinic * Mother's Age 20-24			0.0044	0.0038
			(0.0064)	(0.0062)
WIC Clinic * Mother's Age 25-34			0.0381***	0.0292**
			(0.0098)	(0.0094)
WIC Clinic * Mother's Age 35-44			0.0563***	0.0474***
			(0.0137)	(0.0135)
WIC Clinic * Mother's Age 45+			0.0431	0.0527
			(0.0801)	(0.0837)
WIC Clinic * Mother's Ed <HS			-0.0387**	-0.0422**
			(0.0140)	(0.0130)
WIC Clinic * Mother's Ed HS Degree			-0.0534***	-0.0475***
			(0.0132)	(0.0120)
WIC Clinic * Mother's Ed Some College			-0.0358**	-0.0330***
			(0.0112)	(0.0097)
WIC Clinic * Mother is Married			0.0260***	0.0212***
			(0.0060)	(0.0055)
WIC Clinic * Number Children			-0.0195**	-0.0146**
			(0.0060)	(0.0053)
Constant	0.1346***	0.0640***	0.1266***	0.0633***
	(0.0132)	(0.0136)	(0.0156)	(0.0135)
First Zip Code of Residence FE	No	Yes	No	Yes
N	612,690	612,690	612,690	612,690

Notes: Each column is a separate regression. The sample is limited to singleton sibling births with mothers that reside in Texas over 2005-2009. Births with missing gestation length or gestation less than 26 weeks are omitted. In addition to the listed covariates, all regressions include main effects for mother's race, age, education, marital status, and number of children as well as birth year and birth month fixed effects. The regressions in the 2nd and 4th columns also include fixed effects for the mother's first zip code of residence. All robust standard errors are clustered on the mother's first zip code of residence.

Omitted categories: mother's race - other; mother's age <20; mother's education college+; mother is unmarried.

Significance levels: +p<0.10 **p<0.05 ***p<0.001

Table 4: Effects of WIC Clinic Access in Zip Code of Residence on WIC Food Receipt

	Dependent Variable: Mother Received WIC Food During Pregnancy									
	All Texas Singleton Births					Texas Sibling Singleton Births				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Zip FE	Zip FE and County Time Trends	Zip FE	Zip FE and County Time Trends	Mother FE	IV-Mother FE, No Controls	IV-Mother FE	IV-Mother FE; HS Education or Less at Time of First Birth	IV-Mother FE; First Birth Paid by Medicaid	IV-Mother FE; College-Educated at Time of First Birth
Mean of Dependent Variable	0.537	0.537	0.556	0.556	0.556	0.556	0.556	0.740	0.764	0.072
Any WIC Clinic in Zip Code of Residence During Pregnancy	0.0147** (0.0075)	0.0148** (0.0074)	0.0221** (0.0084)	0.0220** (0.0083)	0.0075** (0.0023)	0.0317** (0.0140)	0.0308** (0.0138)	0.0443** (0.0185)	0.0398+ (0.0232)	-0.0053 (0.0137)
Mother's Age <20	0.1691*** (0.0100)	0.1692*** (0.0100)	0.1788*** (0.0287)	0.1776*** (0.0287)	0.0185 (0.0468)		0.0181 (0.0359)	-0.0569 (0.0924)	-0.0440 (0.1654)	
Mother's Age 20-24	0.1499*** (0.0098)	0.1499*** (0.0098)	0.1631*** (0.0286)	0.1619*** (0.0286)	-0.0121 (0.0467)		-0.0125 (0.0357)	-0.0890 (0.0922)	-0.0481 (0.1653)	0.0337 (0.0254)
Mother's Age 25-34	0.0676*** (0.0096)	0.0677*** (0.0096)	0.0940*** (0.0284)	0.0929** (0.0285)	-0.0130 (0.0466)		-0.0133 (0.0357)	-0.0793 (0.0922)	-0.0482 (0.1653)	0.0141 (0.0240)
Mother's Age 35-44	0.0285** (0.0096)	0.0286** (0.0096)	0.0672** (0.0284)	0.0661** (0.0284)	0.0125 (0.0463)		0.0121 (0.0354)	-0.0291 (0.0918)	-0.0132 (0.1645)	0.0165 (0.0237)
Mother's Ed: <HS	0.3475*** (0.0035)	0.3469*** (0.0035)	0.3784*** (0.0043)	0.3776*** (0.0043)	0.0678*** (0.0077)		0.0678*** (0.0063)	0.0561*** (0.0159)	0.1230*** (0.0125)	
Mother's Ed: HS degree	0.3211*** (0.0043)	0.3203*** (0.0043)	0.3540*** (0.0049)	0.3532*** (0.0049)	0.0801*** (0.0073)		0.0802*** (0.0060)	0.0670*** (0.0161)	0.1269*** (0.0125)	
Mother's Ed: Some College	0.1871*** (0.0045)	0.1868*** (0.0045)	0.2152*** (0.0054)	0.2148*** (0.0054)	0.0517*** (0.0068)		0.0517*** (0.0056)	0.0274+ (0.0164)	0.1088*** (0.0124)	
Mother is Married	-0.1185*** (0.0030)	-0.1183*** (0.0030)	-0.1007*** (0.0032)	-0.1006*** (0.0032)	-0.0431*** (0.0034)		-0.0430*** (0.0028)	-0.0288*** (0.0031)	-0.0392*** (0.0036)	-0.1154*** (0.0147)
Mother is Non-Hispanic White	-0.0499*** (0.0027)	-0.0499*** (0.0027)	-0.0484*** (0.0038)	-0.0483*** (0.0038)						
Mother is Black	0.0924*** (0.0034)	0.0921*** (0.0034)	0.0799*** (0.0045)	0.0796*** (0.0045)						
Mother is Hispanic	0.1339*** (0.0034)	0.1333*** (0.0034)	0.1290*** (0.0040)	0.1285*** (0.0040)						
N	1,918,123	1,918,123	607,002	607,002	607,002	607,002	607,002	366,865	281,838	107,175

Notes: Each column is a separate regression. The sample is limited to singleton births with mothers that reside in Texas over 2005-2009. Births with missing gestation length or gestation less than 26 weeks are omitted. Columns 3-10 additionally limit the sample to sibling births only. In columns 3-10, for each outcome, births by mothers who have at most one child with non-missing data for that outcome are omitted. Exposure to a WIC clinic is calculated by considering length of pregnancy from the time of conception (estimated using the child's birth date and gestation length). Unless otherwise noted, all regressions include fixed effects for birth order, birth year, and birth month. The first 4 columns present results from OLS regressions that include zip code fixed effects. Columns 2 and 4 add county-specific linear time trends. Column 5 presents results from regressions with mother fixed effects. Columns 6-10 present results from regressions with mother fixed effects where the key variable of interest is instrumented by an indicator for any WIC clinic during the current pregnancy assuming it had lasted 39 weeks and assuming that the mother remained at her first pregnancy zip code. Column 6 omits controls for maternal and child demographics and birth order, while column 7 includes all of the controls. Columns 8-10 limit the sample to mothers who at the time of the first birth had a high school education or less, were covered by Medicaid, and had a college degree or more, respectively. In columns 1-5, robust standard errors are clustered on the mother's zip code of residence. In columns 6-10, robust standard errors are clustered on the mother's zip code of residence at the time of the *first* birth.

Significance levels: +p<0.10 **p<0.05 ***p<0.001

Table 5: Geographic Access to WIC: By Type of Location and Clinic, IV-Mother FE Method

Dependent Variable: Mother Received WIC Food During Pregnancy				
	Urban Zip Codes	Rural Zip Codes	WIC Clinic in Health Center	WIC Clinic in Non-Health Center
Any WIC Clinic in Zip Code of Residence During Pregnancy	0.0354** (0.0148)	0.0019 (0.0257)		
Any Health Center WIC Clinic in Zip Code of Residence During Pregnancy			0.0047 (0.0150)	
Any Non-Health Center WIC Clinic in Zip Code of Residence During Pregnancy				0.0276** (0.0095)
N	507,851	76,449	607,002	607,002

Notes: Each coefficient is from a separate regression. See Table 4 for more information about the sample, controls, and the IV-Mother FE estimation method. Health center WIC clinics are those that contain one of the following strings in their name: “hospital”, “medical”, “health center”, “health ctr”, “health”, “clinic”. Significance levels: +p<0.10 **p<0.05 ***p<0.001

Table 6: Effects of WIC Clinic Access in Zip Code of Residence on Pregnancy Behaviors and Conditions: IV-Mother FE Method

	Weight Gain <16 Lbs	Weight Gain >40 Lbs	Prenatal Care Received from a Public Clinic	Diabetes	Gestational Hypertension	Eclampsia	Birth Paid by Medicaid
A. All Mothers: IV-Mother FE							
Mean of Dependent Variable	0.146	0.191	0.092	0.030	0.036	0.001	0.480
Any WIC Clinic in Zip Code of Residence During Pregnancy	-0.0172+ (0.0091)	0.0267+ (0.0137)	0.0082 (0.0242)	0.0070 (0.0049)	0.0129** (0.0049)	0.0001 (0.0008)	0.0499 (0.0512)
N	589,574	589,574	612,686	612,686	612,686	612,686	604,661
B. Mothers with High School Degree or Less at Time of First Birth: IV-Mother FE							
Mean of Dependent Variable	0.167	0.182	0.132	0.028	0.034	0.001	0.625
Any WIC Clinic in Zip Code of Residence During Pregnancy	-0.0317** (0.0127)	0.0389** (0.0183)	0.0147 (0.0352)	0.0127** (0.0047)	0.0130** (0.0056)	0.0005 (0.0011)	0.0605 (0.0627)
N	355,376	355,376	371,533	371,533	371,533	371,533	364,953
C. Mothers with College Degree at Time of First Birth: IV-Mother FE							
Mean of Dependent Variable	0.083	0.194	0.011	0.032	0.038	0.001	0.049
Any WIC Clinic in Zip Code of Residence During Pregnancy	-0.0063 (0.0111)	-0.0052 (0.0125)	0.0047 (0.0076)	-0.0145 (0.0092)	0.0033 (0.0092)	0.0010 (0.0015)	-0.0081 (0.0092)
N	105,651	105,651	107,483	107,483	107,483	107,483	107,004

Notes: Each coefficient in each panel is from a separate regression. See Table 4 for more information about the sample, controls, and the IV-Mother FE estimation method.

Significance levels: +p<0.10 **p<0.05 ***p<0.001

Table 7: Effects of WIC Clinic Access in Zip Code of Residence on Birth Outcomes: IV-Mother FE Method

	Birth Weight (g)	Low Birth Weight (<2500g)	Gestation (weeks)	Premature (<37 weeks)	Child Breastfed	Child Matched to Death Record
A. All Mothers: IV-Mother FE						
Mean of Dependent Variable	3274.410	0.060	38.431	0.091	0.745	0.004
Any WIC Clinic in Zip Code of Residence During Pregnancy	27.3023** (7.9839)	-0.0053 (0.0056)	0.0582 (0.0417)	-0.0037 (0.0109)	0.0201 (0.0168)	-0.0011 (0.0019)
N	612,640	612,640	612,686	612,686	608,982	612,551
B. Mothers with High School Degree or Less at Time of First Birth: IV-Mother FE						
Mean of Dependent Variable	3236.176	0.069	38.423	0.098	0.682	0.004
Any WIC Clinic in Zip Code of Residence During Pregnancy	32.5030*** (8.9690)	-0.0100+ (0.0053)	0.0711 (0.0569)	-0.0054 (0.0126)	0.0405** (0.0185)	0.0003 (0.0024)
N	371,504	371,504	371,533	371,533	369,000	371,424
C. Mothers with College Degree at Time of First Birth: IV-Mother FE						
Mean of Dependent Variable	3381.123	0.038	38.535	0.067	0.913	0.004
Any WIC Clinic in Zip Code of Residence During Pregnancy	16.3060 (14.9501)	-0.0112 (0.0116)	0.0929 (0.0753)	0.0014 (0.0088)	-0.0217 (0.0168)	-0.0006 (0.0030)
N	107,477	107,477	107,483	107,483	107,076	107,477

Notes: Each coefficient in each panel is from a separate regression. See Table 4 for more information about the sample, controls, and the IV-Mother FE estimation method.
Significance levels: +p<0.10 **p<0.05 ***p<0.001

Table 8: Placebo Effects of WIC Clinics on Prenatal WIC Food Receipt, Birth Weight, and Breastfeeding

Table 7. Placebo Effects of WIC Clinics on Prenatal WIC Food Receipt, Birth Weight, and Breastfeeding:
Texas Sibling Births 2005-2009

	Dependent Variable: Mother Received WIC Food During Pregnancy					Dependent Variable: Birth Weight (g)					Dependent Variable: Child is Breastfed at Time of Discharge				
	Zip FE & County Time Trends					Zip FE & County Time Trends					Zip FE & County Time Trends				
	Zip FE	FE	Mother	RF-Mother	FE	Zip FE	FE	Mother	RF-Mother	FE	Zip FE	FE	Mother	RF-Mother	FE
A. All Mothers															
At Least One WIC Clinic 3-6 Months Before or After Pregnancy & No WIC Clinics During Pregnancy	-0.0012 (0.0154)	-0.0013 (0.0154)	-0.0034 (0.0176)	-0.0023 (0.0183)	-0.0031 (0.0179)	-8.8582 (17.5737)	-8.8695 (17.5241)	-19.9775 (20.7472)	-26.0794 (21.9681)	-35.4600 (23.5515)	0.0047 (0.0108)	0.0045 (0.0108)	-0.0062 (0.0147)	-0.0079 (0.0189)	-0.0107 (0.0185)
At Least One WIC Clinic 6-9 Months Before or After Pregnancy & No WIC Clinics During Pregnancy	-0.0047 (0.0118)	-0.0047 (0.0118)	-0.0201 (0.0161)	-0.0037 (0.0182)	-0.0051 (0.0183)	1.5355 (18.7600)	0.7957 (18.7264)	16.0030 (23.3029)	20.8911 (21.4456)	29.3213 (21.9082)	0.0041 (0.0142)	0.0030 (0.0142)	0.0122 (0.0150)	0.0170 (0.0184)	0.0237 (0.0189)
N	607,002	607,002	607,002	607,002	607,002	612,640	612,640	612,640	612,640	612,640	608,982	608,982	608,982	608,982	608,982
B. Mothers with High School Degree or Less at Time of First Birth															
At Least One WIC Clinic 3-6 Months Before or After Pregnancy & No WIC Clinics During Pregnancy	0.0035 (0.0229)	0.0036 (0.0229)	-0.0051 (0.0246)	-0.0042 (0.0269)	-0.0058 (0.0271)	-26.0558 (23.2901)	-26.1545 (23.3007)	-24.9839 (22.4614)	-31.9811 (23.4409)	-44.4283+ (23.6391)	-0.0223 (0.0144)	-0.0226 (0.0144)	-0.0365+ (0.0189)	-0.0445** (0.0210)	-0.0517+ (0.0305)
At Least One WIC Clinic 6-9 Months Before or After Pregnancy & No WIC Clinics During Pregnancy	-0.0204 (0.0191)	-0.0209 (0.0191)	-0.0338 (0.0244)	-0.0142 (0.0296)	-0.0197 (0.0301)	7.2430 (20.1771)	6.0043 (20.1609)	32.4890 (27.2863)	31.2457 (27.3351)	43.7363 (28.0755)	0.0126 (0.0201)	0.0112 (0.0203)	0.0269 (0.0192)	0.0168 (0.0219)	0.0237 (0.0227)
N	366,865	366,865	366,865	366,865	366,865	371,504	371,504	371,504	371,504	371,504	369,000	369,000	369,000	369,000	369,000

Notes: Each column in each panel is from a separate regression. See notes under Table 4 for more information about the sample and estimation methods. The key explanatory variables of interest are indicators that are equal to 1 if a first WIC clinic opens in the mother's zip code of residence 3-6 and 6-9 months after childbirth or if a last WIC clinic closes in the 3-6 and 6-9 months before conception, and zero otherwise.
Significance levels: +p<0.10 **p<0.05 ***p<0.001.

Notes: Each column in each panel is from a separate regression. See Table 4 for more information about the sample, controls, and estimation methods. The key explanatory variables of interest are indicators that are equal to 1 if a first WIC clinic opens in the mother's zip code of residence 3-6 and 6-9 months after childbirth or if a last WIC clinic closes in the 3-6 and 6-9 months before conception, and zero otherwise. In the RF-Mother FE specifications, these variables refer to the mother's *first* zip code of residence.
Significance levels: +p<0.10 **p<0.05 ***p<0.001

Table 9: Effects of WIC Clinic Access on Births in Texas

	Total Number Births	Log Total Births	Total Number Sibling Births	Log Sibling Births
Any WIC Clinic in Zip Code of Residence During Pregnancy	-0.5100 (0.4162)	0.0076 (0.0201)	-0.3808 (0.4843)	0.0059 (0.0260)
N	94,796	94,796	76,945	76,945

Notes: Each coefficient is from a separate regression. Units of analysis are residence zip code - birth year - birth month cells. In the first two columns, the sample includes the universe of Texas singleton births over 2005-2009. The last two columns use the siblings sample. All regressions include birth year, birth month, and zip code fixed effects. Robust standard errors are clustered on the zip code level.

Significance levels: +p<0.10 **p<0.05 ***p<0.001

Appendix Table 1: First Stage/Reduced Form for IV-Mother FE

	First Stage: Any WIC Clinic in Zip Code of Residence During Pregnancy				Reduced Form: WIC Food Receipt During Pregnancy			
	All Mothers	Mothers with HS Education or Less at Time of First Birth	Mothers with First Births Paid by Medicaid	Mothers with College Degree or More at Time of First Birth	All Mothers	Mothers with HS Education or Less at Time of First Birth	Mothers with First Births Paid by Medicaid	Mothers with College Degree or More at Time of First Birth
Any WIC Clinic in Zip Code of Residence at FIRST Birth During Current Pregnancy, Assuming 39 Weeks Gestation	0.7617*** (0.0173)	0.7468*** (0.0143)	0.7223*** (0.0251)	0.8448*** (0.0425)	0.0234+ (0.0123)	0.0331+ (0.0192)	0.0287 (0.0234)	-0.0044 (0.0163)
Mother's Age <20	0.0186 (0.0420)	-0.0212 (0.0719)	0.0572 (0.0874)		0.0187 (0.0498)	-0.0578 (0.1275)	-0.0417 (0.2274)	
Mother's Age 20-24	0.0219 (0.0420)	-0.0165 (0.0721)	0.0624 (0.0875)	0.0152 (0.0292)	-0.0119 (0.0495)	-0.0898 (0.1272)	-0.0456 (0.2272)	0.0336 (0.0359)
Mother's Age 25-34	0.0197 (0.0423)	-0.0218 (0.0720)	0.0634 (0.0867)	0.0031 (0.0264)	-0.0127 (0.0494)	-0.0803 (0.1273)	-0.0456 (0.2271)	0.0141 (0.0340)
Mother's Age 35-44	0.0194 (0.0415)	-0.0269 (0.0714)	0.0671 (0.0848)	0.0011 (0.0252)	0.0127 (0.0490)	-0.0303 (0.1267)	-0.0105 (0.2260)	0.0164 (0.0336)
Mother's Ed: <HS	0.0007 (0.0078)	-0.0033 (0.0175)	-0.0058 (0.0154)		0.0679*** (0.0088)	0.0559** (0.0218)	0.1227*** (0.0172)	
Mother's Ed: HS degree	-0.0003 (0.0075)	-0.0034 (0.0174)	-0.0061 (0.0151)		0.0801*** (0.0083)	0.0669** (0.0221)	0.1267*** (0.0171)	
Mother's Ed: Some College	-0.0037 (0.0066)	-0.0035 (0.0177)	-0.0080 (0.0144)		0.0516*** (0.0077)	0.0273 (0.0225)	0.1084*** (0.0170)	
Mother is Married	-0.0002 (0.0037)	0.0006 (0.0040)	-0.0008 (0.0047)	-0.0024 (0.0202)	-0.0430*** (0.0039)	-0.0288*** (0.0042)	-0.0392*** (0.0049)	-0.1154*** (0.0209)
Constant	0.1073** (0.0467)	0.1766** (0.0768)	0.1148 (0.0895)	0.0436 (0.0428)	0.5317*** (0.0516)	0.7452*** (0.1319)	0.7549*** (0.2283)	0.1842*** (0.0395)
R-squared	0.8087	0.7841	0.7689	0.8628	0.7662	0.6504	0.6188	0.7001
N	607,002	366,865	281,838	107,175	607,002	366,865	281,838	107,175

Notes: The partial F-statistics for the first stage are 1934.99, 2712.84, 829.80, and 394.53, respectively. See notes under Table 4 for more information about the sample and estimation methods. All regressions also include mother fixed effects, and fixed effects for birth order, birth year, and birth month.

Significance levels: +p<0.10 **p<0.05 ***p<0.001

Appendix Table 2: Effects of WIC Clinic Access on Pregnancy Weight Gain by Mother's Pre-First-Pregnancy BMI

	Weight Gain <16 Lbs	Weight Gain >40 Lbs
A. Mothers with Pre-First-Pregnancy BMI <25: IV-Mother FE		
Mean of Dependent Variable	0.147	0.191
Any WIC Clinic in Zip Code of Residence During Pregnancy	-0.0189** (0.0090)	0.0114 (0.0109)
N	353,798	353,798
B. Mothers with Pre-First-Pregnancy BMI ≥25: IV-Mother FE		
Mean of Dependent Variable	0.209	0.186
Any WIC Clinic in Zip Code of Residence During Pregnancy	-0.0142 (0.0158)	0.0477** (0.0236)
N	234,846	234,846

Notes: Each coefficient is from a separate regression. See Table 4 for more information about the sample, controls, and the IV-Mother FE method.

Significance levels: +p<0.10 **p<0.05 ***p<0.001

Appendix Table 3: Effects of WIC Clinic Access in Zip Code of Residence on WIC Food Receipt: Alternative Definitions of WIC Clinic Access

	Dependent Variable: Mother Received WIC Food During Pregnancy					
	IV-Mother			IV-Mother		
	Zip FE	Mother FE	FE	Zip FE	Mother FE	FE
Any WIC Clinic in Zip Code of Residence Open During Entire Pregnancy	0.0209** (0.0102)	0.0072** (0.0022)	0.0234** (0.0113)			
Fraction of Time During Pregnancy At Least One WIC Clinic Open in Zip Code of Residence				0.0237** (0.0109)	0.0073** (0.0023)	0.0316** (0.0138)
N	607,002	607,002	607,002	607,002	607,002	607,002

Notes: Each coefficient is from a separate regression. See notes under Table 4 for more information about the sample and estimation methods. In the first three columns, the key explanatory variable of interest is an indicator for any WIC clinic being open during the entire pregnancy in the mother's zip code of residence. In the last three columns, the key explanatory variable of interest is a continuous variable that is equal to the fraction of days during the pregnancy duration that at least one WIC clinic was operating in the mother's zip code of residence.

Significance levels: +p<0.10 **p<0.05 ***p<0.001

Appendix Table 4: Effects of WIC Clinic Access in Zip Code of Residence on WIC Food Receipt: Differences in Variation Due to Openings vs. Closings and Birth Spacing, IV-Mother FE Method

	Dependent Variable: Mother Received WIC Food During Pregnancy				
	Mothers with WIC Clinic In Zip Code of Residence During Any Pregnancy	Mothers Who Experience an Increase in Number of WIC Clinics Between First and Last Birth	Mothers Who Experience a Decrease in Number of WIC Clinics Between First and Last Birth	Mothers with Less than 2 Years Between First and Last Birth	Mothers with 2+ Years Between First and Last Birth
Any WIC Clinic in Zip Code of Residence During Pregnancy	0.0303** (0.0138)	0.0607 (0.0466)	0.0577 (0.0451)	0.0220 (0.0180)	0.0339** (0.0165)
N	357,272	72,251	89,952	260,366	346,635

Notes: Each coefficient is from a separate regression. See Table 4 for more information about the sample, controls, and the IV-Mother FE method.
Significance levels: +p<0.10 **p<0.05 ***p<0.001

Appendix Table 5: Robustness Check: Effects of WIC Clinic Access on Prenatal WIC Food Receipt, Birth Weight, and Breastfeeding; Dropping “Bad Data” Zip Codes

	Mother Received WIC		
	Food During Pregnancy	Birth Weight (g)	Child Breastfed
A. All Mothers: IV-Mother FE			
Mean of Dependent Variable	0.541	3279.029	0.748
Any WIC Clinic in Zip Code of Residence During Pregnancy	0.0346** (0.0123)	22.4266** (7.9759)	0.0213 (0.0173)
N	554,498	559,904	556,437
B. Mothers with High School Degree or Less at Time of First Birth: IV-Mother FE			
Mean of Dependent Variable	0.731	3238.760	0.681
Any WIC Clinic in Zip Code of Residence During Pregnancy	0.0473** (0.0164)	25.1173** (9.3908)	0.0407** (0.0197)
N	328,231	332,702	330,334

Notes: Each coefficient is from a separate regression. See Table 4 for more information about the sample, controls, and the IV-Mother FE method. “Bad data” zip codes are zip codes that have at least one WIC clinic which could not be matched to a longitude and latitude coordinate using the address provided. There are 96 such zip codes in the data.

Significance levels: +p<0.10 **p<0.05 ***p<0.001