PAGAN, LORISSA CHARIS, Ph.D. Three Essays on the Microeconomic Analysis of Long-Acting Reversible Contraception. (2020)
Directed by Dr. Christopher Swann. 206 pp.

In this dissertation I use a variety of methods to study the effect of and choice to use long-acting reversible contraceptives (LARCs) using data from the National Survey of Family Growth. Effective contraception may increase women's welfare by allowing better control of the timing of fertility. However, many contraceptives rely on consistent use to achieve low failure rates, potentially leaving benefits of fertility control forgone due to user error. As LARCs do not rely on contraceptive adherence, they may be welfare improving through eliminating the gap between the "perfect use" and "typical use" failure rates.

How much LARCs can reduce the risk of unintended pregnancies depends on the degree to which LARC users would have used other methods consistently and correctly, how sensitive the other methods would be to inconsistent use, and how long LARCs are used. In my first essay, I implement survival analysis techniques to analyze which reversible methods women used before transitioning to a long-acting method and the duration of LARC use. Consistent with the literature, I find that LARC use is associated with high continuation rates. I also find that contraceptive spells of methods that are more sensitive to inconsistent use are not at a greater risk of ending due to switching into LARC use, which may dampen the effect of increased LARC use on pregnancies among contracepting women.

Evaluating the additional effectiveness of using a LARC compared to other methods on pregnancy is difficult as women may select into LARC use due to their risk of pregnancy. In my second essay, I use an exogenous change in provider recommendations to get around the selection issue and evaluate the causal effect of LARC use on pregnancies and births using an instrumental variables approach. First, I show that the release of the recommendation had a differential effect for younger mothers of one child compared to older mothers of one child. Then using this exogenous variation, I find that LARC use decreases the probability of pregnancies in the current year, in the following year, and births in the following year compared to other methods, at least among young mothers who were affected by the recommendation. Using a correlated random coefficients model, I find evidence that women who choose LARCS would have been more likely to experience pregnancy in the following year.

Finally, LARCs can only be welfare improving if women choose them over other alternatives. As with any product, each contraceptive can be thought of as a bundle of its different characteristics such as its maximum duration of use, its effectiveness, if it is hormonal, and if the method requires the insertion of a device. In my third essay, I use discrete choice models to estimate how attributes of contraceptives affect method choice. I find that the LARC-specific attribute of being a physical device may discourage some women from choosing a LARC method.

THREE ESSAYS ON THE MICROECONOMIC ANALYSIS OF LONG-ACTING REVERSIBLE CONTRACEPTION

by

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A Dissertation Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
2020

Approved by

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Committee Chair

To my parents, who have always made feel like I could accomplish whatever I put my mind to, and my partner Sergey for his support.

APPROVAL PAGE

This dissertation written by Lorissa Charis Pagan has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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ACKNOWLEDGEMENTS

I would like to thank Christopher Swann for his support and guidance throughout these years of graduate school. I would also like to thank Martin Andersen for his help and all the times he let me stop by his office with questions, and Dora Gicheva for her useful comments and suggestions. Additionally, I would like to thank the faculty in the Department of Economics, who have cheered me on throughout my journey, and the Administrative Staff who have been a valuable source of support.

I would also like to thank my cohort from my MA in Applied Economics, who helped me get through those early years of graduate school, and my colleagues in the PhD program who have been a source of encouragement and comradery.

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CHAPTER I

INTRODUCTION

Effective contraception has been shown to improve women's welfare by increasing educational attainment, wages, and labor market attachment (Bailey & Lindo, 2018; Bailey, 2006; Goldin & Katz, 2002). Many contraceptives rely on correct and consistent use for maximum effectiveness. Because individuals may make mistakes, the actual failure rates of contraceptives tend to be much higher than their "perfect use" failure rates (Trussell, 2011). Thus, due to user error, some benefits of fertility control may be lost.

My dissertation contains three essays on long-acting reversible contraceptives (LARCs). LARCs are physical devices that are highly effective at preventing pregnancy for 3 to 10 years, depending on the type chosen. One of the important features of LARC methods is that they require little (if any) effort on the part of the woman during their duration of use. Thus, they reduce the probability of mistakes. If LARCs increase fertility control compared to other methods by removing user error, then increased use of LARCs may be welfare improving.

The usefulness of LARC methods in increasing control over fertility depends on how long they are used, what method woman would have used otherwise, and how consistently she would have used the other method. The first two essays of my dissertation address these three factors using contraceptive histories from the National

Survey of Family Growth. In my first essay, I use Kaplan-Meier survival probabilities and a discrete-time hazard model to study the duration of LARC use and a competing risk model to assess which reversible method spells are more at risk of ending due to switching to a LARC.

It is possible that LARCs are more attractive to women who struggle to use contraceptive methods consistently. It is also possible that women who choose LARCs tend to be more cautious and would have correctly used other potentially effective methods had they not had access to a LARC. In my second essay, I use contraceptive histories from the National Survey of Family Growth to study the causal effect of LARC use on pregnancies and births among young mothers using exogenous variation in LARC use due to the release of provider recommendations.

Finally, in order for LARCs to make a difference on the rates of unintended pregnancies, women need to find IUDs and implants as an attractive contraceptive option. As physical devices, LARCs have unique barriers to use compared to other contraceptive methods, such as high upfront costs, yet LARC use has grown considerably since the early 2000s (Kavanaugh & Jerman, 2018). Despite this growth, LARCs were still used by less than 16% of contracepting women between the ages of 15-49 in 2016 (Daniels & Abma, 2018). It is likely that the proportion of women currently using a LARC is influence by continued barriers to use, however it is also likely that some women do not choose LARCs simply because they do not like various characteristics of LARC methods. In my third essay, I use data from the National Survey of Family Growth and information on birth control prices from the literature to estimate a set of models of contraceptive choice to assess how the characteristics of contraceptive methods (including the LARC-specific attribute of being a device) affect the likelihood that a woman chooses that method.

CHAPTER II

WHO CHOSES LONG-ACTING REVERSIBLE CONTRACEPTION AND FOR HOW LONG?

2.1 Introduction

The United States has a relatively high rate of unintended pregnancies compared to other developed nations (Singh et al., 2010). It was estimated that 45% of pregnancies were unintended in 2011(Finer & Zolna, 2016). Such unintended fertility can be costly. For example, public expenditures on unplanned pregnancies in 2010 were estimated to be $21 billion (Sonfield & Kost, 2015). This cost does not take into the account the effect of mistimed fertility on women's lifetime utility. Women who experience unintended pregnancies may not be able to make their preferred decisions regarding education, careers, or in the marriage market, which may lead to poorer economic outcomes (Bailey & Lindo, 2018; Bailey, 2006; Goldin & Katz, 2002).

While over half of unintended pregnancies are due to not using a contraceptive method (54%), a large minority (41%) are due to inconsistent method use. Only 5% of unintended pregnancies occur due to a "true" failure of the contraceptive method, in which a correctly used method still results in pregnancy (Sonfield et al., 2014). Because non-adherence with contraceptive regimens accounts for such a large proportion of unintended pregnancies among contraceptive users, one potential avenue for decreasing the rate of unplanned pregnancies is reducing the proportion of women who depend on methods that are sensitive to user adherence. Increasing the use of long-acting reversible contraceptives would accomplish this goal, as long-acting reversible contraceptives (or LARCs) are physical devices that do not rely on regular effort to maintain effectiveness (American College of Obstetricians and Gynecologists, 2015).

Public health advocates, physicians, and professional organizations such as the American College of Obstetricians and Gynecologists have called for increased access to long-acting reversible contraceptives, which can have unique barriers compared to other methods and high out-of-pocket expenses (Committee on Adolescence, 2014; Foster et al., 2015; American College of Obstetricians and Gynecologists, 2015). Because LARCs can be used for multiple years, increased LARC use has the potential to provide cost-savings despite frequently high upfront costs (Trussell et al., 2013, 2015). In a 2015 study, Trussell et al. estimate how long a LARC would need to be used before its use would be considered "cost-neutral" compared to other methods, in which the calculations consider both the cost of the methods and their effectiveness. The authors' estimates suggest that it could take 1.7 years before the cost and benefits of using LARC would be equal to using no method at all, or 2.1 years of LARC use to achieve cost-neutrality compared to other hormonal methods (Trussell et al., 2015). Switching from barrier methods would require an even longer duration of use to reach this point—around 3 years. Thus, in order to consider increasing access to LARCs for the purpose of reducing expenditures on unintended fertility, policy makers need to consider not only the effectiveness of LARCs, but also the duration of LARC use.

There are two important factors that determine the benefits of using a LARC compared to other methods, at least regarding pregnancy prevention. The first is how long LARCs are used, and the second is what method the woman would have used otherwise. While the literature on the duration of LARC use has grown considerably in the past 20 years, there is a lack of studies using recent US data on what methods women were using before choosing a LARC.

In this paper I use data from the National Survey of Family Growth to study the duration of LARC use and to explore what methods women were using before switching to a LARC method. While studying what women were using previously is not a perfect measure of what she would have used had she not had access to LARCs, knowing who is more likely to switch to a long-acting method may shine some light on the benefits of LARC use.

I first estimate the Kaplan-Meier survival probabilities. Since Kaplan-Meier analysis does not allow for the inclusion of (many) covariates, I next estimate a discrete-choice hazard model with random effects. Finally, I estimate a competing risk model that allows me to look at the likelihood that contraceptive users exit their non-LARC contraceptive spells to switch to a LARC while allowing for other exits such as to pregnancy or sterilization.

My results confirm that long-acting reversible methods exhibit high continuation rates with 77%, 65%, and nearly 54% of LARC spells continuing out to one, two, and three years respectively. My estimates from a discrete time hazard model of contraceptive discontinuation indicate that spells of LARC use have reduced odds of discontinuation compared to spells of short-acting reversible contraceptive (or SARCs) use such as birth control pills, even after accounting for spurious duration dependence. Finally, my competing risk results imply that spells of contraceptive use of methods with higher typical use failure rates (such as barrier and traditional methods) are not at greater risk of ending in LARC use than spells of moderately effective SARC methods, which may dampen the effect of LARC use and increase the time needed to achieve cost-neutrality. Taken together, these results imply that long-acting reversible contraception is used longer than other methods. However, it is unclear if the methods are used long enough to offset the upfront costs of their provision for the purpose of lowering expenditures on pregnancies, as over one third of LARC spells are discontinued by two years of use.

2.2 Background

Since the early 2000s, there has been increased use of long-acting reversible contraceptives in the United States (Branum & Jones, 2015). Long-acting reversible contraception includes subdermal implants and intrauterine devices (IUD). These contraceptives can be used for 3 to 10 years, depending which method is chosen (American College of Obstetricians and Gynecologists, 2015). Over the lifespan of the device, LARCs offer low failure rates (>1%) without requiring frequent effort from those using them (American College of Obstetricians and Gynecologists, 2015; Trussell, 2011).

The modern history of LARC use in the US began in the 1960s with the introduction of several IUDs to the US market (Hubacher & Cheng, 2004). By 1973, close to 10% of married contracepting women reported relying on an IUD (Mosher & Westoff, 1982). However, factors including negative and dangerous experiences with a poorly designed IUD in the 1970s diminished the use of LARCs in subsequent decades, and use of LARCs by American women fell below 2% by 1988 and remained low until the 2000s (Branum & Jones, 2015; Hubacher & Cheng, 2004; Hubacher et al., 2011). It was not until the release of new IUDs and changes in views of professionals in the early 2000s that LARCs began to regain traction (Hubacher et al., 2011). The proportion of LARC users has increased to nearly 16% of contracepting women in 2016 (Daniels & Abma, 2018).

Researchers, physicians, and professional organizations have encouraged the use of LARCs and have advocated for the removal of barriers to LARC use (Committee on Adolescence, 2014; Hubacher, 2002; The American College of Obstetricians and Gynecologists, 2015). Some of these barriers include demand-side issues such as patient misinformation or a lack of knowledge and supply-side issues such as misinformation among providers and difficulties keeping the devices in stock (Beeson et al. 2014; Foster et al., 2015; Luchowski et al., 2014; Phillips & Sandhu, 2018). LARCs are also costly, with out-of-pocket expenses up to $1,000 (Planned Parenthood, n.d.). However, when considering these costs spread out over the lifespan of LARCs, LARCs can be less expensive compared to other methods (Mavranezouli, 2008; Trussell et al., 2013, 2015).

Researchers have studied the duration of LARC use, often by estimating Kaplan-Meier survival probabilities or the hazard of discontinuation of LARCs compared to other contraceptives using Cox proportional hazard models or other similar approaches.

Consistently, LARCs have high continuation rates. While there is some variation in survival probabilities based on which type of LARC is used, the continuation rates are substantially higher for LARCs they are for short-acting methods. IUDs and implants have continuation rates from 81 to 88% at one year, compared to 41 to 61% for short-acting reversible contraceptives (SARCs), such as pills and patches (Abraham et al., 2015; Aoun et al., 2014; Chiles et al., 2016; Diedrich, Madden, et al., 2015; Diedrich, Zhao, et al., 2015; Grunloh et al., 2013; Peipert et al., 2011; Romano et al., 2018).

O'Neil-Callahan et al. (2013) estimated 24-month continuation rates of 77% for LARC users. Diedrich, Madden, et al. (2015) found that the continuation of IUDs was 63.2% at four years, and 53.9 at five years, with older women having higher rates of continuation. Similarly, the hazards for discontinuing the use of LARC methods are much lower than they are for other methods (Berenson et al., 2015; Grunloh et al., 2013; Peipert et al., 2011).

One primary source of data for studying the duration of LARCs and related outcomes is the St. Louis Contraceptive CHOICE Project (Abraham et al., 2015; Grunloh et al., 2013; O'Neil-Callahan et al., 2013; Peipert et al., 2011). The CHOICE Project was an initiative aimed at removing barriers to LARC use by providing contraceptive counseling and the method of choice free of charge. With cost and information barriers removed, 75% of participants chose LARCs (Birgisson et al., 2015; McNicholas et al., 2014). Women who participated in the CHOICE Project were followed up with every 6 months for two to three years, providing rich data on failure rates, satisfaction, and continuation. At one year, LARC continuation ranged from 82 to 88%, depending on method (Abraham et al., 2015; Diedrich, Zhao, et al., 2015; O'Neil-Callahan et al., 2013; Peipert et al., 2011). At two years, continuation remained high ranging from 66 to 79%, with IUD users having higher continuation rates. LARC users also had low failure rates and were more likely to report being satisfied with their method compared to other contraceptive users (Peipert et al., 2011).

Other papers have used a variety of data sources to study the duration of LARC use, including insurance claims (Berenson et al., 2015; Romano et al., 2018), records from Tricare enrollees (Chiles et al., 2016), and electronic records from healthcare systems (Aoun et al., 2014). Results are similar across studies, leading to continuation rates of 75 to 80% in at one year, and lower hazards of discontinuation when compared to short-acting methods. Chiles, Roberts, and Klein (2016) found IUD continuation to be 61.2% at 36 months for IUDs and 45.8% for implants at 33 months.

In Huchbacher et al (2017), the authors offered the option to be randomized to a LARC or SARC to women seeking short-acting methods from Planned Parenthood clinics in North Carolina. If a woman chose to randomize, she would have her contraceptive provided free of cost for the duration of the study. She could freely discontinue LARC use, however she would need to pay for her new method if she did switch. The results showed that among women who originally requested a SARC, LARCs were acceptable and continuation was 77.8% at one year. Interestingly, a lower proportion of women who were randomized planned to have children in the future, implying that women who were willing to potentially be given a LARC method may have been more interested in limiting their family size (Hubacher et al., 2017).

The results from previous studies have found that long-acting reversible contraceptives are associated with high continuation rates, which is intuitive. A woman can easily discontinue her other reversible methods if she is unsatisfied, no longer wishes to use contraception or is not currently sexually active. Most reversible methods require active continuation of the method. If an individual is relying on condoms or SARCs, she will have to go to the store, pharmacy, or doctor's office to continue use and may have reoccurring out-of-pocket expenses. These factors could lead to more frequent discontinuation and switching, especially if there is no cost to stopping the method.

The only reversible methods that have discontinuation costs are LARCs. To stop using a LARC, the woman must at least go to the doctor's office to get the device removed. She may also face other costs and barriers to removal, including out-of-pocket expenses (Amico et al. 2020; Gomez et al. 2014). Her desire to discontinue use would have to be greater than the cost to stop using the method and she may also have to more carefully consider discontinuation as it could be costly to resume LARC use. Though they are one-time costs, the presence of initiation and discontinuation costs may make discontinuing a LARC more difficult compared to other methods.

As discussed above, the how much LARCs can reduce unintended pregnancies depends in part on what contraceptives women would have used had they not had access to LARCs. Using data from the 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth, Kavanaugh and Jerman (2018) compare the proportions of contraceptive methods used in 2008, 2012, and 2014. They find that the use of LARCs increased by 8.3 percentage points between 2008 and 2014, while the use of sterilization decreased by 8.4 percentage points. The use of pills and condoms also fell by 2.1 and 1.8 percentage points, respectively, while the use of traditional methods increased. While Kavanaugh and Jerman's results exhibit some interesting patterns, the authors did not examine switching patterns between methods.

It is not possible to know the counterfactual of what women would have used, but one way to attempt to gain some information is to examine the methods women were using prior to LARC use. To my knowledge, there has been little work discussing what method women were using before switching to LARCs among American women using recent US data[1]. In one study, the authors use the 1995 NSFG to estimate a competing risk model of the hazard of switching methods within a two-year period (Grady et al., 2002). Due to few unmarried women relying on LARCs and sterilization, the authors combined the switching to sterilization and LARC methods outcomes. Thus, it is not possible to learn about switching into LARC use among unmarried women. Another study examines contraceptive use patterns (including switching behaviors) in 2004, but the authors grouped together all hormonal and long-acting methods (Frost et al., 2007). Neither of these studies focused primarily on transitions into LARC use. By grouping LARC use with other methods for some or all women, it becomes impossible to

[1] The mix of available LARCs has changed considerably since 2000. While copper IUDs have been available for decades, one of the most popular LARCs—a hormonal IUD called Mirena—was not approved by the FDA until 2000. As noted in Hubacher et al. (2011), the approval and marketing of Mirena may have increased the use of LARCs. There are now multiple hormonal IUDs available in the US (Planned Parenthood, n.d.). The first contraceptive implant in the US was Norplant, which stopped being inserted during the early 2000s and Implanon (the precursor to Nexplanon) was not available until 2006 (The Henry J. Kaiser Family Foundation, 2019b). Additionally, professional organizations such as ACOG now encourage increased LARC access and use in a wide population of women (American College of Obstetricians and Gynecologists, 2015).

disentangle which types of contraceptive spells are at a greater risk for ending due to transitions into LARC use.

In this paper, I expand upon the current literature by estimating a hazard model that includes random effects to account for the possibility of spurious duration dependence. I also analyze what flexible methods (SARCs, barrier methods, or traditional methods) women were using before switching to a LARC by estimating a competing risk model. Estimating a single model with contraceptive indicators allows me to detect significant differences in the hazard of a spell ending due to switching into LARC use depending on method.

2.3 Data

I use data from the 2006-2010, 2011-2013, and 2013-2015 public file releases of the female respondent questionnaires from the National Survey of Family Growth (NSFG) with some supplementation from the corresponding NSFG pregnancy interval files.[2] The NSFG is a nationally representative sample of the non-institutionalized civilian population of the United States when properly weighted and uses a stratified multistage area probability sampling design, with oversampling of Black and Hispanic women and teenagers between the ages of 15-19.

The survey was designed to collect information on fertility, contraception, marriages, and cohabitation from male and female respondents. The female respondent

[2] Because the female respondent file does not included information on the number of births resulting from a pregnancy, the pregnancy interval files are used to obtain information on non-singleton births.

questionnaire records demographic and socioeconomic information on women in the sample, information on their fertility, current work and education, and other factors deemed significant regarding reproductive well-being such as age of first intercourse and mother's education. The pregnancy interval files are pregnancy-level datasets and contain information on the number of live births, pregnancy intentions, contraceptive use surrounding the pregnancies, and both prenatal and post-partum behaviors. Importantly, the NSFG contains a life-history calendar and records important events such as marriages, whether the respondent was sexually active, pregnancies, and contraceptive use month-by-month for up to four years.

As I am conducting my analyses based on the duration of contraceptive use, it is important that I know when the woman initiated use of a method. I choose to exclude left-censored spells where the start month is not within the months covered in the NSFG calendar.[3] I also exclude all spells in which the woman was less than 20 years old at the start of the spell, as teenagers may face different choices than adults. In total, there were 77,695 spells and 19,784 spells were removed due to the age restriction. Among women who were at least 20 years old, 16,258 spells were left censored (or both left and right censored). A breakdown of the number of spells that are censored by method for women ages 20 and older can be found in Appendix A.

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[3] The NSFG does include a variable for the start month of a method prior to the start of the calendar, but out of concerns that there may be misreporting of the dates due to recall bias and missing values for nonuse spells, I only include spells that start during the contraceptive calendar.

Because women may report multiple methods used in a month, I construct my spells based on the "main method" used, where "main method" is determined based on the effectiveness and duration of the method.[4] Women can rely on female or male sterilization, LARCs, SARCs, barrier methods, traditional methods, emergency contraception, other methods, and no method.[5] More details about the hierarchy used in spell construction are available in Appendix A.

The number of months without contraceptive use may be overstated because a woman is pregnant. To correct for this, I reassigned her contraceptive status to pregnancy if she reports being pregnant and not using a method during a given month.[6] Women also sometimes report switching to another method after being sterilized even though sterilization is permanent method. These occurrences could reflect legitimate reversals of sterilization or data errors. As the NSFG includes the presence of perturbed data to protect the confidentiality of the respondents, some of these switches could also be related to the perturbation process. To address this issue, I replace the method used in any month after the woman becomes sterilized by sterilization if she did not report a reversal. I take a similar approach to male sterilization. All months past the first mention of male sterilization were recoded to male sterilization if the marriage did not end and the respondent did not report her partner having a reversal.[7]

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[4] The coding of my main method hierarchy is similar (but not exactly) like that of the NSFG's "CONSTAT1" variable. For an example of a paper that uses a similar hierarchy (with some differences) see Sundaram et al. (2017).
[5] An example of "other method" includes the use of the lactational amenorrhea method among breastfeeding mothers or sterility of the woman or her partner.
[6] I also assigned women to this category if she had given birth that month.
[7] I am also assuming that she is monogamous.

Some women may report nonuse of contraception during months when she is sexually inactive, even if she is using a method that cannot be easily discontinued. If the woman reports using a LARC both before and after a period of sexual inactivity and that she is not using a method during the sexually inactive period, then I reassign her main method during her sexually inactive months from "no method" to "LARC" as she may still be using a LARC during these months, even if she does not currently need protection from pregnancy.

My analysis sample includes 41,653 spells covering 294,551 months from 10,814 women. In Table 1, I report the descriptive statistics for the cross-section of individual women at time of survey. I do not use the weights from the NSFG and thus my descriptive statics reflect the oversampling by race and ethnicity.[8] Nearly 70% of the sample has children and slightly under 8% are using a LARC. Despite female sterilization being one of the most popular contraceptive methods (Kavanaugh & Jerman, 2018), only 8.2% of women in my sample are using female sterilization. This disparity likely reflects the removal of left-censored spells, as many women relying on sterilization would have become sterilized prior to the first month of the contraceptive calendar. On average, each woman contributes slightly more than 5 spells.

[8] The survey weights of the NSFG are constructed to create a dataset that is nationally representative of the midpoint of the survey. These weights were not constructed to be used with month-by-month contraceptive data; thus, I do not use weights in my primary analysis. Weighted results of select estimates are available in Appendix B.

Table 1. Descriptive Statistics of the 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth

Variable	**Mean**
Age during calendar month	29.869
Respondent is Black	0.243
Respondent is Hispanic	0.239
Currently married	0.376
Has children	0.682
Number of children (among mothers)	2.088
Currently working	0.668
Household income is below the poverty level	0.305
Respondent is insured	0.785
Less than high school education	0.151
Has high school diploma or equivalent	0.492
Greater than high school education (any level)	0.356
Number of spells	5.121

Unweighted data from the 2006-2010, 2011-2013, and 2013-2015 NSFG. N = 10,814 (7,373 mothers) ages 20-45.

In Table 2 I report descriptive information about the spells. The median spell length (including spells of nonuse and pregnancy) is 4 months. Nearly half of spells are of some type of contraceptive use, while 14.1% are spells of pregnancy. Over 35% of spells are among women who are not pregnant and not using a method. The high proportion of barrier method spells likely indicates that women often switch in and out of barrier method use, resulting in many short spells. Methods that are longer lasting such as sterilization and LARCs make up a much smaller proportion of the spells.

Table 2. Descriptive Statistics of Contraceptive Spells in the National Survey of Family Growth

Variable	Median
Median spell length (in months)	4
Variable	**Mean**
Pregnant	0.141
Using contraception	0.496
Female sterilization	0.022
Male sterilization	0.013
LARC	0.028
SARC	0.118
Condoms	0.227
Traditional	0.089
EC	0.004
Other Method	0.005

Data from the 2006-2010, 2011-2013, and 2013-2015 NSFG. Data are unweighted. N = 41,653 spells. EC is Emergency Contraception.

2.4 Empirical Approach

To analyze the duration of LARC use, I use a number of different hazard rate methods. I first estimate the Kaplan-Meier survival probabilities. The Kaplan-Meier (KM) survival estimator is a natural starting point to assess the duration of LARC use as it is frequently used in studies on LARC use. The KM estimator does not make any parametric assumptions and is specified as the following (Cleves et al., 2016):

$$\hat{S}(t) = \prod_{j|t_j \leq t} \frac{n_j - d_j}{n_j} \quad \textbf{(1)}$$

where n_j is the number of contraceptive spells at time j and d_j is the number of spells that end at time j. I can use this estimate of the survivor function to compare the survival probabilities for different contraceptive methods. However, a limitation of the KM estimator is that other than stratifying by a limited number of characteristics, it does not allow me to adjust for other important factors that may influence the duration of contraceptive use (Etikan, 2017).

Another approach to assessing the duration of contraceptive use is estimating a discrete-time hazard model. A discrete-time approach is more appropriate than continuous-time methods since the data is recorded in months (Allison, 1982). My outcome variable is the hazard of discontinuing a contraceptive. Unlike in the KM estimator, I can include a broad set of observed characteristics that may influence the duration of contraceptive use. Additionally, women may differ in unobserved ways that affect their duration of using a contraceptive. To allow for this, I include a random effect at the woman-level (Zorn, 2000). I define the hazard of a contraceptive spell ending at duration t as (Allison, 1982):

$$h(t) = \frac{\exp\{\psi\nu(t) + \delta' x(t) + \gamma\}}{1 + \exp\{\psi\nu(t) + \delta' x(t) + \gamma\}} \quad \textbf{(2)}$$

In which γ is the woman-level random effect which is normally distributed with variance σ_γ^2. $\nu(t)$ is a set of duration dummies indicating the number of months that the woman has been using the method, which are quarterly for the first year, in 6-month intervals for the second year, and then grouped together for any month greater than 24 months. ψ are the parameters to be estimated on the duration dummies, which make up the baseline hazard that the spell will end. $x_i(t)$ is a $(kx1)$ vector of covariates which includes indicators of the main method a woman is using that month (LARC, SARC, barrier, traditional, no method[9]), an indicator of the woman's age group at the beginning of the contraceptive spell (20-24, 25-29, 30-34, 35-39, and 40-45), if she is Black, if she is Hispanic, the number of children she has (0,1, 2, and 3+), if she is sexually active, marriage duration (unmarried, 1-3 years, 4-6 years, and 7+ years) and a set of year controls. I also include an indicator for if the woman is postpartum (Steele et al., 2004). δ is the $(k \times 1)$ vector capturing the effect of the covariates on the hazard of the spell ending. I select SARC as the omitted contraceptive category. I estimate this model using the *xtlogit* command in Stata16 and cluster my standard errors at the woman-level.

To investigate which contraceptive spells are at greatest risk of ending due to switching into LARC, I use a competing risk model. A competing risk model is used when there is more than one way that a spell – in this case a contraceptive spell – can end. I estimate the model for women who are currently using a flexible contraceptive method. This "flexible" category includes the use of SARCs, barrier methods, and traditional methods. I do not estimate the results for women who are relying on sterilization (male or female) as no one transitions out of female sterilization due to my data construction and very few individuals transition out of male sterilization in my data. I also do not include women relying on emergency contraception or "other method" as very few spells fall within in these categories. Finally, I exclude women who are currently using LARCs as they cannot transition into LARC use. As I am interested in

[9] As emergency contraception is meant to be used temporarily, I do not include an EC indicator when assessing the hazard of discontinuation.

how spells of contraceptive use end, I also exclude women who are currently pregnant and women who are not currently using a method.

My primary interest is the hazard of ending a contraceptive spell by switching to LARC use. I designate four other competing risks that could cause a spell to end. These include switching into no method, switching to another flexible method, becoming pregnant, or switching to sterilization (either male or female). As some of the benefits of using a LARC for pregnancy prevention are due to long-acting methods not relying on adherence for their effectiveness, women switching from methods with a large gap between the perfect use and typical use failure rates such as barrier methods and traditional methods could experience a greater reduction in the risk of pregnancy compared to women switching from hormonal methods. If women who are using SARCs are more likely to switch to LARCs, then the effect of increasing access to LARCs on unintended pregnancies might be dampened as the typical use failure rates for SARCs range from 4 to 9%, compared to over 12% for male condoms (the most popular barrier method) and 19.9% or greater for traditional methods (Kavanaugh & Jerman, 2018; Sundaram et al., 2017; Trussell, 2011).

The approach to implementing the discrete-time competing risk hazard model is similar to that of the binary discrete-time hazard model. Instead of estimating a model of the hazard of discontinuation for any reason, I can break out different hazards for different causes for the end of the spell (Allison, 1982). I denote the cause-specific hazard as $h_k(t)$. Summing up all cause specific hazards gives the hazard of a contraceptive spell ending for any reason ($h(t)$) (Allison, 1982). I allow the hazard of discontinuing a contraceptive spell due to cause $k = (1 \dots 4)$ to depend on the same set of covariates, $x(t)$:

$$h_k(t) = \frac{\exp\{\omega_k \alpha_k(t) + \beta_k' x(t)\}}{[1 + \sum_{l=1}^{5} \exp\{\omega_l \alpha_l(t) + \beta_l' x(t)\}} \quad \textbf{(3)}$$

As there are five ways that a spell can end, there are five $(k \times 1)$ vectors of coefficients, β_k. $\alpha_k(t)$ is the set of duration dummies as defined previously, and ω_k gives the baseline hazard for the spell to end for a specific reason, k.

By estimating my results for all women in a flexible contraceptive state and including the indicators of contraceptive use, I can compare how the type of flexible contraceptive used affects the hazard of switching into LARC use. I use SARC as the omitted category, and thus the coefficients on the included contraceptive variables indicate proportional shifts in the baseline hazard of using a barrier or traditional method versus a SARC. I estimate all coefficients using maximum likelihood estimation. The log-likelihood function is (Schmidheiny, 2007):

$$LL = \sum_{i=1}^{n} \sum_{k=1}^{4} d_{ik} \log(h_{ik}(t)). \quad \textbf{(4)}$$

I use the $mlogit$ command in Stata 16 to estimate the results, with standard errors clustered at the woman-level.

2.5 Results

In Table 3 I report the Kaplan-Meier survival estimates for all LARCs and separately for IUDs and implants. I also present the estimated survival probabilities for SARCs for comparison.

Table 3. Kaplan-Meier Survival Probabilities of Long-Acting Reversible Contraceptives

Method	6 months	12 months	18 months	24 months	30 months	36 months
All LARC	87.45	77.43	70.90	65.56	62.60	53.69
IUD	86.67	77.64	70.64	66.31	63.62	56.18
Implant	91.75	75.82	72.49	60.81	56.23	36.90
SARC	63.90	46.33	36.45	29.74	24.61	21.15

Unweighted data from the 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth.
Number of spells when t=1: 1,097 (LARC), 923 (IUD), 174 (implant), 4,225 (SARC).

By 12 months, the survival probabilities for a spell of LARC use is 77.43%. By 24 months this number has fallen by only 12 percentage points to 65.56%, and by 36 months the survival probability is 53.69%. The estimated survival probabilities for IUDs (and thus LARCs overall, as IUDs make up a large proportion of LARC use) are on the low end compared to other recent studies, possibly due to excluding left-censored spells, but the pattern of LARC methods having high survival probabilities compared to other methods remains. Fewer than half of SARC spells are continued through 12 months. This number falls to 29.74% at 24 months. The estimated survival probabilities for SARCs are also low compared to the results of other studies (Hubacher et al., 2017; O'Neil-Callahan et al., 2013; Peipert et al., 2011).

In Table 4 I report the results of the discrete-time hazard model with and without random effects. Coefficients indicate a proportional change in the hazard of discontinuation. Positive coefficients imply an increased risk of the contraceptive spell ending, and negative coefficients imply a decrease in the risk.

Table 4. Discrete-Time Hazard of Contraceptive Spell Ending Results

Variable	**(1) Logit Discontinuation of Contraception**	**(2) Random Effects Logit Discontinuation of Contraception**
Contraceptive variables		
SARC	Omitted	Omitted
	-	-
LARC	-1.017***	-1.182***
	(0.0626)	(0.0679)
Barrier	0.928***	0.982***
	(0.0277)	(0.0318)
Traditional	0.858***	0.804***
	(0.0361)	(0.0406)
Other method	0.712***	0.897***
	(0.0689)	(0.0845)
No method	0.638***	0.760***
	(0.0256)	(0.0300)
Demographic variables		
Respondent is Black	0.0894***	0.0993***
	(0.0249)	(0.0259)
Respondent is Hispanic	-0.0286	-0.0372
	(0.0274)	(0.0272)
Age group		
20 - 24	0.0104	0.0330
	(0.0233)	(0.0246)
25 - 29	Omitted	Omitted
	-	-
30 - 34	-0.0121	-0.0478*
	(0.0289)	(0.0286)
35 - 39	0.0172	-0.0753**
	(0.0366)	(0.0371)

Table 4 Continued

40 - 45	-0.0129	-0.220***
	(0.0590)	(0.0558)
Number of children		
0	Omitted	Omitted
	-	-
1	-0.0461*	-0.0828***
	(0.0263)	(0.0266)
2	-0.102***	-0.158***
	(0.0307)	(0.0319)
3+	-0.173***	-0.265***
	(0.0374)	(0.0377)
Marriage duration		
0	Omitted	Omitted
	-	-
1 - 3 years	-0.135***	-0.143***
	(0.0308)	(0.0314)
4 - 6 years	-0.0816**	-0.129***
	(0.0329)	(0.0320)
7+ years	-0.0261	-0.0465
	(0.0547)	(0.0523)
Postpartum	-0.0723	0.167***
	(0.0443)	(0.0459)
Sexually active	-0.146***	0.0535*
	(0.0234)	(0.0275)
Intraclass correlation		0.1305***
		(0.0050)
σ_γ		0.7027***
		(0.0153)

Unweighted data from the 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth. N = 218,880 months. Includes controls for duration and year. Standard errors are clustered at the woman level and are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010

The coefficient on LARC use in the random effects model is -1.182. Another way to interpret results from a logit model is to report exponentiated coefficients or odds ratios (OR) (Hosmer et al., 2013). The OR for LARC use is 0.307, meaning that the odds of discontinuation for a spell of LARC use are nearly 70 percentage points lower than they are for the reference category of SARC use. This implies that LARC use is associated with higher contraceptive persistence, even with the inclusion of random effects. Spells of other methods increase the hazard of discontinuation compared to SARCs spells.

Having children, being postpartum, and being older are associated with a decrease in the hazard of discontinuation. Interestingly, in the random effects model, sexual activity is associated with an increased hazard of discontinuing a contraceptive spell. This could possibly reflect short spells of barrier method use and traditional method use, as traditional and barrier methods are used while the woman is sexually active. This could also reflect the adjustments to spells of LARCs and sterilization, in that more women will still be in a LARC spell or a spell of sterilization even if they are not sexually active.

I now turn to switches among contraceptive methods. I first calculate the transition probabilities of switching from one method to another contraceptive for all methods. Table 5 presents the monthly transition probabilities. Consistent with the duration results, LARCs have lower monthly transition probabilities verses SARCS (2.04% versus 6.78%). Less effective methods such as traditional methods have a greater probability of transitioning into pregnancy than more effective methods, such as LARCs.

The transition probabilities are helpful for both looking at patterns of how LARC spells end and also which methods have higher month-to-month probabilities of moving into LARC use. But as some methods are much more prevalent than others (e.g., a much greater proportion of women rely on SARCs than emergency contraception), analyzing what women were using prior to switching to a LARC is also useful. As a simple first pass to understanding what methods women use prior to LARC use, I tabulate the contraceptive status in the month before the first month of a LARC spell. From the results in Table 6 below, nearly one third women initiating LARC use do so after pregnancy, and over 30% third switch from no method. Only a small proportion of the LARC users were relying on traditional methods. A similar proportion of LARC users were previously SARC and barrier method users (14.19% versus 14.76%, respectively).

Next, I turn to the competing risk model. Table 7 summarizes the outcome variable. Over one quarter of the spells transition into nonuse, and over 35% result in switches to another flexible method. Over 12% of spells among women using flexible contraceptive methods end due to pregnancy. A much smaller proportion of spells end in the use of LARCs (1.63%) or sterilization (1.39%). Almost 23% of spells are censored.

Table 8 presents the coefficients for the competing risk models. The sign of the coefficient indicates direction of the effect of an increase in that variable on the cause specific hazard, compared to the hazard of the spell not ending during the month. Larger coefficients imply a greater shift.

Table 5. Contraceptive Method Monthly Transition Probabilities

Method Used Last Month	Method Used This Month									
	Sterilization (F)	LARC	SARC	Barrier	Traditional	Sterilization (M)	Other method	EC	No method	Pregnancy
Sterilization (F)	**100**	0	0	0	0	0	0	0	0	0
LARC	0.06	**97.88**	0.43	0.27	0.14	0.05	0.07	0	0.9	0.19
SARC	0.09	0.27	**93.22**	1.49	0.72	0.1	0.05	0.03	3.36	0.68
Barrier	0.08	0.27	1.56	**83.02**	1.51	0.16	0.07	0.04	11.81	1.49
Traditional	0.08	0.2	1.29	2.28	**84.83**	0.14	0.05	0.08	8.68	2.37
Sterilization (M)	0.1	0.01	0	0.01	0	**99.86**	0	0	0.01	0.01
Other method	0	1.07	4.03	3.37	1.32	0.41	**84.54**	0	3.87	1.4
EC	0.47	1.4	9.77	10.7	9.3	0	0.47	**27.44**	33.49	6.98
No method	0.12	0.34	1.91	6.82	2.14	0.17	0.04	0.1	**85.35**	3.02
Pregnancy	0.91	0.7	2.41	1.76	0.73	0.08	0.04	0.03	6.05	**87.27**

Unweighted data from 2006-2010, 2011-2013, and 2013-2015 NSFG. N = 281,737 months.20-45. EC is emergency contraception.

Table 6. Method Used Prior to LARC Use

Prior Method	Proportion
SARC	14.19
Barrier	14.76
Traditional	4.73
Male sterilization	0.12
Other	1.50
Emergency contraception	0.35
No Method	31.60
Pregnancy	32.76

Unweighted data from 2006-2010, 2011-2013, and 2013-2015 NSFG. N = 867 LARC spells.

Table 7. Competing Risk Contraceptive Spell Exit Outcomes

Outcome	Proportion (How Spells End)
Censored	22.93
LARC	1.63
No method	26.34
Other flexible method*	35.32
Pregnancy	12.39
Sterilization	1.39

Unweighted data from 2006-2001, 2011-2013, and 2013-2015 NSFG. N = 32,743 spells.
*Includes SARCs, barrier method, and traditional method.

Table 8. Competing Risk Contraceptive Spell Exit Results

Variable	(1) LARC	(2) No Method	(3) Other Flexible Method	(4) Pregnancy	(5) Sterilization
Baseline hazard (SARC use) months					
1 - 3	-5.980***	-2.198***	-3.939***	-5.367***	-6.371***
	(0.365)	(0.079)	(0.161)	(0.193)	(0.381)
4 - 6	-6.193***	-3.227***	-4.734***	-5.858***	-6.465***
	(0.364)	(0.084)	(0.167)	(0.198)	(0.378)
7 - 9	-6.845***	-3.625***	-5.177***	-6.071***	-6.688***
	(0.396)	(0.091)	(0.174)	(0.202)	(0.393)
10 - 12	-6.304***	-3.620***	-5.002***	-6.011***	-6.914***
	(0.396)	(0.095)	(0.174)	(0.206)	(0.423)
13 - 18	-6.710***	-3.870***	-5.457***	-6.146***	-6.872***
	(0.402)	(0.095)	(0.177)	(0.207)	(0.414)
19 - 24	-7.010***	-4.291***	-5.534***	-6.143***	-6.806***
	(0.458)	(0.114)	(0.191)	(0.217)	(0.428)
25 +	-7.293***	-4.263***	-5.667***	-6.425***	-7.307***
	(0.522)	(0.118)	(0.206)	(0.234)	(0.480)
Method					
SARC	Omitted	Omitted	Omitted	Omitted	Omitted
Barrier	0.148	1.174***	0.101**	0.945***	0.347**
	(0.146)	(0.042)	(0.051)	(0.074)	(0.160)
Traditional	-0.325	0.940***	0.286***	1.435***	0.102
	(0.213)	(0.054)	(0.065)	(0.079)	(0.207)
Black	-0.364**	0.227***	0.111	0.254***	-0.516***
	(0.184)	(0.041)	(0.088)	(0.069)	(0.193)
Hispanic	-0.331**	-0.0662	0.221**	0.0242	-0.841***
	(0.161)	(0.046)	(0.104)	(0.069)	(0.184)
Age Group					
20 - 24	0.104	-0.0971**	-0.0198	0.275***	-0.409*
	(0.172)	(0.041)	(0.071)	(0.068)	(0.241)
25 - 29	Omitted	Omitted	Omitted	Omitted	Omitted
30 - 34	-0.183	0.174***	-0.0976	-0.0772	0.083
	(0.181)	(0.051)	(0.091)	(0.078)	(0.196)
35 - 39	-0.403	0.450***	-0.289**	-0.543***	0.709***
	(0.259)	(0.059)	(0.133)	(0.118)	(0.197)
40 - 45	-1.151**	0.593***	0.0191	-1.353***	0.904***
	(0.499)	(0.087)	(0.205)	(0.224)	(0.265)

Table 8 Continued

Parity					
0	Omitted	Omitted	Omitted	Omitted	Omitted
1	0.759***	-0.214***	-0.151*	0.523***	0.534*
	(0.200)	(0.045)	(0.080)	(0.075)	(0.277)
2	1.242***	-0.454***	-0.221**	0.506***	1.604***
	(0.206)	(0.055)	(0.092)	(0.089)	(0.248)
3+	1.124***	-0.491***	-0.356***	0.633***	1.991***
	(0.224)	(0.067)	(0.129)	(0.098)	(0.259)
Marriage duration in years					
Not married	Omitted	Omitted	Omitted	Omitted	Omitted
1-3	0.317*	-0.479***	-0.287***	0.230***	-0.215
	(0.190)	(0.058)	(0.072)	(0.076)	(0.268)
4-6	-0.0197	-0.358***	-0.173	-0.0626	0.274
	(0.177)	(0.061)	(0.110)	(0.085)	(0.172)
7+	0.203	-0.366***	0.0381	-0.452**	0.152
	(0.297)	(0.095)	(0.156)	(0.199)	(0.230)
Postpartum	1.038***	-0.928***	-0.328**	0.134	0.411
	(0.224)	(0.105)	(0.128)	(0.136)	(0.302)
Sexually active	0.0815	-0.193***	1.318***	0.450**	-0.528**
	(0.265)	(0.068)	(0.140)	(0.179)	(0.256)

Unweighted data from 2006-2010, 2011-2013, and 2013-2015 NSFG. Includes 120,485 months of data from spells of SARC, barrier, or traditional method use. "Other flexible" includes SARCs, barrier, and traditional. Standard errors are in parenthesis and clustered at the woman-level.
* p<.10, ** p<.05, *** p<.01

The first two rows of Table 8 show the proportional shift in the cause specific hazards for barrier methods and traditional methods compared to SARC use. The risk of switching to a LARC is not statistically different for spells of traditional and barrier method use compared to SARC use. Consistent with higher failure rates for both traditional and barrier methods versus short-acting hormonal methods, use of barrier methods and traditional methods increases the chance that the spell will end in a pregnancy. Condom and barrier spells are also more likely to end due to switching into another flexible method or into nonuse. Barrier method spells are at an increased risk of the spell ending due to switching to sterilization.

Consistent with research on contraceptive preferences (Jackson et al., 2016), spells of use among Black and Hispanic women have a lower hazard of switching to the use of long-lasting methods, including sterilization. The hazard of a spell ending due to switching into nonuse or becoming pregnant is greater for Black women. Young age increases the hazard of a spell ending in pregnancy compared to women ages 25-29, though young age is also associated in a decreased hazard of the spell ending due to the woman discontinuing use of any method. The positive effect of young age on the risk of pregnancy is consistent with younger women having more unintended pregnancies (Finer & Zolna, 2016).

Being older than 29 is associated with a reduced risk of a spell ending due to pregnancy, which is consistent with reduced fecundity with age. The increased hazard of switching into no method use with age could also reflect this reduced fecundity. The increased hazard of becoming sterilized for spells of use among older women could be related to increased access to permanent methods for women over the age of 30.[10] The hazard of switching to a LARC is similar for spells of use among women ages 20-39.

[10] A 1999 study found that women who were sterilized before 30 were more likely to express regret (Hillis et al., 1999). In a 2017 Committee Opinion, the American College of Obstetricians and Gynecologists note that physicians sometimes wish to prevent "sterilization regret" among their patients. It should be noted that the Committee Opinion recommends that physicians avoid paternalism when working with young patients (American College of Obstetricians and Gynecologists, 2007b).

Women over 40 are at a reduced risk of spell exit due to use of an IUD or implant, perhaps due to increased access to sterilization or reduced fecundity.

Having children is associated with an increased risk of switching into a LARC method. The positive effect on LARC use for women with children could partially reflect the barriers to the use of IUDs that women without children sometimes face, in that some providers do not consider nulliparous women as suitable candidates for IUD use (Luchowski et al., 2014). Spells among women with children are also more at risk of ending due to the woman becoming sterilized. The effect is much larger for women with at least two children. Mothers have a greater hazard of a contraceptive spell ending due to pregnancy but also have reduced hazard of switching into nonuse or into another flexible method. Spells of contraceptive use among women who are postpartum but are currently relying on flexible methods have a greater chance of ending due to the woman switching to more effective methods, such as LARCs or sterilization.

In the specification from Table 8, I am assuming that the effect of using a traditional method or a barrier method follow the same baseline hazard as SARC users, other than the hazard being shifted up or down. Under this specification I do not find evidence that the hazard of a spell ending due to switching into LARC use is statistically significantly different for traditional or barrier spells verses SARC spells. It is possible that the baseline hazards of these methods take on a different shape and that time-dependent differences are being obscured. For example, becoming a SARC user may require more planning and thus women deciding to use SARCs may plan to use the methods for an extended period of time. On the other hand, some women may use barrier methods or traditional methods as bridge methods between other, more effective methods, or they may use these methods due to sporadic sexual activity, which could result in more switching into nonuse and other methods early in a spell.

To explore this possibility, I re-estimate the competing risk model described by Equation 4 and allow each method to have a different baseline hazard. This is done by including a set of interactions of the method and the duration dummies in place of the contraceptive indicators. I show these results in Table 9 and discuss the differences in the baseline hazards below. I restrict the coefficients of the other covariates to be the same across flexible methods and do not allow the effect of the other variables to depend on the duration of the spell. Due to these restrictions, the rest of the results in Table 9 are similar to those in Table 8.

Table 9. Competing Risk Contraceptive Spell Exit Results: Time-Method Interactions

Variable	(1) LARC	(2) No Method	(3) Other Flexible Method	(4) Pregnancy	(5) Sterilization
Baseline hazard (SARC use) months					
1 - 3	-6.641***	-2.455***	-4.125***	-5.521***	-6.393***
	(0.418)	(0.083)	(0.170)	(0.204)	(0.416)
4 - 6	-5.786***	-3.155***	-4.587***	-5.696***	-6.735***
	(0.356)	(0.104)	(0.169)	(0.220)	(0.448)
7 - 9	-6.677***	-3.267***	-5.017***	-6.191***	-6.749***
	(0.441)	(0.112)	(0.185)	(0.255)	(0.458)
10 - 12	-6.031***	-3.274***	-4.830***	-5.786***	-6.856***
	(0.424)	(0.121)	(0.186)	(0.242)	(0.499)
13 - 18	-6.286***	-3.457***	-5.338***	-5.988***	-6.629***
	(0.409)	(0.115)	(0.191)	(0.244)	(0.462)
19 - 24	-6.743***	-3.931***	-5.232***	-6.171***	-6.529***
	(0.509)	(0.156)	(0.208)	(0.293)	(0.465)

Table 9 Continued

25 +	-6.648***	-3.938***	-5.472***	-6.295***	-7.455***
	(0.526)	(0.165)	(0.232)	(0.317)	(0.655)
Barrier ×Time months					
1 - 3	1.126***	1.481***	0.393***	1.120***	0.454*
	(0.245)	(0.066)	(0.078)	(0.116)	(0.253)
4 - 6	-0.713**	1.145***	-0.233**	0.750***	0.621*
	(0.327)	(0.080)	(0.108)	(0.150)	(0.357)
7 - 9	-0.3	0.747***	-0.105	1.257***	0.515
	(0.519)	(0.102)	(0.150)	(0.207)	(0.421)
10 - 12	-0.348	0.713***	-0.201	0.715***	0.21
	(0.441)	(0.116)	(0.161)	(0.216)	(0.540)
13 - 18	-0.489	0.623***	-0.158	0.723***	-0.199
	(0.454)	(0.117)	(0.185)	(0.212)	(0.458)
19 - 24	-0.351	0.486**	-0.401	0.864***	-0.346
	(0.710)	(0.190)	(0.244)	(0.295)	(0.582)
25 +	-1.503	0.730***	-0.646**	0.814**	0.463
	(1.086)	(0.195)	(0.320)	(0.345)	(0.742)
Traditional ×Time months					
1 - 3	0.544*	1.303***	0.499***	1.680***	-0.126
	(0.321)	(0.078)	(0.101)	(0.123)	(0.348)
4 -6	-0.727*	0.711***	0.260**	1.245***	0.721*
	(0.420)	(0.104)	(0.123)	(0.159)	(0.409)
7 - 9	-0.0563	0.323**	-0.0766	1.336***	-0.0709
	(0.593)	(0.142)	(0.195)	(0.234)	(0.600)
10 - 12	-0.692	0.450***	0.016	1.046***	0.0448
	(0.635)	(0.160)	(0.200)	(0.237)	(0.695)
13 - 18	-15.85***	0.234	0.185	1.251***	-0.146
	(0.265)	(0.167)	(0.211)	(0.227)	(0.586)
19 - 24	-0.712	0.796***	-0.53	1.645***	-0.0127
	(1.087)	(0.220)	(0.347)	(0.298)	(0.691)
25 +	-15.59***	0.399	0.418	1.222***	0.543
	(0.435)	(0.269)	(0.302)	(0.384)	(0.919)
Black	-0.358*	0.229***	0.114	0.255***	-0.518***
	(0.184)	(0.040)	(0.089)	(0.069)	(0.193)
Hispanic	-0.309*	-0.0565	0.230**	0.0269	-0.834***
	(0.161)	(0.046)	(0.104)	(0.069)	(0.185)
Age Group					
20 - 24	0.116	-0.0936**	-0.0158	0.277***	-0.401*
	(0.172)	(0.041)	(0.071)	(0.068)	(0.241)
25 - 29	Omitted	Omitted	Omitted	Omitted	Omitted

Table 9 Continued

30 - 34	-0.179	0.173***	-0.0993	-0.0774	0.0786
	(0.181)	(0.051)	(0.091)	(0.078)	(0.196)
35 - 39	-0.391	0.446***	-0.291**	-0.543***	0.714***
	(0.257)	(0.059)	(0.133)	(0.118)	(0.196)
40 - 45	-1.122**	0.591***	0.0222	-1.352***	0.916***
	(0.499)	(0.086)	(0.205)	(0.224)	(0.264)
Parity					
0	Omitted	Omitted	Omitted	Omitted	Omitted
1	0.759***	-0.214***	-0.151*	0.523***	0.534*
	(0.200)	(0.045)	(0.080)	(0.075)	(0.277)
2	1.242***	-0.454***	-0.221**	0.506***	1.604***
	(0.206)	(0.055)	(0.092)	(0.089)	(0.248)
3+	1.124***	-0.491***	-0.356***	0.633***	1.991***
	(0.224)	(0.067)	(0.129)	(0.098)	(0.259)
Marriage duration in years					
Not married	Omitted	Omitted	Omitted	Omitted	Omitted
1 - 3	0.340*	-0.468***	-0.277***	0.234***	-0.207
	(0.191)	(0.057)	(0.072)	(0.076)	(0.268)
4-6	-5.786***	-3.155***	-4.587***	-5.696***	-6.735***
	(0.356)	(0.104)	(0.169)	(0.220)	(0.448)
7+	-6.677***	-3.267***	-5.017***	-6.191***	-6.749***
	(0.441)	(0.112)	(0.185)	(0.255)	(0.458)
Postpartum	1.296***	-0.854***	-0.255**	0.177	0.417
	(0.231)	(0.106)	(0.128)	(0.138)	(0.313)
Sexually active	-0.0121	-0.218***	1.296***	0.429**	-0.537**
	(0.261)	(0.069)	(0.140)	(0.179)	(0.254)

Unweighted data from 2006-2010, 2011-2013, and 2013-2015 NSFG. Includes 120,485 months of data from spells of SARC, barrier, or traditional method use. "Other flexible" includes SARCs, barrier, and traditional. Standard errors are in parenthesis and clustered at the woman-level.
* p<.10, ** p<.05, *** p<.01

The first set of coefficients is the baseline hazard for SARC users. The next two sets of coefficients are the interaction of barrier methods and traditional methods with duration dummies. For women using barrier methods, there is no difference in the baseline hazard of switching to LARCs versus SARCs other than within the first six months. During the first three months, barrier method spells have an increased hazard of spell exit for all causes compared to spells of SARC use. This result is consistent with barrier methods being used in short spells as a bridge method or due to sporadic sexual activity. Barrier methods have a decrease risk of ending due to a switch to LARCs during the 4-6 month interval, though this result may reflect an increase in the risk of switching to LARCs for SARC spells. Consistent with higher failure rates, barrier methods spells are associated with greater chance of a spell ending due to pregnancy. Despite higher failure rates, barrier method spells have a similar risk of ending due to switches into LARC use as spells of the more effective SARC methods after the first 6 months.

Similar to the results for barrier methods, spells of traditional method use have a higher hazard of ending due to pregnancy compared to spells of SARC use. Spells of traditional methods have a greater risk of ending due to switching into nonuse of a method, except in the 13-18 month and 25+ month intervals. The hazard to switching to a LARC follows a similar pattern as barrier method spells during the first year. For the first few months of a spell, traditional method spells have a higher hazard of switching into LARC use, followed by a lower hazard compared to SARC spells during the 4-6 month interval. After the first year, few traditional method spells end due to LARC use, as evidenced in the baseline hazard of essentially 0 during the 13-18 month and 25+ month intervals. Other than during the first three months, the coefficients on the traditional method interactions are negative, but the coefficients are not always statistically different from zero.

Taken together, these results imply that despite being more sensitive to incorrect and inconsistent use, traditional method spells are not at a greater risk (and may actually be at a lower risk) of ending due to a switch into LARC use compared to SARC spells.

2.6 Discussion

The results from the KM estimator demonstrate that LARCs have high rates of continuation, with 77% of LARC spells continuing at 12 months, 65% continuing at 24 months, and around 53.69% of continuing at 36 months. This is particularly salient as it has been estimated that LARCs become cost-neutral at 1.7 to 3 years. The discrete-time hazard model results show that the hazard of discontinuation during a given month is much lower in spells of LARC use compared to SARC use, while other methods increased the hazards of the spell ending. When interpreted as an odds ratio, the odds of a LARC spell ending is roughly 70 percentage points lower than that of SARC spells.

The results from the competing risk models imply that overall, the risk of a spell ending due to switching to a LARC is similar for spells of SARC use and barrier method use, other than during the first 6 months. The pattern is similar for traditional method spells, other than that very few spells of traditional method use end due to switches into LARC use after the first year. This implies that spells of contraceptive use of methods with gaps greater than 10 percentage points between the perfect use and typical use failure rates are not more likely to switch to adherence-free LARC methods. This may dampen some of the potential impact of LARC use for pregnancy prevention.

It has been estimated that it takes between 1.7 to 3 years to reach cost-neutrality of LARC use, depending on if the woman is using no method, a SARC method, or a barrier method. To my knowledge, there has not been a formal calculation of how long a LARC would need to be used compared traditional methods. Traditional methods have higher failure rates, which would increase the benefits of switching to LARCs in terms of pregnancy-related costs avoided compared to SARCs and barrier methods; however, traditional methods are also often free to implement, which makes them less expensive than SARCs and barrier methods.[11] It should be noted that even traditional methods such as withdrawal have much lower failure rates compared to nonuse, with typical use failure rates of 19.9% compared to 85%, respectively (Sundaram et al., 2017; Trussell, 2011). Given the substantial decrease in failure rates compared to nonuse of any contraception, it seems likely that the time needed to achieve cost-neutrality for traditional methods could still tend towards the middle to upper range of the 1.7 to 3 year estimate.

Cost-neutrality is not the only concern regarding if women should use LARCs and whether or not policies to increase LARC access should be implemented. Implants and IUDs may still be beneficial for women who wish to use very effective methods, are using a method for birth spacing, or who prefer the convenience of a method that does not require constant effort, even when the LARC is use for less than its full duration. The analyses in Trussell et al. (2015) only account for direct medical costs associated with unintended pregnancies such as the cost of a birth or an abortion, however not being able

[11] Some natural family planning methods include using thermometers and other devices or apps.

to time fertility may have other costs over the course of a woman's life (Bailey, 2006). Thus, increasing access to LARC methods so that women who would benefit from long-acting options can use them may still be welfare improving, even if the methods are not used long enough to become "cost-neutral."

2.6.1 Limitations

This paper has some important limitations to consider. I find that one-third of LARC spells are discontinued at the two years needed to achieve cost-neutrality for SARCs and that nearly half of spells are discontinued at three years of use, but have not addressed what proportion of women would need to continue LARC use before a program providing LARCs would generate more savings than costs. A formal cost-benefit or cost-effectiveness analysis of LARC use which includes comparisons to barrier method use and traditional method use in the US may be needed, but it is beyond the scope of this study.[12]

By not allowing for correlations between cause-specific hazards in my competing risk models, I am making the strong assumption that the risks are independent from each other. An approach like that in Steele et al. (2004), in which models for switching within contraceptive use and between using a method and nonuse are estimated jointly may provide additional insights. Also, while I allow the effect of methods to have different

[12] Trussell et al. (2014) studies the cost-effectiveness of a specific IUD in the US compared to SARC methods. A 2008 UK study also assesses the cost-effectiveness of LARCs compared to various hormonal options (Mavranezouli, 2008).

baseline hazards in my second specification of the competing risk model, I do not allow this flexibility for other covariates.

What women were using previously is not a perfect measure of what she would have used if she had not switched to a LARC, as some women would have still ended their contraceptive spells without access to LARCs. LARC use has increased substantially during a time where sterilization has decreased, thus it is also possible that some LARC use is crowding out sterilization. In this case, increased LARC use would not result in large differences in unintended pregnancies. Studies of the substitution patterns between LARCs and sterilization are needed.

LARC use may have a greater effect on pregnancies among special populations such as teenagers. Analyses using data from the Colorado Family Planning Initiative find that increased LARC access lowered teen pregnancy rates and abortions (Kelly et al., 2019; Lindo & Packham, 2017). It is also possible that women who choose to switch to LARCs do so because they struggle to use their methods consistently. In this case, increased LARC access could still provide a large reduction in the probability of pregnancy even among women who are switching from moderately effective methods. In order to better understand the benefits of long-acting methods, studies are needed to investigate if women choosing LARC methods are more likely to have higher failure rates when using other methods.

Using the National Survey of Family Growth also has its limitations. The contraceptive calendar is relatively short (a maximum of four years) and collected retrospectively, thus there may be concerns with the reliability of reporting.[13,14] Additionally, the NSFG was shortened after the 1995 survey by omitting questions regarding work and education over the span of the calendar. The user guide of the NSFG datasets also note that the data have been perturbed to prevent individuals from being identified, but no details regarding the perturbation are given.

2.7 Conclusion

More than 40% of pregnancies that occur in the United States are unintended, with 41% of these pregnancies occurring due to inconsistent and incorrect use of contraception. Long-acting reversible contraceptives do not rely on user compliance and are very effective, thus increased LARC access could be an important part of a strategy to reduce unintended pregnancies. Because LARCs can have high up-front costs and unique barriers, policy interventions may be needed to increase access to LARCs.

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[13] A paper assessing potential errors in the 1995 found inconsistencies within roughly 10% of the NSFG data (Martin & Wu, 1998). However, it should be noted that the 1995 NSFG was conducted with the interviewer using pencil and paper, collected information on sexual activity differently, and had a much longer questionnaire than the ones used in more recent versions of the NSFG. The paper assessing the quality of the 1995 NSFG recommended shortening the survey and rephrasing the sexual activities questions improve the quality of the survey; both of these changes were implemented by the next survey, with the survey time reduced from 100 minutes to 80.

[14] Approaches similar to the calendar method in the NSFG have been used in some of the Demographic and Health Surveys (DHS). DHS are administered in developing countries and include 5-year calendars of contraceptive use if the prevalence of contraceptive use in the country is not below a certain threshold. Some DHS surveys with life-history calendars have interviewed the same women multiple times and have some overlap between the latter survey and the earlier survey, allowing for researchers to study inconsistencies between current use in the first wave and reports of use at that time in the second wave. Tabulating the results revealed some inconsistencies between the two waves at the individual level (Callahan & Becker, 2012; Strickler et al. 1997). It was also found that women with more complicated histories of fertility and contraception tend to have more inconsistencies in their responses (Callahan & Becker, 2012; Strickler et al. 1997).

In this paper I analyze the duration of LARC use and what women were using before they switched to a LARC. My results indicate that continuation of LARC use is high relative to the continuation rates of other contraceptives. Among contracepting women, spells of contraceptive use of moderately effective and less effective methods are at a similar risk of ending due to switching to a LARC—and perhaps even a reduced chance in the case of traditional method spells. This may dampen the effect of increased LARC use on pregnancy prevention.

CHAPTER III

OF IVS AND IUDS: ASSESSING THE EFFECT OF LONG-ACTING REVERSIBLE CONTRACEPTION ON PREGNANCIES USING AN INSTRUMENTAL VARIABLES APPROACH

3.1 Introduction

Correct use of effective contraception allows women to control their fertility, which enables them to pursue higher levels of education, increase labor market attachment, and delay marriage (Bailey & Lindo, 2018; Bailey, 2006; Goldin & Katz, 2002). Many contraceptive methods are difficult to use, resulting in typical use failure rates that are higher than the “perfect use” failure rates (Sundaram et al., 2017). Higher failure rates imply that there are unrealized welfare gains from reducing the gap between typical and perfect use, which can be filled by contraception that does not require regular user action. Subdermal contraceptive implants and intrauterine devices (IUDs) are very effective at preventing pregnancies with little to no user involvement for a period of 3 to 10 years, depending on the type of device chosen (American College of Obstetricians and Gynecologists, 2015). Due to their long-acting nature, contraceptive implants and IUDs are collectively known as long-acting reversible contraception (LARC). By reducing the potential for user error, LARC use may improve women’s economic outcomes, particularly among women who are more likely to have contraceptive failures.

Identifying the causal effect of LARCs on pregnancies and births is difficult because the decision to use a long-acting method may be related to a women's probability of becoming pregnant when she uses other contraceptive methods. If the decision to use a LARC is endogenous, then estimates of the impact of LARC use on pregnancies and births from approaches that do not account for this endogeneity will be biased. In this paper, I overcome this problem by using exogenous variation in LARC use due to a change in contraceptive recommendations from the American College of Obstetricians and Gynecologists (ACOG). The new recommendation encouraged providers to counsel patients on all contraceptive options, including IUDs and implants, and to encourage LARC use among women for whom it is appropriate. Using data from the National Survey of Family Growth, I demonstrate that the change in ACOG's recommendation increased LARC use by roughly 9 percentage points for younger women with one child compared to older women with one child. The ACOG publication also reduced the probability of pregnancy among younger women in this cohort by over 5 percentage points.

I combine these estimates to yield an estimate of the causal effect of LARC use on the probability of pregnancy and birth. My instrumental variables results indicate that LARC use reduced the probability of becoming pregnant in the subsequent year by 58.7 percentage points and the probability of giving birth in the subsequent year by 44.3 percentage points, compared to OLS estimates of 7.5 and 6.9 percentage points, respectively. These results imply that the marginal woman who was induced to use a

LARC would have had a relatively high failure rate if she used an alternative contraceptive method.

Women who are poorer compliers with other contraceptive methods may select into LARC use because they find the compliance-free aspect of IUDs and implants to be particularly beneficial. To investigate the possibility that unobserved heterogeneity is driving some of my results, I estimate a correlated random coefficients model using a control function approach (Wooldridge, 2015). My results indicate that among current contraceptive users, women who select into LARC use would have been more likely to become pregnant in the subsequent year than the average woman had she not used a LARC. These results provide evidence that women who choose LARCs do so because they will experience a greater reduction in their probability of becoming pregnant compared to women who do not choose long-acting methods.

The rest of the paper is organized as follows: In Section 3.2, I summarize relevant literature connecting contraceptive effectiveness to economic outcomes and relating LARCs to contraceptive effectiveness. In Section 3.3, I discuss the factors associated with LARC use, including ACOG guidelines and recommendations, such as the one I use for identification. In Section 3.4, I describe my data and sample selection and in Section 3.5, I define my methods. In Section 3.6, I report the results of my difference-in-differences estimation of the effect of the ACOG recommendations on LARC use and the reduced form estimates. In Section 3.7, I present my main results of the effect of LARCs on pregnancies and births. In section 3.8 I discuss various robustness checks. Section 3.9 concludes.

3.2 Literature

3.2.1 Contraceptive Effectiveness and Economic Outcomes

Bailey and Lindo (2018) summarize the effect of fertility control on economic outcomes. Because many societal changes were occurring around the introduction of effective contraception in the 1960s and 1970s, it is difficult to disentangle the effect of birth control on economic outcomes from changes in women's opportunities increasing the demand for contraception (Bailey, 2006; Bailey & Lindo, 2018). Much of the relevant literature uses exogenous variation in access to the pill for identification to estimate the causal effect of contraceptives on economic outcomes (Bailey, 2006; Bailey & Lindo, 2018; Bailey et al., 2018; Beauchamp & Pakaluk, 2019; Goldin & Katz, 2002).

Goldin and Katz (2002) use the introduction of the pill to younger, unmarried women in the 1970s to find that contraception allowed women to pursue higher levels of education and to delay marriage. Using the overturning of anti-obscenity statutes which had banned contraceptives, Bailey (2006) finds that while birth control does not explain the declines in fertility, it allowed women to control the timing of their pregnancies, leading to greater labor market attachment. Bailey et al. (2018) use the rollout of Title X to find that children born in households in which mothers had access to effective contraception were more likely to have greater economic resources. This literature implies that access to modern contraception has had positive effects on the economic outcomes of women and their children (Bailey & Lindo, 2018; Bailey et al. 2018).

There may have been heterogeneous effects of the pill. Using changes in access due to the overturning of anti-obscenity laws, Beauchamp and Pakaluk (2019) find that the introduction of the pill actually led to more nonmarital births and a lower probability of obtaining a high school diploma for some women, particularly among women of color and working-class women. The authors suggest that the mechanism of the "paradox of the pill" is through increased nonmarital sexual activity and subsequent contraceptive behavior and failures, which may be related to differential failure rates (Musick et al., 2009). Access to a contraceptive that does not require user adherence could be particularly welfare improving for women who are more likely to experience contraceptive failures with other methods.

3.2.2 Effectiveness of LARCs and Other Contraceptives

LARC methods include intrauterine devices and subdermal contraceptive implants. LARCs are placed in the uterus or the arm by a medical professional and are approved to prevent pregnancy for 3 to 10 years, unless they are removed early (American College of Obstetricians and Gynecologists, 2015). The contraceptive effectiveness of these devices has been well established through clinical trials (Stoddard et al., 2011).

Table 10 compares the perfect use and typical use failure rates for various contraceptive methods. LARCs, short-acting reversible contraceptives (SARCs), permanent methods, and condoms all have perfect use failure rates of 2% or less. The more substantial differences in effectiveness are seen in the typical use failure rates, in which LARCs are considerably more effective than methods that are less forgiving of user error (Sundaram et al., 2017; Trussell, 2011).

Table 10. Contraceptive Method Perfect and Typical Use Failure Rates

Method Type	Methods	Perfect Use Failure Rate	Typical Use Failure Rate
No method	N/A	**85%**	**85%**
Traditional	Withdrawal, fertility-awareness and calendar-based methods	**0.4% - 4%**	**19.9+%**
Barrier	Male condoms, female condoms, diaphragms, creams, jellies	**2 – 20 %**	**12.6+%**
SARC	Pills, patches, rings, shots	**0.3%**	**4 - 9%**
LARC	Implant, hormonal IUD, copper IUD	**0.05% – 0.6%**	**0.05% - 0.8%**
Sterilization	Male, female (including Essure, tubal ligation, hysterectomy)	**0.1% – 0.5%**	**0.15% – 0.5%**

Source: Trussell (2011) and Sundaram et al. (2017). Failure rates denote the probability of a couple becoming pregnant during the first year of use.

The low failure rates of LARCs are also demonstrated in observational and prospective studies. The St. Louis Contraceptive CHOICE Project aimed to remove barriers to LARC use by offering contraceptive counseling and covering the cost of contraception for two to three years. Telephone surveys of participants occurred every six months during this time (McNicholas et al., 2014). Results based on data from the CHOICE Project show that the failure rates for LARC users were less than 1% at years 1,2, and 3, respectively, and that these rates were considerably lower than those of women using non-LARC reversible contraception (McNicholas et al., 2014).

There are two papers in the economics literature, both using data from the Colorado Family Planning Initiative (CFPI), that identify causal effects of LARC access on outcomes such as unintended pregnancies and abortions. The CFPI increased access to LARCs by providing IUDs and implants without cost to patients and implementing informational campaigns to increase awareness of Title X clinics (Ricketts et al., 2014). Lindo and Packham (2017) use a difference-in-differences approach by defining counties near or with Title X clinics as the treatment group and find that increased LARC access decreases teen pregnancies and abortion. In a recent paper, Kelly et al. (2019) refine the 2017 difference-in-differences approach by using ZIP codes to gauge the distance from Title X clinics and defining the treatment group as ZIP codes that were close to clinics. The Kelly et al. (2019) results indicate that LARC use decreases pregnancies among both teens and young adults and also decreases the abortion rate.

3.3 Background

3.3.1 Contraceptive Use in the United States

Before the creation of the pill, contraceptive options in the United States included barrier methods such as condoms and diaphragms and traditional methods such as withdrawal (Tietze, 1965). The 1960s brought in new types of modern contraception (Bailey & Lindo, 2018; Hubacher & Cheng, 2004). The first pill was approved as a form of birth control in 1960 and women quickly began adopting the method, with nearly 24% of married contracepting women using the pill by 1965 (Bailey & Lindo, 2018; Mosher & Westoff, 1982). The modern history of LARC use in the US started in the 1960s with the introduction of several IUDs (Hubacher & Cheng, 2004).[15] IUDs became the method of choice for close to 10% of married contracepting women by 1973 (Hubacher & Cheng, 2004; Mosher & Westoff, 1982). Due to a poorly designed device called the Dalkon Shield and concerns that IUDs increased the probability of pelvic inflammatory disease, IUDs fell out of favor in the United States and their use remained very low through the 1990s (Branum & Jones, 2015; Hubacher, 2002; Hubacher & Cheng, 2004).

The pill continues to be one of the most popular forms of reversible contraception, used by nearly 20% of contracepting women (Daniels & Abma, 2018). Other short-acting reversible methods have been introduced in the past few decades, including injectable contraception (Depo-Provera), rings, and patches. Additionally, women can also choose to use barrier and traditional methods. LARC use has increased in recent years, with pills,

[15] Hubacher and Cheng (2004) note that IUD access in the US prior to 1960 was "extremely limited."

LARCs, and male condoms being the most frequently used reversible methods (Daniels & Abma, 2018).

3.3.2 Factors Associated with LARC Use

Variation in LARC use depends on age, with a higher prevalence among women in their 20s and 30s compared to teens and women in their 40s (Branum & Jones, 2015; Daniels & Abma, 2018). In earlier studies, Hispanic women and non-Hispanic White women are more likely to use LARCs than Black women (Branum & Jones, 2015). While this pattern of LARC use by race and ethnicity is still present in the most recent estimates, the differences in use by race and ethnicity are no longer statistically significant (Daniels & Abma, 2018). LARC use is similar across types of insurance and does not vary significantly by education level (Daniels et al., 2015). LARC prevalence has historically been greater among mothers than women without children, but LARC use has increased among women without children in recent years (Branum & Jones, 2015).

Less than 2% of women were using a LARC method in the late 1980s through the early 2000s (Branum & Jones, 2015). The use of long-acting methods began to rise in the mid-2000s and soon made up over 11% of contraceptive use by 2012 (Kavanaugh & Jerman, 2018).This upward trend has continued, with nearly 16% of contraceptive users ages 14-49 reporting using an implant or IUD in 2016 (Daniels & Abma, 2018). Thus, after decades of nearly negligible LARC use, the US has seen a considerable increase in LARC use in less than two decades.

There are issues on both the supply and demand side of the market for LARCs that can explain some of the previously low prevalence of use and the recent increases in utilization. Demand-side issues that have affected LARC uptake include a lack of familiarity with the methods, concerns over side effects, misinformation, and prohibitively high costs of insertion (Foster et al., 2015), though the implementation of the Affordable Care Act's contraceptive mandate in August 2012 has made LARCs more affordable for some women (Becker & Polsky, 2015). Supply-side issues preventing wider use of LARCs have included misinformation and reluctance from providers to insert LARCs into women who are adolescents, do not have children, or who have a history of sexually transmitted infections (Luchowski et al., 2014). Additional supply-side barriers include difficulty keeping the devices in stock and a lack of trained providers (Beeson, et al. 2014; Foster et al., 2015; Phillips & Sandhu, 2018).

Hubacher et al. (2011) discuss factors that could contribute to the recent rapid rise in LARC use, breaking up the potential explanations into three categories. The first category is patient factors, such as direct-to-consumer marketing, increased affordability, and positive word-of-mouth. The second category is product factors, such as new devices (e.g. Mirena) and changes in labeling of the devices. Finally, the third category is provider factors, which includes greater training and familiarity with LARCs, recognition of their non-contraceptive benefits, awareness of LARC use outside the US, and organizations working to help providers become better informed about long-acting methods (Hubacher et al., 2011).

Hubacher et al. (2011) also point to changes in provider recommendations from the American College of Obstetricians and Gynecologists (ACOG) as a reason that LARC use has increased. The authors focus on the release of two publications. The first publication is Practice Bulletin 59, which was released in January 2005 (American College of Obstetricians and Gynecologists, 2005). This bulletin endorsed LARC use in a broad population of women, including some women without children. The second publication mentioned was a 2007 committee opinion supporting the use of LARCs as "front-line" contraceptives for some adolescents (American College of Obstetricians and Gynecologists, 2007a.; Hubacher et al., 2011).

In December 2009, ACOG released a new opinion, Committee Opinion 450 ("Increasing Use of Contraceptive Implants and Intrauterine Devices to Reduce Unintended Pregnancy"), which may have had a larger effect on women in their 20s than women in their 30s. This committee opinion differed from the previous ACOG publications in that it actively encouraged providers to increase LARC use to prevent unintended pregnancies, encouraged providers to discuss all contraceptive options (even if the woman had a preferred option), detailed potential barriers to LARC use, and described how providers could help overcome these barriers (American College of Obstetricians and Gynecologists, 2009).

Medical professionals have been wary of IUD use in young women, women without children, or women at risk of sexually transmitted infections (STI) (Luchowski et al., 2014). In the early 1990s, ACOG released a bulletin noting that IUDs were best suited for older mothers in monogamous relationships (American College of Obstetricians and Gynecologists, 1992). Because women in their 20s may not have been seen ideal candidates for LARCs previously and because they have historically had the highest rates of unintended pregnancies (Finer & Zolna, 2016), providers may have responded more strongly to CO 450 when counseling younger women. This response could have led to increased LARC use in this population compared to older women. It is this variation in LARC use that I use as an instrument in my main analysis.

3.4 Data

3.4.1 The National Survey of Family Growth

I use data from the 2006-2010, 2011-2013, and 2013-2015 female respondent files of the National Survey of Family Growth (NSFG). The female respondent questionnaire records demographic and socioeconomic information and other factors regarding reproductive well-being. Importantly, the NSFG contains a life-history calendar and records events such as marriages, sexual activity, pregnancies, and contraceptive use month-by-month for up to four years preceding the interview. After combining the datasets, there were observations from 23,579 women. After removing observations that were missing pertinent information, there were 23,362 woman-level observations.

In Table 11, column 1, I report summary statistics from the NSFG. Slightly under half of the women in my sample have not had children. The high proportion of women without children reflects the NSFG's oversampling of women under 20. The proportion Black and proportion Hispanic also reflect the NSFG's sampling scheme. Over half of the women used private insurance in the past year, and 62% of women are currently working at the time of the interview.

Table 11. Summary Statistics from 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth

Women-Level Variables	(1) NSFG	Time Varying	(2) NSFG	(3) Ages 21-27: Pre-Period	(4) Ages 21-27: Post-Period	(5) Ages 31-35: Pre-Period	(6) Ages 31-35: Post-Period
Age at interview	28.639	Age during year	27.136	24.015	24.036	32.935	32.928
Black	0.227	Pregnant this year	0.080	0.197	0.176	0.095	0.124
Hispanic	0.236	Pregnant next year	0.076	0.174	0.143	0.086	0.106
Currently married	0.313	Birth next year	0.060	0.138	0.116	0.070	0.085
No children	0.455	Black	0.227	0.320	0.289	0.207	0.208
Parity [b]	2.162	Hispanic	0.236	0.242	0.280	0.200	0.210
Private insurance	0.563	LARC use	0.058	0.096	0.237	0.089	0.142
Public insurance	0.257	SARC use	0.267	0.498	0.420	0.397	0.390
No insurance	0.143	Condom use	0.193	0.380	0.292	0.296	0.277
Currently working	0.623	Traditional	0.071	0.138	0.161	0.136	0.192
		Sexually active	0.736	0.979	0.972	0.958	0.943
		Married	0.350	0.358	0.337	0.609	0.570
		LTHS	0.060	0.183	0.118	0.119	0.071
		Any contraception [a]	0.683	0.782	0.800	0.708	0.733
Number of women:	23,362	Number of woman-years	93,233	1,641	1,375	818	718

Notes: Unweighted data from the 2006-2010, 2011-2013, and 2013-2015 NSFG. Data used from non-survey years only. Columns 3-6 includes contraceptive users only (except for the "Any contraception" row, which includes both contracepting and non-contracepting women). Women in the treatment group are between the ages of 21 to 27 with one child, and women in the control group are between the ages of 31 and 35 with one child. LTHS indicates that the respondent has less than a high school education.

[a] Number of women years (Any contraception): 2,666, 2,223, 1,514, and 1,225 for columns 3-6, respectively.

[b] Among women with at least one child.

Using the month-by-month contraceptive and sexual history calendars, I construct retrospective panel data of contraceptive use. Women were interviewed in different months and were asked about their contraceptive use during the current year and the three years before the survey. Because of this, some women contributed 37 months of data while others contributed up to 48 months. I consider the implications of this issue in a sensitivity analysis in which I restrict my sample to non-survey years. My final dataset contains information on race, ethnicity, age, sexual activity, pregnancy, births, and contraceptive use.

The reliability of retrospective contraceptive histories from life table calendars may be questionable as recall is not completely accurate, especially among women with more complicated contraceptive histories (Callahan & Becker, 2012; Martin & Wu, 1998.; Strickler et al., 1997). Due to evidence of heaping of the month of contraceptive initiation, I aggregate the monthly data into years.[16] A woman is considered sexually active if she was sexually active at any time during the year and married if she reported being married for any of the months. Similarly, if the woman reports a new pregnancy during any month, then she has had a pregnancy that year. A woman's contraceptive status depends on the most effective method used during any month of the year.[17] The year-level indicators are not exclusive. For example, if a woman used a SARC and condoms from January-March, she will be considered a SARC user for those months. At

[16] Appendix C, Table C.1 reports the proportion of new contraceptive spells initiated in each month. The proportion beginning in January is 13.48% compared to a range of 6.76-8.73% in other months.
[17] Appendix C, Table C.2 lists the criteria used to rank the "main contraceptive method" in a particular month.

the year level, she will be considered a SARC user. If she switched to using a LARC method from April-December, then she will be a LARC user for those months, and at the year level she will also be considered a LARC user.

In Table 11, column 2, I provide descriptive statistics of the time-varying variables. Women report using some form of contraception during 68% of the years, with SARCs being the most common method. Women also reported being sexually active in 74% of the years and married during 35% of the years.

3.4.2 Sample Restrictions

To analyze the effect of CO 450, I designate contracepting women between the ages of 21 to 27 with one child as the treatment group and contracepting women between the ages of 31 to 35 with one child as the control group. I define the pre-period as years 2005-2009 and the post-period as the years 2010-2013. Because I am interested in the additional effectiveness of LARCs compared to other methods, I restrict my sample to contraceptive users only. In order to make this restriction, increased LARC use must not affect contraceptive use on the extensive margin differently for younger women compared to older women.[18]

I only include women with one child for two reasons. First, though LARC use among nulliparous women was slowly increasing during this time frame, many providers were hesitant to insert IUDs (which make up a large majority of LARC use) in women without children (Branum & Jones, 2015; Luchowski et al., 2014). This likely dampened

[18] I test this assumption by assessing the impact of CO 450 on the decision to use any contraceptive (reported in Table 12). I also report my main results without this sample restriction in Appendix E.

the effect of CO 450 in this population. Second, young women with two or more children may be fundamentally different than others in my treatment and control groups and women in their 30s with more than one child may be more likely to be considered candidates for sterilization.

I exclude women under the age of 20 as adolescents may face different circumstances regarding their reproductive care than older women. Because I am using an estimated age based on the woman's age at time of survey, I do not include women who are 20 as they may have been 19 for the majority of the year. I also do not include women between the ages of 28 and 30 to prevent women from aging out of my treatment group and into my control group as each woman can contribute up to 4 years of information.

Practice Bulletin 59 was released in January 2005 and may have affected providers' attitudes towards LARCs; thus, I begin my pre-period in 2005 and continue it through 2009. I define my post-period as the years 2010-2013. These cutoffs are sensible as 2010 was the first year after the release of CO 450, and various changes from the Affordable Care Act (ACA) were implemented in 2014, such as the rollout of Medicaid Expansion for many of the participating states (U.S. Department of Health and Human Services, 2014, as cited in Forum on Medical and Public Health Preparedness for Catastrophic Events et al., 2014, Appendix F).

In Table 11, columns 3 through 6, I report summary statistics for women in my treatment and control groups during the pre- and- post periods. In the pre-period, younger women and older women have a similar prevalence of LARC use (9.6% and 8.9% for younger and older women, respectively), but in the post-period the difference has grown considerably, with 23.7% of younger women using a LARC compared to 14.2% of older women. Despite the large gap in LARC use, the use of any contraception increases slightly but similarly in both groups (from 78.2% to 80.0% for young women and 70.8% to 73.3% for older women). There are changes in the proportion of women with less than high school education in the pre- and post- periods, which are also quite different when comparing the two groups of women. There are also differences in both groups regarding marital status, but these differences are similar in both periods.

3.5 Methods

3.5.1 The Effect of CO 450

I use a difference-in-differences (DID) design to estimate the effect of ACOG's Committee Opinion 450 on the LARC use of younger women versus older women. I specify the DID as:

$$LARC_{it} = \gamma post_{it} \times treatment_{it} + x_{it}'\eta + \delta_{it} \quad \textbf{(5)}$$

In which $post_{it}$ indicates years 2010-2013 and $treatment_{it}$ indicates that the woman is between the ages of 21 and 27. x_{it} is a vector of regressors that includes indicators for if the respondent is Black, of Hispanic ethnicity, married, and sexually active and a set of age and year controls. [19] δ_{it} is an error term. I do not include the main effects for $post_{it}$ and $treatment_{it}$ as the age and year controls subsume them. Because I am using

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[19] I include women who are not sexually active in my analysis for both the LARC and the pregnancy equations as some women may choose abstinence as a contraceptive method. I report results excluding sexually inactive women in Appendix E.

retrospective histories and most of the socioeconomic information was collected for the time of the survey, I do not include variables such as income or insurance status in my analyses.[20]

To be valid as an instrument, CO 450 needs to satisfy the conditions of relevance, independence, excludability and monotonicity (Lousdal, 2018). As a committee opinion actively aiming to increase LARC use, CO 450 should have an effect on the probability of using a LARC (relevance); as a supply-side shock, the committee opinion should be unrelated to unobserved woman-level factors that would affect the probability of becoming pregnant (independence); CO 450 should only have affected the probability of pregnancy through changes in contraceptive use (excludability) and should have not caused women to choose to not use a LARC (monotonicity).

3.5.2 The Effect of LARC Use on Pregnancy

I use an instrumental variables approach to estimate the effect of LARC use, in which the previously described difference-in-differences model is the first stage. I consider three outcomes in my second stage. First, I consider the probability of becoming pregnant in the current year. This outcome introduces timing issues, as I cannot differentiate between pregnancies that occur before and after the initiation of a contraceptive method. Second, I estimate the effect of LARCs on the probability of becoming pregnant in the following year. This relationship may be of interest, as LARC methods are long-acting and have continuation rates of greater than 80% for the first year

[20] Analyses including controls for income and insurance are included in Appendix E.

(Diedrich, Zhao, et al., 2015). This outcome also does not face the same timing issue as the current year pregnancy variable. Finally, I consider the effect of LARCs on the probability of giving birth in the following year, in which the pregnancy could have started in the current year. The outcomes related to the future can only be estimated in years when there is information on the following year, and thus observations from the survey year are removed during estimation.

My estimating equation for the second stage is as follows:

$$y = \alpha Contra_{it} + x'_{it}\beta + \epsilon_{it} \quad \textbf{(6)}$$

Where y is whether or not a woman reports a pregnancy during the current year, whether or not a woman reports a pregnancy in the following year, or whether or not a woman reports a birth in the following year. $Contra_{it}$ is a set of indicators for contraceptive use, including LARC and non-LARC methods, x_{it} is defined as it was in equation 1, and ϵ_{it} is an error term.

If the decision to use contraception (including LARCs) is exogenous, then I can use OLS to estimate the causal relationship between LARC use and fertility. It seems likely, however, that due to factors such as differences in fecundity, difficulty complying with contraceptive regimens, sexual activity, or openness to unintended pregnancy, the decision to use any particular method may be related to ϵ_{it}. That is:

$$cov(e_{it}, contra_{it}) \neq 0 \quad \textbf{(7)}$$

I am interested in estimating the causal effect of LARC use on a woman's probability of becoming pregnant or giving birth. I designate this effect as:

$$\theta_{it} = y_{it1} - y_{it0} \quad \textbf{(8)}$$

In the above, y_{i1} indicates a woman's probability of becoming pregnant or giving birth while using a LARC and y_{i0} indicates her probability of becoming pregnant or giving birth when not using a LARC. In practice, I can only observe either y_{1i} or y_{i0}, thus I must estimate the average causal effect of LARC use, which can be expressed as (Cerulli, 2015):

$$\theta = E[Y_{it}|LARC = 1] - E[Y_{it}|LARC = 0] \quad \textbf{(9)}$$

Based on the clinical effectiveness of LARCs, $E[Y_{it}|LARC = 1]$ should be close to zero. If the decision to choose a LARC is randomly assigned, then the difference between the terms in equation 9 will give an unbiased estimate of the average effect of LARCs on pregnancies and births. As noted, ϵ_{it} and the decision to use a long-acting method may not be independent for the reasons listed previously.

If women who are more likely to become pregnant choose LARCS, then women who do not use LARCs are less likely on average to become pregnant. In this case, the estimated difference between the probability of becoming pregnant for LARC users and non-LARC users will be too small and OLS will understate the effect of LARCs. It is also possible that there is a negative correlation between ϵ_{it} and the decision to use a

LARC. For example, if women who use IUDs and implants would correctly use other methods but prefer LARCs as a matter of convenience or because they are very averse to pregnancy, then it is unlikely that they would have become pregnant while using a short-acting method. In this case, women who choose LARCs would have a lower probability of pregnancy and birth on average compared to women who remain in the non-LARC group. Thus, the difference between the probability of becoming pregnant for LARC users and non-LARC users will be too large and OLS will overstate the effect of LARCs. Because of this, it is necessary to use an alternative method (such as 2SLS) to estimate θ.

A benefit of 2SLS is that it is fairly robust and that it can produce good approximations of local average treatment effects when the probability of the outcome equation is not too close to zero or one (Angrist, 2001; Chiburis et al., 2012). A drawback of 2SLS is that the standard errors are often larger than that of OLS (Wooldridge, 2010). Ignoring the binary nature of the LARC variable can lead to less efficient estimation of the LARC equation (Cerulli, 2015). To gain efficiency, I estimate a probit model of LARC use on the exogenous variables and the interaction of $post_{it}$ and $treatment_{it}$ and use the predicted propensity score from the probit regression as the instrument in the 2SLS estimation.[21] This procedure increases efficiency in the first stage, as the predicted propensity score should be more strongly related to LARC use than just the DID

[21] The procedure is as follows: 1.) Use probit regression to estimate a model of LARC use on the x's and the $Post_{it} \times Treatment_{it}$ interaction and obtain the predicted probabilities from this model. 2.) Estimate the LPM first stage of $LARC_{it}$ on the x variables and the predicted probabilities from the probit model. 3.) Run an LPM of y on the x variables and the predicted values from the $LARC_{it}$ equation. Note that the standard errors do not need to be corrected for the presence of a generated instrument. See Cerulli (2015) p. 170-171.

interaction term on its own (Cerulli, 2015). Following Cerulli (2015), I will refer to the traditional 2SLS procedure as “direct 2SLS” and the 2SLS using the predicted propensity score as an instrument as “probit 2SLS.”

Another common way to estimate the average causal effect when both the outcome and endogenous variables are binary is by estimating a recursive bivariate probit model using maximum likelihood estimation (Chiburis et al., 2012; Heckman, 1978). In my current application, this requires specifying the LARC and pregnancy equations as:

$$y = \boldsymbol{I}(\theta LARC_{it} + x_{it}'\beta + \epsilon_{it} > 0) \quad \textbf{(10)}$$

$$LARC = \boldsymbol{I}(\alpha Post_{it} \times Treatment_{it} + x_{it}'\beta + \delta_{it} > 0) \quad \textbf{(11)}$$

And assuming joint normality of the error terms, δ_{it} and ϵ_{it}. A criticism of this approach is that it requires strong assumptions about the functional form (Angrist, 2001). In column 5 of Table 14, I report the marginal effects from the recursive bivariate probit specification.

3.6 First Stage and Reduced Form Results

3.6.1 Difference-in-Differences Estimates

In the top row of Table 12, I report the first stage results for women with one child, regardless of contraceptive status. The release of CO 450 did not affect the use of any contraception among young women compared to older women, but it did increase the use of LARCs and decrease the use of short-acting methods (such as pills) and condoms. It also did not affect the use of traditional methods. The impact on the use of SARCs and condoms implies that women who use IUDs and implants may have used other potentially effective methods. Thus, increases in contraceptive effectiveness should be through LARC methods reducing the possibility of user error.

In the bottom row of Table 12, columns 2 through 5, I re-estimate the difference-in-difference results for the four method categories among contraceptive users only. There is a slightly stronger effect of CO 450 on both LARC use and SARC use while the effect on traditional method use remains insignificant. The coefficient from the condom use model is no longer statistically different from zero. Column 6 reports the results from the LARC use equation during non-survey years, and column 7 reports the average marginal effect from the probit model used to generate the instrument in the probit 2SLS results.

I also estimate the reduced form results using the specification listed in equation 5, but with the three outcomes of interest as the left-hand variables. I report these results in Table 13. The coefficient on the difference-in-differences interaction term is statistically significant and negative across outcomes, indicating that the release of CO 450 had a negative impact on pregnancies and births.

Table 12. Difference-in-Differences Results: The Effect of CO450 on LARC Use

	(1) Any Contraceptives	(2) LARC	(3) SARC	(4) Condoms	(5) Traditional	(6) LARC (Non-Survey Years)	(7) LARC (Probit)[a]
Any Contraceptive Status							
PostxTreatment	-0.021	0.078***	-0.060**	-0.053**	-0.032	0.071***	0.060**
	(0.025)	(0.020)	(0.029)	(0.026)	(0.021)	(0.022)	(0.025)
N	7,628 (3,647)	7,628 (3,647)				5,891(3,261)	7,628 (3,647)
Contraceptive Users Only							
PostxTreatment		0.096***	-0.069*	-0.055	-0.039	0.089***	0.083***
		(0.026)	(0.036)	(0.033)	(0.027)	(0.028)	(0.031)
N	5,832 (2,958)	5,832 (2,958)				4,552 (2,629)	5,832 (2,958)

Number of woman-years (number of women). Unweighted data. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 with one child while control group includes women ages 31-35 with one child. All specifications include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman level.

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

[a] Average marginal effect.

Table 13. Reduced Form Results: The Effect of CO450 on Pregnancies

	(1) **Pregnant This Year (OLS)**	(2) **Pregnant next year (OLS)**	(3) **Birth next year (OLS)**
PostxTreatment	-0.052*** (0.018)	-0.052*** (0.020)	-0.039** (0.018)
N	5,832 (2,958)	4,552 (2,629)	4,552 (2,629)

Number of woman-years (number of women). Unweighted data from the 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth. Contraceptive users only. N indicates the number of woman-years (number of women). Pre-period is 2005-2009; post-period is 2010-2013. Columns 2 and 3 do not include observations from the survey year. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.
*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

3.6.2 Threats to Validity

CO 450 was released in December 2009, when the economy was in the midst of the Great Recession and right before the Affordable Care Act was signed into law. A discussion of how these factors may affect my results is warranted.

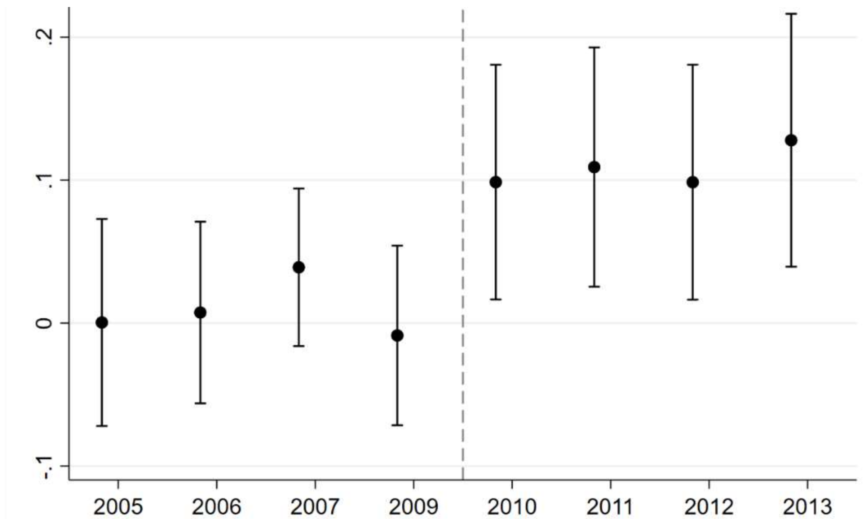
The recession may have increased the relative cost of childbearing (Stone, 2018) and thus increased the demand for more reliable contraception. There was growth in the popularity of long-acting reversible methods among most groups of women during this time (Branum & Jones, 2015). It seems unlikely, however, that LARC use would experience a sudden jump in 2010 compared to 2008 or 2009 due to the recession or that there would be such a differential effect on LARC use for mothers in their 20s versus mothers in their 30s.

More concerning is the passage of the Affordable Care Act, which included a dependent care coverage provision for children up to the age of 26, a contraceptive mandate which required that private insurance cover all FDA-approved contraceptives at 100%, and the Medicaid expansions. I discuss each of these pieces of the ACA in turn.

The dependent care provision was implemented in September 2010. After this time, children ages 18-25 could be covered under their parents' insurance (Sommers et al., 2013). For the difference-in-differences results to be valid, the gap in LARC use must be explained by CO 450 and not by increased insurance access from the ACA. The initial gap in LARC use for younger women compared to older women occurred in 2010, even though the increases in coverage did not begin until late that year. If increased insurance coverage explained the divergence, then there should have been another substantial increase in LARC use in 2011—perhaps more substantial than in the initial jump in 2010—as the number of young adults insured under the dependent care provision was greater in 2011 than in 2010 (Sommers et al., 2013). Such a pattern is not observed in the event study (Figure 1). Also, though the dependent care provision did increase insurance among young adults, the contraceptive mandate was still not in effect at this time (Becker & Polsky, 2015). Thus, the price of LARCs may have still been prohibitively high for some.

The contraceptive mandate was implemented in August 2012, though its effect was not felt by many until 2013 (Becker & Polsky, 2015). Because the contraceptive mandate went into effect towards the end of the post-period, it cannot explain the gap that began in 2010. Similarly, while states were considering Medicaid Expansion during this time, the expansions themselves were implemented in 2014 (The Henry J. Kaiser Family Foundation, 2019a).

Figure 1. Event Study: The Effect of CO450 on LARC Use Among Mothers with One Child



Unweighted data from the 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth. Sample includes 5,838 woman-years from 2,561 women between the ages of 21 and 27, and 2,744 woman-years from 1,328 women between the ages of 31 and 35. Dotted line indicates the release of Committee Opinion 450 in December 2009. The base year is 2008.

3.7 Main Results

3.7.1 The Effect of LARC Use

In Table 14, I report the effect of LARC use on fertility outcomes. The OLS, direct 2SLS, probit 2SLS coefficients are in columns 1, 2, and 3, respectively. The marginal effects from a probit specification are reported in column 4, and the bivariate probit marginal effects are reported in column 5. Because I only have one instrument, I include an indicator for LARC use but not for any other form of contraception. The coefficient on LARC use can be interpreted as the additional effectiveness of using an IUD or implant compared to other methods. The three rows correspond with the three outcomes: Pregnant this year, pregnant next year, and birth next year.

Table 14. Instrumental Variables Results: The Effect of LARC Use on Pregnancies

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate Probit[a]
Pregnant this year					
LARC use	-0.106***	-0.536**	-0.389**	-0.104***	-0.240***
	(0.010)	(0.226)	(0.160)	(0.009)	(0.061)
Confidence set [b]		[-1.274, -0.173]			
Pregnant next year					
LARC use	-0.075***	-0.587**	-0.395**	-0.074***	-0.080
	(0.012)	(0.278)	(0.186)	(0.012)	(0.164)
Confidence set [b]		[-1.66, -0.175]			
Birth next year					
LARC use	-0.069***	-0.443*	-0.246	-0.067***	-0.043
	(0.011)	(0.241)	(0.156)	(0.010)	(0.203)
Confidence set [b]		[-1.34, -0.057]			

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.
N: 5,832 woman-years from 2,958 women (row 1) and 4,552 woman-years from 2,629 women (rows 2 and 3)
F-stats for 2SLS first stage (column 2): 13.32 (row 1); 9.86 (row 2 and 3)
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively. Standard
[a] Average marginal effects
[b] Weak instrument-robust Anderson-Rubin confidence set computed using the 'weakiv' command in Stata.

Across specifications, LARC use has a negative and statistically significant effect on the probability of becoming pregnant in the current year. The OLS results indicate that LARC use decreases the probability of becoming pregnant among contraceptive users by 10.6 percentage points. The 2SLS results are much larger but less precise, with an estimated 56.3 percentage point decline in the probability of becoming pregnant. The probit 2SLS results are smaller than the direct 2SLS results, but still indicate a larger effect on becoming pregnant in the current year than the OLS estimates. The bivariate probit results are smaller than either of the 2SLS results, but still more negative than those of OLS, with an estimated 24 percentage point decrease in the probability of becoming pregnant.

The pattern for the "pregnancy next year" results is similar to that of the current year pregnancy results, with an exception of the estimates reported in column 5. The marginal effect from the bivariate probit model is similar to that of the OLS coefficient (-0.08 vs. -0.075, respectively), though the results are imprecise and not statistically different from zero. The birth equations also exhibit a similar pattern to the next year pregnancy results, only now the probit 2SLS results are no longer statistically significant. The bivariate probit results—while not different from zero—are smaller in magnitude than the OLS results. The estimates across the three outcomes indicate that LARC use has a large negative effect on the probability of pregnancy and subsequent birth among women who chose a LARC due to the release of CO 450. Given that women in their early 20s have the highest rates of unintended pregnancies (Finer & Zolna, 2016), this implies that increased access to LARCs could have a substantial impact on unintended pregnancies in the United States.

Table 14 reports the F-statistics for the first stage of the direct 2SLS results. Because the F-statistics are fairly low (Andrews et al., 2019; Stock & Yogo, 2005), I also estimate Anderson-Rubin confidence sets for each of the outcomes (Anderson & Rubin, 1949). The sets are wide and imprecise, but only contain negative values. These results provide further evidence that LARCs decrease the probability of pregnancy and births compared to other contraceptive methods.

3.7.2 Possible Explanations

To place the estimates into context, it is important to characterize what the mean of pregnancy would have been without any LARC use. In Table 11, I report that roughly 18% of women in my treatment group experience a pregnancy. Assuming that LARC users do not become pregnant, the proportion of non-LARC users experiencing a pregnancy should be close to 24%.[22]

The results vary by model and the coefficients on LARC use in the 2SLS results are quite large. There are multiple reasons why this may be the case. One explanation is that the 2SLS estimates reflect a local average treatment effect (LATE) (Angrist, Imbens, & Rubin, 1996) for women who were induced to use a LARC by the release of CO 450,

[22] In the post period, nearly 24% of young women used a LARC method. Using a back of the envelope calculation which assumes that pregnancies occur only among women who did not use LARCs, I find that the proportion of pregnancies among women not using a LARC should be approximately $0.18 \times \left(\frac{1}{1-.24}\right) \approx 0.237$.

and that these women were particularly poor compliers with other methods and thus experienced a large reduction in their probability of pregnancy. This could explain the divergence between the 2SLS and bivariate probit results, as the bivariate probit is measuring the average treatment effect (Chiburis et al., 2012). Another explanation of the difference between the results more generally is that the sample sizes are less than 5,000, and it is expected that the 2SLS and bivariate probit models would produce different results, even if I had estimated the LATE from the bivariate probit (Chiburis et al., 2012).

A second consideration when assessing the magnitudes of the coefficients is that LARC methods are difficult to discontinue. The coefficients may reflect decreases in the probability of pregnancies due to both the elimination of user error and less frequent discontinuation of contraceptive use. I explore this explanation in Table 15 in which I consider the importance of discontinuation and the intensity of contraceptive use by reestimating the results among women who have used contraception for at least nine months of the year. The direct 2SLS results are still quite large, ranging from -0.484 to -0.500. The probit 2SLS coefficients are smaller (ranging from -0.226 to -0.331), but still larger than those of OLS. The marginal effects in column 5 range from -0.117 to -0.136, though the results for becoming pregnant in the following year are not statistically significant from zero. Taken together, these results imply that using a LARC provides contraceptive effectiveness over other methods, but the magnitudes of the coefficients in the main results are affected partially by women with sporadic contraceptive use.

Table 15. Instrumental Variables Results: The Effect of LARC Use on Pregnancies Among Women Who Use Contraception 9+ Months of Year

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate Probit[a]
Pregnant this year					
LARC use	-0.064***	-0.484**	-0.226*	-0.062***	-0.117***
	(0.009)	(0.239)	(0.131)	(0.008)	(0.031)
Confidence set [b]		[-1.773, -0.158]			
Pregnant next year					
LARC use	-0.082***	-0.492*	-0.331*	-0.079***	-0.136
	(0.014)	(0.292)	(0.187)	(0.013)	(0.121)
Confidence set [b]		[-2.07, -0.024]			
Birth next year					
LARC use	-0.038***	-0.500**	-0.305**	-0.038***	-0.132**
	(0.008)	(0.243)	(0.137)	(0.008)	(0.054)
Confidence set [b]		[-2.059, -0.173]			

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child who have used contraception for at least 9 months of a year. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.

N: 3,121 woman-years from 1,816 women (row 1); 2,877 woman -years from 1,734 women (rows 2 and 3)

F-stats for 2SLS first stage (column 2): 7.29 (row 1); 6.76 (rows 2 and 3)

*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

[a] Average marginal effects

[b] Weak instrument-robust Anderson-Rubin confidence set computed using the 'weakiv' command in Stata.

It is also possible the estimated effects of LARCs may be driven by some form of unobserved heterogeneity and that the effect of LARC use varies across women. One way of characterizing this is by using a correlated random coefficients model, in which the treatment effect for an individual depends on both the average treatment effect and a mean-zero random component (Wooldridge, 2015). I can use a control function approach in which I include an interaction of the potentially endogenous LARC variable and generalized residuals to account for the random component (Wooldridge, 2015). [23] In the first step, I estimate a probit first stage, regressing LARC use on the instrument and other covariates (equation 10) and then use the predicted values to generate generalized residuals. In the second step, I estimate the following:

$$y = \theta LARC_{it} + x_{it}'\beta + \hat{v} + \hat{v} \times LARC_{it} + \epsilon_{it} \qquad \textbf{(12)}$$

In Table 16, I report the results of this two-step process. In all specifications, I include the generalized residual. If the coefficient on the residual is not statistically significant, then I cannot reject the null that LARC use is exogenous. In columns 2, 4, and 6, I add the interaction of LARC use and the generalized residuals. The coefficient on the interaction term is not statistically significant in the "pregnant this year" or "birth next year" results. Coupled with the lack of significance on the main effect of the generalized

[23] I use generalized residuals because the LARC use variable is binary. Generalized residuals are calculated as $\hat{v} = D(\lambda(z\hat{\gamma})) - (1 - D)(\lambda(-z\hat{\gamma}))$, where $\lambda(*)$ is the inverse mills ratio, D is a binary indicator for if the woman is using a LARC and z is the vector of exogenous variables (which includes the instrument). See Wooldridge (2015).

residual, I do not have evidence of heterogeneous treatment effects of LARCs on either of these outcomes.

The more interesting results come from the pregnant next year outcome, in which there is evidence of selection into the use of long-acting methods based on heterogeneous treatment effects. The results in Table 16 indicate that women who choose LARCs experience a greater decrease in their probability of becoming pregnant in the following year. These results are sensible, as the long-acting, compliance-free nature of LARCs are likely what draw many women into using them.

Table 16. Control Function Results: The Effect of LARC Use on Pregnancies

	(1) Pregnant this year	(2) Pregnant this year	(3) Pregnant next year	(4) Pregnant next year	(5) Birth next year	(6) Birth Next Year
LARC Use	-0.313***	-0.349***	-0.123	-0.268*	-0.106	-0.190
	(0.117)	(0.131)	(0.136)	(0.156)	(0.124)	(0.142)
$\hat{v}$	0.115*	0.180	0.027	0.274*	0.020	0.164
	(0.065)	(0.125)	(0.075)	(0.151)	(0.068)	(0.137)
LARC×$\hat{v}$		-0.056		-0.202*		-0.117
		(0.091)		(0.107)		(0.097)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only. N = 5,832 woman-years from 2,958 women with one child (columns 1 and 2); N = 4,552 woman-years from 2,629 women with one child (columns 3 through 6). Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. $\hat{v}$ indicates generalized residuals. All specifications include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls.
*, **, and *** indicate significance at the 0.10 ,0.05 and 0.01 levels, respectively.
Bootstrap standard errors forthcoming.

3.8 Other Results and Robustness Checks

3.8.1 Sample Selection

In my main analysis, I define my sample as women with one child, however there is a possible sample selection issue introduced through this restriction. Women who have one child in their late 20s or early 30s may be better at preventing pregnancies than women in their early 20s, as women who have additional children—perhaps due to repeated contraceptive failures—select out of the sample over time. I re-estimate my main results after redefining my sample as women with one child or two same-sex children. I make this restriction as women with same-sex children are more likely to have a third child than women who have two opposite sex children (Angrist & Evans, 1996). As reported in Table 17, LARC use still decreases the probability that a woman will have a pregnancy or birth in the following year. The magnitudes of the 2SLS coefficients are smaller, and the coefficients in the current year pregnancy direct 2SLS specification is not significantly different than zero.

Table 17. Instrumental Variables Results: The Effect of LARC Use on Pregnancies Among Women with One Child or Two Children of Same Sex

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.094***	-0.245	-0.188	-0.091***	-0.162***
	(0.008)	(0.150)	(0.121)	(0.007)	(0.041)
Confidence set [b]		[-0.618, 0.034]			
Pregnant next year					
LARC use	-0.072***	-0.327*	-0.260**	-0.069***	-0.108*
	(0.009)	(0.168)	(0.130)	(0.009)	(0.062)
Confidence set [b]		[-0.771, -0.028]			
Birth next year					
LARC use	-0.067***	-0.268*	-0.216*	-0.064***	-0.103
	(0.008)	(0.150)	(0.115)	(0.007)	(0.415)
Confidence set [b]		[-0.667, -0.001]			

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include year and age controls. Standard errors are clustered on the woman-level.
N: 8,696 woman-years from 4,164 women (row 1); 6,793 woman -years from 3,731 women (rows 2 and 3)
F-stats for 2SLS first stage (column 2): 18.72 (Panel A, row 1); 16.25 (Panel A, row 2 and 3)
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.
[a] Average marginal effects
[b] Weak instrument-robust Anderson-Rubin confidence set computed using the ‘weakiv’ command in Stata.

3.8.2 Other Robustness Checks

Appendix E includes various sensitivity analyses. In Tables E.1–E.5, I consider other variations of my sample. In Table E.1, I report the main results for women regardless of contraceptive status while in Table E.2, I report the results for sexually active women only. In Tables E.3 through E.5, I vary the age groups and consider women ages 18-27 versus 31-35, 23-27 versus 31-35, and 23-27 versus 31-35, respectively. The results are overall similar to the main results, though there are some differences in the 23-27 versus 31-35 estimates.

Because some women do not contribute a full year of data during the survey year, Table AV.6 reports the estimates using only observations from non-survey years. The results are identical in the case of the pregnant and birth next year results, as they were already estimated without survey year observations, and the pregnant this year results are similar to the main results. In Table E.7, I report the results using the weights provided in the NSFG and in Table E.8, I reestimate the main results while controlling for insurance and income at time of survey. Weighting the data reveals a similar pattern to the main results (direct 2SLS results larger than the probit 2SLS results, which are larger than the OLS results), but results from the 2SLS models are very large. Including the income and insurance controls does not substantially impact the estimates.

3.9 Conclusion

In this paper I find that implants and IUDs provide women with better control over their fertility than other reversible methods, at least among women in their early 20s with one child. Increased ability to control the timing of fertility and number of births due to LARCs may be related to the recent decline in fertility among young women (Buckles et al., 2019; Finer & Zolna, 2016). The availability of effective contraception has been shown to improve economic outcomes for women (Bailey & Lindo, 2018; Bailey, 2006; Goldin & Katz, 2002). Thus, by reducing the possibility of contraceptive failure due to use error, LARC use may result in significant economic benefits both to the women themselves and to society over the coming decades.[24]

One limitation of the paper is the retrospective nature of the data, as such histories may be subject to recall bias. Additionally, because retrospective data is only collected for contraceptive use and sexual activity, I do not have information on past use of insurance, income, or labor force participation. The public-use file of the NSFG also does not include state identifiers.

Another limitation is that these results may not be generalizable to women without children or women with larger families. Descriptive estimates of failure rates of contraception indicate that women with one child have higher 12-month failure rates than women without children (Sundaram et al., 2017). Thus, these results may be an upper bound on the effect of LARCs. Nonetheless, future work investigating changes in educational attainment and labor market outcomes due to increased LARC use is warranted (Bailey and Lindo, 2018).

[24] Bailey (2013) finds evidence that access to family planning may have long-run effects on the outcomes of children even into adulthood.

CHAPTER IV

THE IMPACT OF LONG-ACTING REVERSIBLE CONTRACEPTIVE ATTRIBUTES ON METHOD CHOICE

4.1 Introduction

The United States has a higher rate of unintended pregnancies than other developed nations (Singh et al., 2010). It is estimated that 45% of pregnancies in the United States in 2011 were unplanned. Estimates from the Guttmacher Institute indicate that 41% of unplanned pregnancies occur among women who rely on contraceptives that are inconsistently or incorrectly used (Sonfield et al., 2014). Intrauterine devices (IUDs) and implants (collectively known as long-active reversible contraceptives or LARCs) do not rely on user adherence and thus have failures rates under 1% (Trussell, 2011). Due to their effectiveness, increased access and use of LARCs has been suggested as a way to decrease the rate of unintended pregnancy in the US (American College of Obstetricians and Gynecologists, 2015).

As physical devices, there may be additional barriers to LARC use compared to other contraceptive methods. On the supply-side, a lack of trained providers, misinformation among providers, and difficulties keeping the devices in stock may prevent women from being able to access these methods (Beeson et al. 2014; Foster et al., 2015; Luchowski et al., 2014; Phillips & Sandhu, 2018). On the demand-side women may be misinformed or unfamiliar with LARCs or may not be able to afford the high out-of-pocket expenses that can be associated with LARC insertion (Foster et al., 2015; Kaye et al., 2009).

LARC use has increased substantially since 2002 (Branum & Jones, 2015), yet a large proportion of women do not rely on implants or IUDs. In 2014, the proportion of women ages 15-45 using a LARC was still under 15% (Kavanaugh & Jerman, 2018). The most recent estimates of LARC use from the 2015-2017 National Survey of Family Growth show that just 10.3% of women between 15-49 years old were using either an IUD or an implant (Daniels & Abma, 2018). Among contracepting women, less than 16% relied on a LARC in 2016 (Daniels & Abma, 2018).

Barriers to use might partially explain why more than 80% of contracepting women are not using either an implant or an IUD, however it is also possible some women decide against using a LARC even when they are accessible (Gomez et al., 2014). Contraceptive choice depends on a variety of factors, including side effect profiles and other considerations (Donnelly et al., 2014; Grady et al., 1999; Jackson et al., 2016; Lessard et al., 2012; Madden et al., 2015). Understanding how different attributes of contraceptives affect the decision of which contraceptive to use is imperative in constructing policies that address the needs of women.

In this paper I estimate a set of models of contraceptive choice using data from the 2011-2013, 2013-2015, and 2015-2017 National Survey of Family Growth (NSFG). The results indicate that the LARC-related attribute of being a physical device is associated with lower levels of use. In order to increase the use of effective contraception, and thus reduce the rate of unintended pregnancies, it may be necessary to both increase access to LARCs and to consider how to better address the needs of women who may want the benefits associated with LARC methods without some of their attributes.

4.2 Background

Many contraceptives are effective when used consistently and correctly (Trussell, 2011). However, as women and their partners sometimes make mistakes, there can be large gaps between the "perfect use" and "typical use" failure rates for contraceptive methods that rely on adherence, including popular methods such as pills and condoms (Sundaram et al., 2017; Trussell, 2011). As a familiar example, the perfect use failure rate of the contraceptive pill is low (<1%), yet the typical use failure rate of the pill has been estimated to be 7.2% (Trussel, 2011; Sundaram et al., 2017). In Table 18, I compare the perfect use and typical use failure rates of various contraceptives.

LARCs are devices that are inserted either in the arm (the contraceptive implant) or in the uterus (intrauterine devices or IUDs) and can provide contraceptive benefits for up to 3 to 10 years, depending on the specific LARC (American College of Obstetricians and Gynecologists, 2015).[25] These methods are effective without requiring frequent effort from the user and have been advocated as a way to reduce the high rates of unplanned pregnancies by both the American College of Obstetricians and Gynecologists and the American Academy of Pediatricians (Committee on Adolescence, 2014; American College of Obstetricians and Gynecologists, 2015). As illustrated in Table 18, the perfect

[25] IUDs are also sometimes referred to as intrauterine systems (IUS) or intrauterine contraception (IUC).

use and typical use failure rates are very similar to each other for long-acting methods, which reflects their lack of reliance on user adherence.

Table 18. Contraceptive Method Perfect and Typical Use Failure Rates

Category	Methods	Perfect Use Failure Rate	Typical Use Failure Rate
Traditional	Withdrawal, fertility-awareness and calendar-based methods	4 - 0.4%	19.9+%
Barrier	Male condoms, female condoms, diaphragms, creams, jellies	2 – 20 %	12.6+%
SARC	Pills, patches, rings, shots	0.3%	4 - 9%
LARC	Implant, hormonal IUD, copper IUD	0.6 – 0.05%	0.8 – 0.05%
Sterilization	Male, female (including Essure, tubal ligation, hysterectomy)	0.5 – 0.1%	0.5 – 0.15%

Source: Trussell (2011) and Sundaram et al. (2017). Failure rates denote the probability of a couple becoming pregnant during the first year of use.

Because LARCs are physical devices that require insertion by trained medical professionals, they can have unique barriers to use. On the supply-side, there may be a lack of providers trained in insertion, difficulty keeping the devices in stock, or providers may be misinformed or following outdated guidelines when determining if a woman is an appropriate candidate for LARC use (Beeson et al., 2014; Foster et al., 2015; Luchowski et al., 2014; Phillips & Sandhu, 2018). On the demand-side, women may be unfamiliar with LARCs, misinformed about their effectiveness or their safety, or they may not be able to afford the cost of having a device inserted (Foster et al., 2015; Kaye et al., 2009).

In 2002, less than 2% of women relied on a LARC method (Branum & Jones, 2015). LARC use increased considerably between 2002 and 2014, yet the proportion of contracepting women ages 15-44 using a LARC in 2014 was still under 15% (Branum & Jones, 2015; Kavanaugh & Jerman, 2018). Hubacher et al (2011) describe factors that could explain increases in LARC use during the 2000s, including patient factors (direct-to-consumer marketing, increased affordability, and positive word-of-mouth), provider factors (greater training and familiarity with LARCs, recognition of their non-contraceptive benefits), product factors (new devices and label changes), and changes in provider recommendations.

Since Hubacher et al (2011), there have been other changes in the landscape of LARC use, including the implementation of the Affordable Care Act's contraceptive mandate which required the provision of LARCs with $0 out-of-pocket charges for women in private health insurance plans (Becker & Polsky, 2015). Despite these changes, the most recent estimate of LARC use from the 2015-2017 National Survey of Family Growth shows that just 10.3% of women between 15-49 years old are using LARC methods, with slightly under 16% of all contraceptive users relying on these methods (Daniels & Abma, 2018). [26]

Foster et al. (2015) surveyed 100 IUD experts on what they believed the largest barriers to IUD use were and what they projected the uptake of IUDs to be if these barriers were removed. The most common answer was that the experts expected LARC

[26] Using data from the NSFG, Daniels & Abma (2018) estimate that 10.3% of women ages 15-49 are LARC users and that women using any type contraception make up 64.9% of women in this age range. (10.3/64.9) =15.87.

adoption among 25-29% of contraceptive users in absence of barriers, implying that there may be other factors discouraging women from choosing LARC methods. It is possible that many women do not like the features of LARCs, leading to lower uptake. That is, some women may not choose LARCs simply because they are not their best contraceptive choice.

4.2.2 Contraceptive Attributes

Birth control methods are primarily used to prevent pregnancies, but they can also provide a range of other medical benefits. For example, certain hormonal birth control pills are prescribed to help regulate menstrual cycles, improve acne, and to treat conditions such as premenstrual dysphoric disorder (PMDD) and endometriosis (Carey & Allen, 2012). Methods vary in price, effectiveness, side effects, and non-contraceptive uses. When deciding on a contraceptive method, a woman balances the cost and benefits of the methods to find the one that best matches her unique needs (Grady et al., 1999). In Table 19 I summarize a number of contraceptive attributes.

Table 19. Attributes of Contraceptive Methods

Method	Cost to Initiate	Reoccurring Costs	Cost to Discontinue	Failure Rates [a]	Hormonal	Benefits	Mode of Administration	Requires Doctor's Visit	Max Duration of Effect
No Method	No	No	No	85% (85%)	No	No	None	No	None
Traditional Method	No	No	No	0.4 – 4% (19.9%+)	No	No	Episode specific/daily tracking	No	Episode specific
Barrier Method	No	Yes	No	2 – 12+% (12+%)	No	Yes- STI protection	Episode specific application	No	Episode specific
SARC	Yes	Yes	No	0.2%-0.3% (4-9%)	Yes	Yes	Daily pill, weekly patch, monthly ring, quarterly shot	Yes	1 – 3 Months
LARCS									
Hormonal IUD	Yes	No	Yes	0.2% (0.2%)	Yes	Yes	Device placed in uterus	Yes	60 Months [b]
Non-Hormonal IUD	Yes	No	Yes	0.6% (0.8%)	No	No	Device placed in uterus	Yes	120 Months [b]
Implant	Yes	No	Yes	0.05% (0.05%)	Yes	Yes	Device placed in arm	Yes	36 Months [b]
Sterilization	Yes	No	Yes	0.1 – 0.5% (0.15 – 0.5%)	No	No	Surgical	Yes	Permanent

[a] Sources: Sundaram et al. (2017) and Trussell (2011). [b] Source: American College of Obstetricians and Gynecologists (2015). Information on contraceptive attributes can be found at https://www.plannedparenthood.org/learn/birth-control. Traditional methods include withdrawal and fertility-awareness/calendar-based methods. Barrier methods include male and female condoms, diaphragms, foams, jellies, and sponges. Short-acting reversible contraceptives (SARCs) include pills, patches, rings and shots. Sterilization includes female methods (Essure, tubal ligation) and male methods (vasectomies). Benefits indicates that the method provides non-contraceptive benefits. Typical use failure rates in parentheses.

Researchers have surveyed women to assess the importance of these contraceptive attributes. One attribute that is commonly reported as a “very important” factor is effectiveness (Donnelly et al., 2014; Grady et al., 1999; Jackson et al., 2016; Lessard et al., 2012; Madden et al., 2015). Some contraceptives are better at protecting women from unplanned pregnancies. Permanent methods, LARCs, and short-acting reversible contraceptives (SARCs) when used correctly have very low rates of failure (<1%), while other methods (in particular, some barrier methods and withdrawal) may still have high failure rates even when used perfectly (Trussell, 2011). Methods also vary in how sensitive they are to mistakes. Traditional and barrier methods are very sensitive to incorrect and inconsistent use, leading to typical use failure rates greater than 12% for barrier methods and greater than 19% for traditional methods. SARCs are somewhat more “forgiving” and have typical use failure rates ranging from 4 to 9% (Sundaram et al., 2017; Trussell, 2011). Because LARCs and sterilization do not depend on user adherence, their typical use and perfect use failure rates are very similar (Trussell, 2011).

Affordability and access are also considered to be important factors. (Jackson et al., 2016; Lessard et al., 2012; Madden et al., 2015). The out-of-pocket costs of contraceptives can vary substantially, particularly for women who are uninsured. Birth control methods may have initiation costs (such as the cost to get a prescription, have a LARC inserted, or the procedure to become sterilized), reoccurring costs (buying more condoms, the copay for a prescription), and discontinuation costs (removal of LARC device, reversal of sterilization), while traditional methods often have zero monetary costs.

Contraceptives also vary in how they work. Some reversible methods rely on synthetic hormones for their contraceptive effect, while others rely on creating a physical barrier, or—in the case of the non-hormonal IUD—the negative effect of copper ions on sperm and ovum (Grimes, 2008). Hormonal methods can provide non-contraceptive benefits, such as improving acne and making conditions such as endometriosis and premenstrual dysphoric disorder (PMDD) more bearable. They can also have side effects including headaches, effects on mood, weight gain, and unfavorable changes in bleeding patterns (Grimes, 2008). Non-hormonal methods also have drawbacks. Non-hormonal IUDs can cause adverse effects on bleeding, and some women and their partners may not like using a method that requires a physical barrier (Higgins et al., 2009; Hubacher et al., 2009). On the positive side, the use of physical barriers such as condoms can provide protection against sexually transmitted infections (Planned Parenthood, n.d.).

Traditional methods, barrier methods, and SARCs offer the flexibility to stop using the methods at will, but this flexibility comes at the price of having to actively continue to use the method and potentially making errors. Among a sample of women seeking abortions, Lessard et al 2012 found that 70% of women reported that they valued the method being “woman controlled.” In a discussion of LARCs and reproductive autonomy, Gomez, Fuentes, and Allina (2014) note:

> For some women, optimal control may mean choosing a method that will almost never fail. For others, optimal control may mean choosing a method that can be started or discontinued as they choose, without the assistance of a health care provider.

Less flexible methods (LARCs and sterilization) do not require constant effort but do require that women give up control over their fertility, either permanently in the case of sterilization, or temporarily in the case of LARCs. These methods rely on insertion and removal by trained professionals or require a surgical procedure. Women who are concerned about potential side effects may also prefer to not use a method that cannot be easily discontinued in case of a negative experience. Additionally, women may find the idea of having a physical device placed in their bodies as unacceptable (Sundstrom et al., 2016).

Other considerations when choosing a method include whether the woman plans to have children in the future, or if she is spacing the births of her children. Women who are trying to space births may prefer long-acting method, while women trying to limit their fertility may prefer long-acting or permanent methods. Using questionnaires from the Contraceptive CHOICE Project, Madden et al. (2015) found that women value long-lasting methods and methods that do not require regular effort. These results may reflect the eligibility requirements of the CHOICE Project, as a woman had to not want to become pregnant for at least one year and be willing to use a new method in order to participate (McNicholas et al., 2014).

Additionally, Black and Hispanic women may value contraceptive features differently than non-Hispanic White women, especially regarding LARC-related attributes. Jackson et al (2016) found that non-Hispanic Black women, Latina women and Asian/Pacific Islander women were more likely to care about changes in menstrual periods, being able to discontinue use at will, and the method being "episode-specific," meaning that is it only used during a sexual encounter. Additionally, non-Hispanic Black women and Latina women were more likely to consider a quick return to fertility as very important compared to non-Hispanic White women, and non-Hispanic Black women and Latina women were more likely to report that "having control over when and whether to use the method" was very important.

Economists have also studied preferences for attributes of contraceptives. Delavande (2008) recruited 100 women from a nearby university and community college to collect information on the current contraceptive used and subjective beliefs about contraceptive attributes and found the largest negative effects on utility from becoming pregnant, contracting an STI, and partner disapproval. Fieberg et al. (2011) conducted a discrete choice experiment using data collected from 528 women through an online platform and found the greatest willingness-to-pay to avoid negative effects on bleeding, to have more effective contraception, and to avoid weight gain compared to the base alternative of an IUD (Fiebig et al., 2011). Knox et al. (2012) also conducted a discrete-choice experiment and found that women prefer methods that reduce bleeding and that have longer durations of use. Taken together, these results imply that while women do value effectiveness, they also consider other factors when choosing a birth control method. Thus, even the most effective methods may not be desirable for some women if they do not fit their needs along other dimensions.

4.3 Data

I use the 2011-2013, 2013-2015, and 2015-2017 National Survey of Family Growth (NSFG) for data on women and their choices. The NSFG collects information on current and planned fertility, contraceptive use, and various socioeconomic and demographic characteristics. The questionnaires also collect retrospective histories of month-by-month contraceptive use for up to four years. Despite this retrospective contraceptive information, many important socioeconomic variables are only asked for the past twelve months or the past calendar year. For example, a woman is asked about her income for the last calendar year and her insurance status for the past twelve months.

The NSFG surveys women who are of reproductive age, which includes women ages 15 to 44 during the 2011-2013 and 2013-2015 surveys and ages 15 to 49 in the 2015-2017 survey. Because minors may face different contraceptive choices than adults, I do not include women under the age of 19. I exclude 18-year-old women as some would have been minors during the months prior to the survey. To keep the age groups consistent across survey years, I also exclude women over 44.

In my analysis, I focus on the choice of a single contraceptive method. Some women rely on multiple methods per month, but I consider the choice of her "main method," which I determine based on effectiveness, duration of use, and if the method is woman controlled.[27] I assume that the woman has the opportunity to change methods

[27] The "main method" is determined by the following hierarchy: 1.) female sterilization, 2.) implant, 3.) non-hormonal IUD, 4.) hormonal IUD, 5.) male sterilization, 6.) SARC method, 7.) condoms, 8.) traditional method, 9.) no method. Other examples of hierarchies used to determine a main method of use can be found in Sundaram et al. (2017) or in the NSFG's codebook for the construction of the

over the course of a year, even if she chooses to continue the same method that she used previously. A woman using a birth control pill must decide every month if she wants to refill her prescription and every day if she wants to take her pill, thus I regard her decision to continue to use a pill as a new choice. Similar logic applies to episode-specific contraception, such as withdrawal methods or condoms. A difficulty with this assumption comes from long-acting reversible contraceptives and sterilization as women must actively decide if they want to *discontinue* these methods. I assume that this feature is captured by constructing a price variable which makes continuing to use the same LARC free for women.

Reversing sterilization can be costly and in some cases impossible, thus I exclude women who were relying on either female or male sterilization at the beginning of the 12-month period. Because so few women and their partners become sterilized during the 12-month interval that it prevents estimation of some of my models, I do not include the choice to become sterilized in my primary specifications.[28] A woman can choose to rely on an implant, non-hormonal IUD, hormonal IUD, SARC, condoms, traditional methods, or nonuse. I restrict my sample to women who have been sexually active at least 3 months during the 12-month period as pregnancy prevention is a primary use for contraception.[29] Additionally, as the 2015-2017 public use data files do not include the start months of pregnancies, I exclude women who are currently pregnant or

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"CONSTAT1" variable. Not included in my hierarchy are other methods such as other barrier methods, emergency contraception, use of lactational amenorrhea method, or non-contraceptive sterility.

[28] I estimate the attributes model including women who are sterilized in Appendix F.

[29] I make this restriction as I do not want to include women who have not been sexually active or only sporadically sexually active in the prior 12 months. I relax this condition in my sensitivity analyses.

postpartum.[30] In Table 20, I present the distribution of women choosing each method as their main method.

Table 20. Distribution of Contraceptive Method Choice

Method	Observed Percentage
LARC (Any)	16.36
Implant	2.93
Non-Hormonal IUD	3.82
Hormonal IUD	9.62
SARC	28.33
Condoms	17.60
Traditional	8.86
No Method	28.85

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG.
N = 7,487 women between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months.
* p<0.10, ** p<0.05, *** p<0.010

As the NSFG does not collect data on out-of-pocket expenditures on contraception, I searched the literature to find reasonable estimates for the average out-of-pocket expenses associated with the use of contraceptives depending on insurance status. Table 21 summarizes this information.

[30] As defined in the NSFG, "postpartum" indicates that the woman gave birth in the past two months.

Table 21. Summary of Contraceptive Out-Of-Pocket Costs

	Uninsured ($)	Public ($)	Private (Pre-ACA) ($)	Private (Post-ACA) ($)
Implant	749.45[a]	0[e]	320.31[c]	91.01[c]
Non-Hormonal IUD	718[a]	0[e]	262.38[c]	84.3[c]
Hormonal IUD	844[a]	0[e]	262.38[c]	84.3[c]
SARC	52.81[b]	0[e]	16.37[c, e]	10.19[c, e]
Condoms	9[a, b]	9[a, d]	9[a, d]	9[a, d]
Traditional	0	0	0	0
No Method	0	0	0	0

[a] Source: Trussell (2010); Source: [b]Trussell et al. (2009). [c] Source: Becker and Polsky (2015); the authors note that the out-of-pocket expenses reported from their data are sometimes women filling 2-3 month prescriptions (Becker & Polsky, 2015), thus I have divided the amount reported by 2; the resulting number is in line with 2010 and 2013 estimates from Kim and Look (2018); [d] Expenses for 1 month of condoms, assuming couple purchases one 12-count box a month, or uses 9 condoms a month at a price of $1 each as in Trussell et al (2009). [e] Family planning is covered by Medicaid; thus, I have assumed $0 out-of-pocket expenses for all methods other than condoms. However, there is variation in family planning coverage by state (Walls et al., 2016.). Since the NSFG does not release state identifiers in their public use files, I cannot account for these state-by-state differences.

I construct a birth control price variable based on information in both the average price dataset and the NSFG. I use the survey year and the woman's insurance status from the NSFG to determine which average birth control price she faces. Factoring in the survey year allows me to consider whether she was surveyed before or after the implementation of the contraceptive mandate in the Affordable Care Act (ACA). I consider all years prior to January 2013 as pre-ACA, and all years 2013 and later to be post-ACA.[31]

[31] The contraceptive mandate took effect in August 2012 but does not apply to grandfathered plans. Many women were not covered by the mandate until they renewed their insurance coverage in January 2013 (Becker & Polsky, 2015).

I also consider the prior method used in determining the price a woman faces. For methods with reoccurring costs, the previous method used does not affect the current price. A woman using condoms or pills last month will face a similar cost this month. For methods with initiation costs but no reoccurring costs (such as LARCs), the cost of the LARC depends on if the woman is choosing to continue or initiate a new method. If a woman is not using a LARC or is switching from one LARC to another, she may have to pay upfront costs for insertion. I assume that the woman is using a LARC that does not need to be replaced, and that she does not have to pay to continue using it. The price variable is $0 if a woman is choosing to continue a LARC and set to the prices found in the literature if she is initiating the use of a LARC.

For my some of my analyses, I view contraceptives as a bundle of attributes to estimate how the choice to use a method depends on its features. To do so, I need information on contraceptive attributes, which are not included in the NSFG. I use manufacturer the Planned Parenthood website and other sources to construct a dataset of contraceptive attributes (Planned Parenthood, n.d.; American College of Obstetricians and Gynecologists, 2015; Trussell, 2011). Table 22 summarizes this data.

Table 22. Contraceptive Attribute Data Summary

Alternative	Price* ($)	Hormonal	Device	Reduction of Pregnancy Risk x 100	Max Duration of Use (Years)
Implant	0 - 749.45	Yes	Yes	84.95	3
Non-Hormonal IUD	0 - 718	No	Yes	84.2	10
Hormonal IUD	0 - 844	Yes	Yes	84.8	5
SARC	0 - 52.81	Yes	No	76	0.083
Condoms	9	No	No	67	0.003
Traditional	0	No	No	62	0.003
No Method	0	No	No	0	0

*Price varies by insurance status (see Table 21)

I construct the attributes such that setting all attributes equal to 0 corresponds with the non-use alternative. For example, instead of using the typical use failure rate of a method (which would be 85% for a no-method option), I convert the failure rate into a measure of absolute risk reduction, in which the decision to not use a method results in a risk reduction of 0.[32] The contraceptive attributes include the price of birth control, if the method is hormonal, if the method is a device, the pregnancy risk reduction based on typical use failure rates, and the maximum duration of use.

My contraceptive attribute data does not contain information on protection from sexually transmitted infections. As condoms are the only method that offer STI protection, the inclusion of such a variable would result in multicollinearity with other attributes. Also, though there are SARCs that can be used for 3 months, most SARC methods provide roughly one month of contraceptive protection, assuming the woman completes the pack of pills or continues to use the ring or patch. Thus, I use one month as

[32] I calculate risk reduction from using a method as risk with no method minus risk with method; see https://bestpractice.bmj.com/info/us/toolkit/learn-ebm/how-to-calculate-risk/

the maximum duration of use for the SARC category. The typical use failure rates to construct the pregnancy risk reduction variable are taken from Trussell (2011). The failure rate for the traditional method category is the average of the failure rates for withdrawal and fertility awareness methods.

Because the utility of various contraceptive methods likely depends on a woman's characteristics, I also include a number of socio-demographic variables. These variables include her age group (19-23, 24-28, 29-33, 34-38, and 39-44), an indicator of if she is married, household income measured in tens of thousands of dollars, an indicator for if she is employed, an indicator for if she has greater than high-school education, the number of children she has (0,1,2,3+), an indicator for if she is limiting her fertility, and an indicator for if she has been diagnosed with an ovulatory or menstrual condition or endometriosis. As there may be differences in contraceptive preferences by race and ethnicity, I also include indicators for if the respondent is Black and an indicator for if the respondent is Hispanic (Jackson et al., 2016).

In addition to the socio-demographic variables, I also include variables to control for access-related factors. These variables include an indicator for if she has a place of usual care as a measure of her access to medical care, and variable for if the woman lives in a metropolitan area, near a metropolitan area, or in rural area as women living in rural areas may have less access to LARC methods (Martins et al., 2016). I also include a set of year controls to capture changes in recommendations and access year by year, along with changes in attitudes of women and physicians towards LARCs. Insurance status is not included as a regressor as it is factored into the price variable.

In Table 23, I present the descriptive statistics for the analysis sample. Because the weights included in the NSFG are designed to reflect the midpoints of each survey rather than at the survey year, the weights may be inappropriate for my analysis. The decision to not use the survey weights is reflected in the descriptive statistics below as 24% percent of respondents are Black and 23% are Hispanic. A majority (55%) of the women have children.

Table 23. Descriptive Statistics of 2011-2013, 2013-2015, and 2015-2017 National Survey of Family Growth

Variable	Mean	SD
Age at interview	29.77	(7.03)
Black	0.24	(0.43)
Hispanic	0.23	(0.42)
Married	0.30	(0.46)
Employed	0.70	(0.46)
Has private insurance	0.60	(0.49)
Has public insurance	0.26	(0.44)
Household income	4.35	(3.19)
Greater than HS Education	0.38	(0.49)
Has kids	0.55	(0.50)
Parity (among mothers)	1.94	(1.08)
Number of kids in household under 18	1.73	(1.03)
Limiting fertility	0.32	(0.47)
Has place of usual care	0.84	(0.37)
Condition	0.18	(0.38)
Using contraception	0.61	(0.24)

N = 9,594 women between ages of 19-44 (5,289 mothers). Household income tens of thousands of dollars (nominal). Limiting fertility indicates that the woman does not plan to have more children and condition indicates that she has been diagnosed with an ovulatory or menstrual condition or endometriosis. Excludes women relying on sterilization.

4.4 Empirical Approach

The analysis begins with a model that focuses on the alternatives themselves rather than the attributes and then is extended to explore the relationship between the underlying attributes and contraceptive choice. In my first specification, I assume each woman can choose from seven contraceptive options. The utility for person i choosing choice j is assumed to be given by

$$u_{ij} = \gamma_p p_{ij} + \alpha_j + X_i\beta_j + \epsilon_{ij} \quad \textbf{(13)}$$

where, p_{ij} is the price of alternative j faced by person i and γ_p is a scalar that gives the effect on utility of this price. α_j is an alternative-specific constant that captures the average unobserved effect of the utility of using method j (Train, 2009), and the $(1 \times k)$ vector X_i includes person-specific characteristics (socio-demographic and access variables) for person i. $\beta_j$is a $kx1$ vector of coefficients that measures the utility effects of these person-specific characteristics on a method, and ϵ_{ij} is the idiosyncratic error term which captures the unobserved component of utility from the contraceptive choices.

I assume that ϵ_{ij} is independent over i and j and is distributed type I extreme value. Assuming the woman has access to all contraceptive methods, the probability of her choosing some method j is the probability that method j maximizes her utility (Cameron & Trivedi, 2009)

$$\pi_{ij}[y_i = j] = \Pr[u_{ij} \geq u_{ik}, all\ k \neq j]. \quad \textbf{(14)}$$

With the assumption that the error terms are distributed type I extreme value, these probabilities have a convenient closed-form solution (Cameron & Trivedi, 2009):

$$\pi_{ij} = \Pr(Y_i = j) = \frac{\exp\{\gamma_p p_{ij} + \alpha_j + X_i\beta_j\}}{\sum_{k=1}^{7} \exp\{\gamma_p p_{ik} + \alpha_k + X_i\beta_k\}}. \quad \textbf{(15)}$$

I use non-use of a method as the base alternative (or the "outside good"), which is normalized to having a utility of 0. By doing this, the coefficients can be interpreted as differences in utility from a contraceptive method compared to not using a method at all. The parameters of this model are estimated using maximum-likelihood estimation, with log-likelihood (Schmidheiny, 2007):

$$LL = \sum_{i=1}^{n} \sum_{j=1}^{7} d_{ij} \log(\pi_{ij}) \quad \textbf{(16)}$$

in which d_{ij} is an indicator equal to 1 if the j^{th} method is chosen by the i^{th}woman, and π_{ij} is given in equation 15. I estimate the results using the *asclogit* command in Stata16 with robust standard errors clustered at the woman-level.

While analyzing the results in models with alternative-specific constants is helpful for studying the differences in utility of the contraceptive alternatives, why women choose their method could be better explained by studying the features of those methods. Viewing a method as a bundle of attributes may be more helpful for understanding why a method is a more or less attractive option. Thus, rather than representing the method with a method-specific constant α_j, I model each method as a linear function of a set of its attributes and rewrite the utility function as:

$$U_{ij} = \delta_p p_{ij} + Z_{ij}\theta + \nu_{ij} \tag{17}$$

In which δ_p is a scalar that indicates the effect of price on utility. Z_{ij} contains the set of non-price attributes (if the method is hormonal, if the method requires the insertion of a device, the risk reduction of pregnancy based on the typical use failure rates, and the maximum duration of use) and the interactions of those attributes with the characteristics of individual women in X_i to allow the utility of the attributes to vary by a woman's characteristics. ν_{ij} is the idiosyncratic error term. I again assume that the error terms are independent across i and j and follow a type 1 extreme value distribution and that women choose a contraceptive method to maximize their utility. The choice probabilities then have a convenient logit form as they did above:

$$\pi_{ij}(Y_i = j) = \frac{\exp\{\delta_p p_{ij} + Z_j\theta\}}{\sum_{k=1}^{7} \exp\{\delta_p p_{ik} + Z_k\theta\}} \tag{18}$$

As in the alternative-specific case, I estimate the results using maximum likelihood estimation, with log-likelihood:

$$LL = \sum_{i=1}^{n}\sum_{j=1}^{7} d_{ij}\log(\pi_{ij}) \tag{19}$$

in which π_{ij} is defined in equation 18. I estimate the results using *clogit* commands in Stata16 with robust standard errors clustered at the woman-level.

4.5 Results

Before estimating my main specification of the model with alternative-specific constants, I estimate a simplified version without the individual characteristics and report the results in Table 24. As there may be differences in how women value contraceptive attributes by race and ethnicity (Jackson et al. 2016), I stratify the results in rows 2 through 4.

Overall, contraceptives are associated with a negative effect on utility compared to not using a method. In the stratified results, the only exceptions to this pattern are that women who are not Black or Hispanic find hormonal IUDs and SARCs to have a positive effect on utility compared to no method. The coefficient on price is negative across specifications, with women who are not Black or Hispanic exhibiting a greater sensitivity to price. For most methods, non-Hispanic Black women find disutility of using a method compared to no method. The negative results across many contraceptives imply that many women would not want to use contraception compared to nonuse. Indeed, nonuse of a method is the most common choice observed in the data, with SARC use as a close second. However, as many women choose to use other forms of contraception, it is likely that there is variation in the utility of methods across women that can be better explored by including the effects of women's socio-demographic characteristics.

Table 24. Contraceptive Choice Logistic Regression Results

	Price ($10)	Implant	Non-Hormonal IUD	Hormonal IUD	SARC	Condoms	Traditional
All Women	-0.116***	-1.162***	-0.933***	-0.0108	0.191***	-0.390***	-1.181***
	(0.009)	(0.078)	(0.078)	(0.060)	(0.035)	(0.036)	(0.044)
Non-Hispanic Black	-0.0781***	-1.458***	-2.110***	-0.923***	-0.121*	-0.564***	-1.507***
	(0.017)	(0.137)	(0.187)	(0.125)	(0.068)	(0.073)	(0.098)
Hispanic	-0.0753***	-1.123***	-0.738***	-0.237**	-0.219***	-0.388***	-1.226***
	(0.013)	(0.141)	(0.126)	(0.115)	(0.074)	(0.069)	(0.089)
Non-Hispanic White or Other Race	-0.163***	-1.010***	-0.492***	0.588***	0.504***	-0.297***	-1.018***
	(0.014)	(0.126)	(0.108)	(0.083)	(0.048)	(0.051)	(0.060)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 (row 1), 1,676 (row 2), 1,778 (row 3), and 4,033 (row 4) women between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. Base alternative is no method use. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010

In Table 25 I report the results of a model that includes individual characteristics. The coefficients on the alternative-specific constants are statistically significant and negative, except for SARC use, which remains positive. The magnitudes of the alternative-specific constants across LARC methods increase after including the individual characteristics.

The estimates indicate that being young increases the likelihood that a woman chooses implants, SARCs, and condoms. Across methods, age is negatively related to the utility of contraception compared to nonuse, perhaps due to reduced fecundity with age. Women with children receive more utility from LARCs compared to women without children. As should be expected, not wanting children in the future increases the utility of contraceptive use. Thus, even though the coefficients on many of the alternative-specific constants are negative, there are variations in the effect on utility of methods by observable characteristics which may result in the observable portion of utility being positive for individual women. For example, the alternative-specific coefficient for non-hormonal IUD use is negative (as it was in the simple model in Table 24), but a working mother of two children who is limiting fertility might find using this method as a better option than choosing to forgo contraception.

Table 25. Contraceptive Choice Logistic Regression Results with Women's Characteristics

Price ($10)	-0.127***					
	(0.011)					
Alternative Specific Constant	Implant	Non-hormonal IUD	Hormonal IUD	SARC	Condoms	Traditional
	-1.728***	-1.820***	-1.267***	0.366*	-0.541**	-1.936***
	(0.595)	(0.484)	(0.351)	(0.213)	(0.240)	(0.312)
Individual Characteristics						
Age						
19-23	0.625***	0.0672	0.0376	0.435***	0.207*	0.0706
	(0.193)	(0.228)	(0.159)	(0.098)	(0.114)	(0.151)
29-33	-1.273***	-0.252	-0.432***	-0.350***	-0.276***	-0.194
	-0.247	-0.188	-0.13	-0.094	-0.104	-0.13
34-38	-1.986***	-0.607***	-0.975***	-0.735***	-0.550***	-0.537***
	(0.344)	(0.216)	(0.244)	(0.108)	(0.116)	(0.147)
39-44	-1.849***	-0.975***	-1.279***	-1.274***	-0.872***	-0.558***
	(0.355)	(0.244)	(0.164)	(0.123)	(0.128)	(0.157)
Black	-0.282	-1.105***	-0.934***	-0.414***	-0.074	-0.410***
	(0.175)	(0.198)	(0.127)	(0.082)	(0.089)	(0.122)
Hispanic	0.299*	0.318**	-0.165	-0.335***	0.0375	-0.240**
	(0.178)	(0.151)	(0.116)	(0.085)	(0.090)	(0.117)
Married	-0.281	0.0219	-0.0208	-0.405***	0.095	0.272***
	(0.205)	(0.157)	(0.113)	(0.081)	(0.082)	(0.104)
Income	0.0537*	0.0987***	0.115***	0.0615***	0.0196	0.0373**
	(0.030)	(0.025)	(0.018)	(0.012)	(0.014)	(0.017)
Working	0.547***	0.427***	0.679***	0.211***	-0.082	0.191*
	(0.163)	(0.152)	(0.112)	(0.074)	(0.079)	(0.101)
Greater than HS	0.0412	0.591***	0.629***	0.383***	0.319***	0.115
	(0.228)	(0.170)	(0.116)	(0.077)	(0.085)	(0.110)

Table 25 Continued

Number of children						
1	0.257	0.390*	0.577***	-0.223***	-0.145	0.296**
	(0.209)	(0.208)	(0.137)	(0.085)	(0.097)	(0.122)
2	0.574**	0.934***	0.919***	-0.0251	0.0371	0.525***
	(0.243)	(0.213)	(0.149)	(0.099)	(0.109)	(0.133)
3+	0.687**	0.690***	0.688***	-0.253**	-0.0469	0.441***
	(0.287)	(0.253)	(0.176)	(0.122)	(0.130)	(0.156)
Limiting fertility	0.636***	0.793***	1.019***	0.677***	0.606***	0.256**
	(0.190)	(0.155)	(0.111)	(0.084)	(0.090)	(0.110)
Condition	-0.185	-1.075***	-0.353***	-0.534***	-0.537***	-0.330***
	(0.210)	(0.230)	(0.120)	(0.082)	(0.095)	(0.116)
Usual care	0.142	0.111	0.148	0.359***	-0.00293	-0.285**
	(0.211)	(0.191)	(0.137)	(0.093)	(0.093)	(0.115)
Place of residence						
Metropolitan	-0.141	0.174	0.112	-0.207**	0.168	0.528***
	(0.220)	(0.220)	(0.152)	(0.100)	(0.116)	(0.161)
Suburban	-0.427*	0.142	0.21	-0.169*	0.125	0.520***
	(0.225)	(0.217)	(0.148)	(0.098)	(0.115)	(0.159)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Base alternative is no method use. Includes set of year controls. Base category for age is 24-28, zero for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

I next move to models that include specific attributes of the choices rather than the alternative-specific constants. In Table 26 I report the results of a simplified model without individual characteristics. Like Table 25, the effect of price is negative. Being a device has a negative effect on utility, and this result holds when stratified by race and ethnicity. Women find being a hormonal method as positive feature, and the effect on utility is greater for women who are not Black or Hispanic. Interestingly, reduction in pregnancy risk is also negative, perhaps due to the inclusion of non-contracepting women who make up over a quarter of the sample.

Being a device is estimated to have a negative effect on utility compared to not using a method. This effect is greater for older women compared to women ages 25-28. Women with higher incomes and who are married find less disutility from devices than other women. The coefficients on number of children (1, 2, or 3+ compared to none) are also positive.

Again, the coefficient on the reduction of the risk of pregnancy is negative and significant. I have included women who are not currently contracepting in my main analytical sample as almost half of unintended pregnancies are among women who are not contracepting (Sonfield et al., 2014). However, among women who are not using a methods may be women who are ambivalent about pregnancy, actively trying to become pregnant, and not currently sexually active, and therefore gain no utility or perhaps some disutility from increased fertility control, which may explain the negative coefficient. Because of these concerns, I reestimate the model on the sample of women who are currently using a contraceptive. Table 28 reports these results

Table 26. Contraceptive Attributes Conditional Logistic Regression Results

	Price	Hormonal	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
All Women	-0.109***	1.084***	-1.169***	-1.157***	0.138***
	(0.008)	(0.036)	(0.068)	(0.050)	(0.011)
Non-Hispanic Black	-0.0709***	0.996***	-1.126***	-1.452***	0.0393
	(0.014)	(0.075)	(0.158)	(0.101)	(0.027)
Hispanic	-0.0721***	0.679***	-0.802***	-1.146***	0.113***
	(0.011)	(0.076)	(0.142)	(0.098)	(0.021)
Non-Hispanic White or Other Race	-0.154***	1.285***	-1.162***	-1.015***	0.175***
	(0.012)	(0.049)	(0.090)	(0.071)	(0.014)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 (row 1), 1,676 (row 2), 1,778 (row 3), and 4,033 (row 4) women between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010

In Table 27 I present the results of the attributes with interactions with individual characteristics. Like Table 26, contraceptive options that require the insertion of a device (i.e., LARCs) have negative effects on utility, as does the reduction in pregnancy risk. Hormonal methods have a positive effect, but the coefficient on maximum duration of use is no longer statistically significant.

The lower portion of the table reports the estimates of the relationship between utility and the individual characteristics interacted with the attributes. The estimates suggest that women who are older, Black, Hispanic, married, or who have large families prefer non-hormonal methods if any, while woman with higher income levels find hormonal methods more attractive. Women who are Black and married experience disutility from methods with longer durations of use.

Table 27. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.119***	1.342***	-1.692***	-1.458***	0.0503
Interactions	(0.00851)	(0.235)	(0.376)	(0.334)	(0.066)
Age group					
19-23		0.208**	0.0873	0.311*	-0.0347
		(0.106)	(0.233)	(0.165)	(0.038)
29-33		-0.0496	-0.572***	-0.403***	0.0609**
		(0.102)	(0.198)	(0.148)	(0.029)
34-38		-0.103	-0.592**	-0.849***	0.0548
		(0.117)	(0.230)	(0.166)	(0.034)
39-44		-0.397***	-0.228	-1.164***	-5.42E-05
		(0.132)	(0.261)	(0.180)	(0.039)
Black		-0.259***	0.175	-0.216*	-0.109***
		(0.091)	(0.191)	(0.128)	(0.030)
Hispanic		-0.302***	0.329*	-0.0443	-0.00314
		(0.091)	(0.175)	(0.128)	(0.025)
Married		-0.573***	0.582***	0.244**	-0.0784***
		(0.084)	(0.169)	(0.118)	(0.025)
Income		0.241***	0.402**	-0.0365	0.0065
		(0.079)	(0.167)	(0.112)	(0.025)
Working		0.107	0.000631	0.378***	0.0356
		(0.084)	(0.175)	(0.122)	(0.026)
Greater than HS		0.0333***	0.0425	0.0366*	0.00364
		(0.013)	(0.026)	(0.019)	(0.004)
Number of children					
1		-0.132	0.671***	-0.0809	-0.00931
		(0.095)	(0.214)	(0.136)	(0.033)
2		-0.137	0.724***	0.194	0.0142
		(0.106)	(0.227)	(0.155)	(0.034)
3+		-0.271**	0.942***	0.0808	-0.0215
		(0.130)	(0.272)	(0.182)	(0.040)
Limiting fertility		0.149*	0.135	0.724***	0.0131
		(0.087)	(0.167)	(0.129)	(0.024)

Table 27 Continued

Condition	0.0426	0.655***	-0.746***	-0.0855***
	(0.097)	(0.191)	(0.131)	(0.030)
Usual Care	0.466***	-0.434**	-0.152	0.0647**
	(0.098)	(0.209)	(0.131)	(0.030)
Place of Residence				
Metropolitan	-0.500***	0.447*	0.411**	-0.0541
	(0.114)	(0.235)	(0.167)	(0.036)
Suburban	-0.403***	0.305	0.339**	-0.0342
	(0.113)	(0.226)	(0.165)	(0.035)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, zero for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Being a device is estimated to have a negative effect on utility compared to not using a method. This effect is greater for older women compared to women ages 25-28. Women with higher incomes and who are married find less disutility from devices than other women. The coefficients on number of children (1, 2, or 3+ compared to none) are also positive.

Again, the coefficient on the reduction of the risk of pregnancy is negative and significant. I have included women who are not currently contracepting in my main analytical sample as almost half of unintended pregnancies are among women who are not contracepting (Sonfield et al., 2014). However, among women who are not using a methods may be women who are ambivalent about pregnancy, actively trying to become pregnant, and not currently sexually active, and therefore gain no utility or perhaps some disutility from increased fertility control, which may explain the negative coefficient. Because of these concerns, I reestimate the model on the sample of women who are currently using a contraceptive. Table 28 reports these results.

Table 28. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions Among Women Using Contraception

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
Interactions	-0.127***	-1.601**	-2.689***	26.14***	-0.339***
	(0.010)	(0.678)	(0.413)	(5.599)	(0.113)
Age					
19-23		-0.238	-0.128	4.863*	-0.0883*
		(0.317)	(0.246)	(2.787)	(0.053)
29-33		0.0386	-0.538**	-1.239	0.0723
		(0.296)	(0.218)	(2.479)	(0.047)
34-38		-0.301	-0.660**	1.043	0.0273
		(0.342)	(0.257)	(2.849)	(0.053)
39-44		-0.417	-0.309	-1.074	0.00107
		(0.383)	(0.290)	(3.168)	(0.061)
Black		-1.222***	-0.255	8.961***	-0.237***
		(0.262)	(0.207)	(2.286)	(0.042)
Hispanic		-0.965***	0.023	6.749***	-0.0987**
		(0.261)	(0.194)	(2.223)	(0.041)
Married		-0.424*	0.537***	-1.114	-0.057
		(0.244)	(0.189)	(2.047)	(0.039)
Working		1.021***	0.674***	-7.515***	0.119***
		(0.230)	(0.182)	(1.964)	(0.037)
Great than HS		0.0971	0.00115	0.553	0.0358
		(0.250)	(0.192)	(2.112)	(0.040)
Income		0.0974**	0.0591**	-0.578*	0.0129**
		(0.039)	(0.029)	(0.330)	(0.006)
Number of children					
1		1.366***	1.115***	-13.93***	0.203***
		(0.288)	(0.224)	(2.449)	(0.047)
2		1.684***	1.241***	-16.30***	0.271***
		(0.316)	(0.241)	(2.642)	(0.051)

Table 28 Continued

3+	1.457***	1.434***	-15.55***	0.221***
	(0.379)	(0.289)	(3.143)	(0.061)
Limiting fertility	0.171	0.136	0.92	0.0163
	(0.256)	(0.183)	(2.108)	(0.040)
Condition	0.44	0.745***	-4.492*	-0.027
	(0.286)	(0.211)	(2.388)	(0.046)
Usual Care	0.139	-0.509**	3.127	0.0159
	(0.267)	(0.227)	(2.273)	(0.044)
Place of Residence				
Metropolitan	0.235	0.700***	-6.578**	0.0465
	(0.340)	(0.257)	(2.955)	(0.055)
Suburban Area	0.484	0.615**	-8.068***	0.0884
	(0.339)	(0.250)	(2.936)	(0.054)

Contracepting women only. Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 5,327 women between the ages of 19 - 44 who are not pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured during the past 12 months. Greater than HS indicates greater than high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, zero for number of children and rural for place of residence. Standard errors (clustered at woman-level) in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

The contraceptive being a device and having a longer maximum duration of use both have negative effects on utility (which is less negative for women with children), however the sign on pregnancy risk reduction has now reversed and becomes quite a bit larger. Mothers place a lower value on effectiveness, which may reflect a higher cost for women transitioning into motherhood compared to having additional children. Interestingly, the main effect from the use of hormonal methods has become negative, though hormonal methods are now a better match for women with children.

In Table 29 I present the average predicted probabilities by method for both of my models. Due to the inclusion of alternative-specific constants, the average predicted probabilities for the alternatives models perfectly match the distribution of observed choices (Cameron & Trivedi, 2009).

Table 29. Average Predicted Probabilities of Contraceptive Choice

Method	Observed Percentage	Predicted (Alternatives)	Predicted (Attributes)
LARC (Any)	16.36	16.36	16.36
Implant	2.93	2.93	5.05
Non-Hormonal IUD	3.82	3.82	4.66
Hormonal IUD	9.62	9.62	6.65
SARC	28.33	28.33	29.17
Condoms	17.60	17.60	11.92
Traditional	8.86	8.86	13.97
No Method	28.85	28.85	28.58

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 women between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months.
* p<0.10, ** p<0.05, *** p<0.010

For the attributes model, the average predicted probability of any LARC use matches the proportion of women who choose LARC, but the distribution of type of LARC differs. The predicted probabilities for implants and non-hormonal IUDs are higher than those observed, and the predicted probabilities for hormonal IUDs are low. The biggest differences between the predicted probabilities and the observed distribution of choices come from condoms and traditional methods, both being over 5 percentage points off, but in opposite directions.

4.5.1 Sensitivity Analyses

As is always the case, I made a number of choices and restrictions during my analysis. To assess the restrictiveness of these decisions, I estimated a series of models that change different assumptions. Specifically, I focus on the inclusion of the price variable, the decision to restrict the analysis to women who were sexually active at least 25% of the year, possible differential use by women who have children, and the decision to use typical failure rates rather than perfect use failure rates.

In my primary specification, I use the price variable I constructed based on average out-of-pocket expenditures in the literature and the woman's insurance status. While the attributes of the contraceptives may account for some differences in prices between the methods (and thus there may be less of a concern about unobserved quality), it is possible that other factors may endogenize price. Examples of such factors could include attributes not considered (like STI protections), partner preferences, and supply-side barriers and changes in access that may be related to the contraceptive method. In order to check the robustness of my estimates, I reestimate my primary specifications for both the alternatives and the attributes, excluding price and adding insurance status as an individual characteristic. I present these results in Tables 30 and 31. In Table 30, the alternative-specific constants on LARC methods are negative, and the coefficients have increased in magnitude. In Table 31, the main effect of "device" is still statistically significantly negative and even larger than it was in the primary specification.

Next, I explore the implication of my assumption to limit my sample to women who were sexually active at least 25% of the year. I test this assumption in two ways. First, by restricting the sample further to women who reported being sexually active the entire year, and second by relaxing the assumption and including all women regardless of reported sexual activity. Results from the alternative-specific model with characteristics for women who are sexually active the entire year and regardless of sexual activity are reported in Tables 32 and 33, respectively.

Table 30. Contraceptive Choice Logistic Regression Results with Women's Characteristics: Insurance Status

Price ($10)	--					
Alternative Specific Constant	Implant	Non-hormonal IUD	Hormonal IUD	SARC	Condoms	Traditional
	-3.475***	-3.736***	-3.300***	-0.091	-0.554**	-1.783***
	(0.561)	(0.472)	(0.343)	(0.214)	(0.244)	(0.316)
Individual Characteristics						
Age						
19-23	0.764***	0.212	0.16	0.453***	0.217*	0.0898
	(0.190)	(0.226)	(0.153)	(0.098)	(0.114)	(0.152)
29-33	-1.345***	-0.345*	-0.528***	-0.364***	-0.283***	-0.203
	-0.24	-0.184	-0.127	-0.0934	-0.104	-0.13
34-38	-2.221***	-0.893***	-1.350***	-0.775***	-0.565***	-0.568***
	(0.344)	(0.214)	(0.247)	(0.107)	(0.116)	(0.147)
39-44	-2.192***	-1.350***	-1.663***	-1.335***	-0.895***	-0.601***
	(0.353)	(0.247)	(0.164)	(0.123)	(0.128)	(0.158)
Black	-0.14	-0.910***	-0.765***	-0.368***	-0.0617	-0.378***
	(0.180)	(0.197)	(0.126)	(0.081)	(0.089)	(0.122)
Hispanic	0.2	0.221	-0.214*	-0.379***	0.013	-0.268**
	(0.178)	(0.148)	(0.113)	(0.084)	(0.091)	(0.118)
Married	-0.463**	-0.25	-0.326***	-0.461***	0.073	0.234**
	(0.202)	(0.159)	(0.113)	(0.080)	(0.082)	(0.105)
Income	0.00703	0.0321	0.0376**	0.0458***	0.014	0.0273
	(0.030)	(0.025)	(0.018)	(0.013)	(0.014)	(0.018)
Working	0.338**	0.202	0.400***	0.121	-0.118	0.135
	(0.159)	(0.147)	(0.110)	(0.075)	(0.081)	(0.103)
Greater than HS	-0.0329	0.457***	0.449***	0.337***	0.303***	0.086
	(0.227)	(0.164)	(0.109)	(0.078)	(0.087)	(0.113)
Number of children						
1	0.839***	0.969***	1.176***	-0.126	-0.104	0.363***
	(0.214)	(0.214)	(0.140)	(0.086)	(0.098)	(0.124)
2	1.194***	1.621***	1.649***	0.0718	0.0722	0.589***
	(0.242)	(0.222)	(0.151)	(0.099)	(0.110)	(0.135)

Table 30 Continued

3+	1.392***	1.532***	1.553***	-0.118	0.00316	0.535***
	(0.271)	(0.242)	(0.163)	(0.108)	(0.121)	(0.151)
Limiting fertility	0.691***	0.849***	1.075***	0.679***	0.606***	0.263**
	(0.186)	(0.152)	(0.108)	(0.083)	(0.090)	(0.109)
Condition	-0.209	-1.112***	-0.389***	-0.538***	-0.541***	-0.331***
	(0.202)	(0.228)	(0.118)	(0.082)	(0.095)	(0.116)
Usual care	0.451**	0.318*	0.252*	0.424***	0.0339	-0.230*
	(0.204)	(0.191)	(0.132)	(0.093)	(0.096)	(0.119)
Place of residence						
Metropolitan	0.0121	0.282	0.213	-0.182*	0.18	0.547***
	(0.209)	(0.215)	(0.145)	(0.099)	(0.117)	(0.161)
Suburban	-0.337	0.181	0.250*	-0.15	0.139	0.530***
	(0.218)	(0.212)	(0.142)	(0.097)	(0.116)	(0.159)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Base alternative is no method use. Includes set of year controls. Base category for age is 24-28, zero for number of children and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses.

* p<0.10, ** p<0.05, *** p<0.010

Table 31. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions: Insurance Status

Attribute	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	—	0.724***	-2.594***	-1.308***	-0.0693
Interactions		(0.242)	(0.378)	(0.339)	(0.066)
Age					
19-23		0.208**	0.135	0.330**	-0.0315
		(0.106)	(0.226)	(0.164)	(0.038)
29-33		-0.0602	-0.583***	-0.408***	0.0572**
		(0.102)	(0.192)	(0.148)	(0.029)
34-38		-0.126	-0.674***	-0.873***	-0.00632
		(0.117)	(0.225)	(0.165)	(0.038)
39-44		-0.430***	-0.394	-1.196***	-0.00632
		(0.132)	(0.256)	(0.180)	(0.038)
Black		-0.236***	0.328*	-0.188	-0.110***
		(0.091)	(0.188)	(0.127)	(0.030)
Hispanic		-0.290***	0.305*	-0.0978	-0.0978
		(0.092)	(0.171)	(0.130)	(0.130)
Married		-0.600***	0.399**	0.211*	-0.0846***
		(0.084)	(0.168)	(0.118)	(0.025)
Working		0.199**	0.239	-0.098	0.00543
		(0.081)	(0.161)	(0.115)	(0.024)
Greater than HS		0.0671	-0.0933	0.360***	0.0279
		(0.086)	(0.166)	(0.125)	(0.025)
Income		0.0222*	-0.0129	0.0293	0.00164
		(0.013)	(0.026)	(0.020)	(0.004)
Number of children					
1		-0.0838	1.242***	-0.0232	-0.0143
		(0.097)	(0.216)	(0.138)	(0.034)
2		-0.077	1.382***	0.244	0.0109
		(0.107)	(0.230)	(0.155)	(0.035)
3+		-0.195	1.661***	0.155	-0.0186
		(0.132)	(0.272)	(0.184)	(0.041)

Table 31 Continued

Limiting fertility	0.147*	0.199	0.725***	0.0123
	(0.087)	(0.162)	(0.129)	(0.024)
Condition	0.0434	0.593***	-0.751***	0.0123
	(0.097)	(0.184)	(0.131)	(0.024)
Usual care	0.445***	-0.315	-0.0677	0.0639**
	(0.100)	(0.204)	(0.135)	(0.030)
Area of residence				
Metropolitan	-0.499***	0.520**	0.438***	-0.0557
	(0.115)	(0.222)	(0.167)	(0.035)
Suburban	-0.405***	0.337	0.364**	-0.0365
	(0.113)	(0.214)	(0.165)	(0.034)
Insurance				
Private Insurance	0.630***	-0.530**	-0.216	0.0978***
	(0.111)	(0.233)	(0.153)	(0.035)
Public Insurance	0.478***	-0.0996	-0.544***	0.0407
	(0.122)	(0.250)	(0.165)	(0.037)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, zero for number of children, rural for place of residence, and no insurance in the last year for insurance. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010

Table 32. Contraceptive Choice Logistic Regression Results with Women's Characteristics: Sexually Active Women

Price ($10)	-0.157***					
	(0.016)					
Alternative Specific Constant	Implant	Non-hormonal IUD	Hormonal IUD	SARC	Condoms	Traditional
	-1.168	-1.168	-0.988*	-0.880*	0.716**	-0.0391
	(0.741)	(0.741)	(0.597)	(0.484)	(0.310)	(0.315)
Individual Characteristics						
Age						
19-23	0.906***	0.315	0.0746	0.654***	0.319*	0.17
	(0.273)	(0.294)	(0.234)	(0.152)	(0.167)	(0.209)
29-33	-1.307***	-0.407*	-0.639***	-0.429***	-0.290**	-0.285*
	-0.322	-0.241	-0.175	-0.133	-0.137	-0.166
34-38	-2.293***	-0.422	-1.357***	-0.750***	-0.551***	-0.682***
	(0.474)	(0.270)	(0.301)	(0.150)	(0.151)	(0.186)
39-44	-2.259***	-1.357***	-1.694***	-1.668***	-1.203***	-1.006***
	(0.443)	(0.301)	(0.216)	(0.172)	(0.167)	(0.196)
Black	-0.323	-1.234***	-0.811***	-0.432***	-0.074	-0.611***
	(0.242)	(0.272)	(0.175)	(0.121)	(0.121)	(0.163)
Hispanic	0.308	0.341*	0.109	-0.137	0.143	-0.166
	(0.235)	(0.195)	(0.154)	(0.120)	(0.120)	(0.150)
Married	-0.658**	-0.452**	-0.353**	-0.888***	-0.460***	-0.290**
	(0.261)	(0.196)	(0.151)	(0.112)	(0.108)	(0.133)
Income	0.0712*	0.133***	0.134***	0.0646***	0.0163	0.0409*
	(0.043)	(0.031)	(0.025)	(0.017)	(0.018)	(0.021)
Working	0.720***	0.27	0.597***	0.199*	-0.0571	0.249*
	(0.229)	(0.190)	(0.147)	(0.105)	(0.106)	(0.129)
Greater than HS	0.499*	0.779***	0.923***	0.627***	0.579***	0.331**
	(0.299)	(0.219)	(0.155)	(0.107)	(0.111)	(0.139)
Number of children						
1	0.00449	0.31	0.557***	-0.156	-0.00923	0.493***
	(0.275)	(0.262)	(0.185)	(0.120)	(0.126)	(0.155)
2	0.680**	1.062***	1.166***	0.137	0.240*	0.744***
	(0.313)	(0.263)	(0.196)	(0.138)	(0.143)	(0.172)

Table 32 Continued

3+	0.675*	0.689**	0.696***	-0.349**	0.0608	0.680***
	(0.363)	(0.312)	(0.233)	(0.169)	(0.165)	(0.193)
Limiting fertility	1.200***	1.111***	1.599***	1.209***	1.056***	0.713***
	(0.262)	(0.194)	(0.155)	(0.125)	(0.126)	(0.145)
Condition	-0.324	-1.136***	-0.604***	-0.708***	-0.646***	-0.476***
	(0.288)	(0.270)	(0.161)	(0.114)	(0.118)	(0.145)
Usual care	-0.216	0.047	0.324*	0.246*	-0.108	-0.347**
	(0.271)	(0.241)	(0.191)	(0.132)	(0.124)	(0.149)
Place of residence						
Metropolitan	0.314	0.271	0.215	-0.0339	0.266*	0.609***
	(0.328)	(0.280)	(0.206)	(0.141)	(0.152)	(0.195)
Suburban	0.0373	0.3	0.367*	0.0166	0.306**	0.558***
	(0.327)	(0.271)	(0.198)	(0.137)	(0.148)	(0.191)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 4,477 between the ages of 19 and 44 who are not currently pregnant or postpartum, not relying on sterilization, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Base alternative is no method use. Includes set of year controls. Base category for age is 24-28, zero for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010

Table 33. Contraceptive Choice Logistic Regression Results with Women's Characteristics: No Restrictions on Sexual Activity

Price ($10)	-0.130***					
	(0.011)					
Alternative Specific Constant	Implant	Non-hormonal IUD	Hormonal IUD	SARC	Condoms	Traditional
	-2.568***	-2.903***	-2.331***	-0.549***	-1.498***	-2.859***
	(0.558)	(0.443)	(0.327)	(0.178)	(0.220)	(0.296)
Individual Characteristics						
Age						
19-23	-0.228	-0.878***	-0.848***	-0.305***	0.0432	-0.293**
	(0.162)	(0.181)	(0.115)	(0.068)	(0.081)	(0.117)
29-33	0.135	0.369***	-0.223**	-0.403***	0.00307	-0.254**
	(0.168)	(0.141)	(0.106)	(0.073)	(0.082)	(0.112)
34-38	0.186	0.496***	0.431***	0.0889	0.726***	0.901***
	(0.196)	(0.150)	(0.106)	(0.072)	(0.077)	(0.100)
39-44	0.0745***	0.104***	0.124***	0.0623***	0.0255**	0.0441***
	(0.027)	(0.023)	(0.017)	(0.010)	(0.012)	(0.016)
Black	0.535***	0.437***	0.725***	0.266***	-0.04	0.223**
	(0.151)	(0.143)	(0.103)	(0.062)	(0.071)	(0.096)
Hispanic	-0.016	0.610***	0.565***	0.279***	0.201***	-0.0025
	(0.207)	(0.162)	(0.106)	(0.065)	(0.078)	(0.105)
Married	-0.228	-0.878***	-0.848***	-0.305***	0.0432	-0.293**
	(0.162)	(0.181)	(0.115)	(0.068)	(0.081)	(0.117)
Income	0.135	0.369***	-0.223**	-0.403***	0.00307	-0.254**
	(0.168)	(0.141)	(0.106)	(0.073)	(0.082)	(0.112)
Working	0.186	0.496***	0.431***	0.0889	0.726***	0.901***
	(0.196)	(0.150)	(0.106)	(0.072)	(0.077)	(0.100)
Greater than HS	0.0745***	0.104***	0.124***	0.0623***	0.0255**	0.0441***
	(0.027)	(0.023)	(0.017)	(0.010)	(0.012)	(0.016)
Number of children						
1	0.679***	0.905***	1.008***	0.183**	0.311***	0.726***
	(0.196)	(0.201)	(0.128)	(0.073)	(0.091)	(0.119)
2	1.013***	1.408***	1.339***	0.343***	0.488***	0.960***
	(0.226)	(0.205)	(0.137)	(0.086)	(0.101)	(0.128)

Table 33 Continued

3+	1.133***	1.261***	1.203***	0.229**	0.491***	0.945***
	(0.271)	(0.242)	(0.163)	(0.108)	(0.121)	(0.151)
Limiting fertility	0.636***	0.793***	1.019***	0.677***	0.606***	0.256**
	0.329*	0.590***	0.744***	0.367***	0.304***	-0.00817
Condition	(0.174)	(0.143)	(0.099)	(0.068)	(0.079)	(0.101)
	-0.0175	-0.669***	-0.148	-0.184***	-0.335***	-0.131
Usual care	(0.195)	(0.203)	(0.112)	(0.070)	(0.090)	(0.113)
	0.109	0.211	0.191	0.422***	-0.00594	-0.287***
Place of residence						
Metropolitan	(0.193)	(0.183)	(0.126)	(0.079)	(0.084)	(0.108)
	-0.133	0.19	0.145	-0.148*	0.188*	0.531***
Suburban	(0.200)	(0.210)	(0.139)	(0.084)	(0.108)	(0.156)
	-0.534**	0.134	0.165	-0.162*	0.101	0.493***
	(0.208)	(0.206)	(0.135)	(0.083)	(0.107)	(0.154)

Data from 201-2013, 2013-2015 and 2015-2017 NSFG. N = 9,594 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Base alternative is no method use. Includes set of year controls. Base category for age is 24-28, zero for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses.

* p<0.10, ** p<0.05, *** p<0.010

In Table 32, the alternative-specific constants of hormonal IUDs and SARCs are negative and statistically significant. The coefficients are negative for implants, non-hormonal IUDs, and traditional methods but the results are not precise. Condoms are now associated with a positive effect on utility. In Table 33, all alternative-specific constants are negative. In both tables, limiting fertility increases the utility of using any method.

The results of the attributes with interactions for women who are sexually active the entire year and women regardless of sexual activity are in Tables 34 and 35, respectively. The main result—that being a device decreases the utility of a method—remains regardless of sexual activity. Among women who are sexually active the entire year, the coefficient on the main effect of reduction in the risk of pregnancy is not statistically different from zero, with women who are young, more educated, and limiting fertility preferring methods with more protection. In both tables, having children increases the likeliness of using a contraceptive device.

Table 34. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions: Sexually Active Women

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.146***	1.049***	-2.005***	-0.613	0.108
Interactions	(0.012)	(0.297)	(0.482)	(0.455)	(0.078)
Age group					
19-23		0.284**	-0.111	0.503**	-0.0108
		(0.138)	(0.305)	(0.250)	(0.048)
29-33		-0.104	-0.527**	-0.444**	0.0446
		(0.126)	(0.243)	(0.201)	(0.035)
34-38		-0.119	-0.900***	-0.876***	0.0967**
		(0.142)	(0.286)	(0.221)	(0.040)
39-44		-0.380**	-0.141	-1.719***	0.00154
		(0.162)	(0.311)	(0.240)	(0.044)
Black		-0.191	0.26	-0.314*	-0.111***
		(0.118)	(0.239)	(0.180)	(0.037)
Hispanic		-0.186*	0.295	0.0816	-0.00182
		(0.112)	(0.210)	(0.176)	(0.030)
Married		-0.377***	0.736***	-0.652***	-0.0615**
		(0.103)	(0.205)	(0.160)	(0.029)
Income		0.0368**	0.0387	0.0354	0.00673
		(0.017)	(0.033)	(0.026)	(0.004)
Working		0.196**	0.534***	0.00817	-0.0226
		(0.100)	(0.207)	(0.154)	(0.030)
Greater than HS		0.0653	0.151	0.767***	0.00851
		(0.105)	(0.218)	(0.162)	(0.031)
Number of children					
1		-0.239**	0.546**	0.156	-0.0234
		(0.118)	(0.267)	(0.183)	(0.041)
2		-0.188	0.767***	0.494**	-0.00027
		(0.129)	(0.278)	(0.208)	(0.041)
3+		-0.510***	1.152***	0.303	-0.0609
		(0.156)	(0.330)	(0.237)	(0.048)

Table 34 Continued

Limiting fertility	0.17	0.192	1.415***	-0.0138
	(0.111)	(0.207)	(0.183)	(0.029)
Condition	0.00238	0.564**	-0.926***	-0.0749**
	(0.120)	(0.247)	(0.168)	(0.037)
Usual Care	0.508***	-0.383	-0.332*	0.0785**
	(0.123)	(0.272)	(0.181)	(0.038)
Place of residence				
Metropolitan	-0.448***	0.463	0.574***	-0.0684
	(0.142)	(0.292)	(0.222)	(0.043)
Suburban	-0.385***	0.368	0.570***	-0.05
	(0.139)	(0.278)	(0.216)	(0.041)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 4,477 between the ages of 19 and 44 who are not currently pregnant or postpartum, not relying on sterilization, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, and zero for number of children and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010

Table 35. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions: No Restrictions on Sexual Activity

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.122***	1.509***	-1.522***	-2.902***	0.0428
Interactions	(0.008)	(0.228)	(0.361)	(0.297)	(0.063)
Age group					
19-23		0.250**	0.0927	-0.00278	-0.0269
		(0.104)	(0.228)	(0.143)	(0.038)
29-33		-0.0111	-0.436**	-0.455***	0.0479*
		(0.100)	(0.191)	(0.136)	(0.029)
34-38		-0.0451	-0.437**	-1.032***	0.0517
		(0.113)	(0.221)	(0.151)	(0.033)
39-44		-0.324**	-0.136	-1.426***	0.00932
		(0.126)	(0.245)	(0.161)	(0.037)
Black		-0.293***	0.0796	-0.0246	-0.0970***
		(0.088)	(0.182)	(0.115)	(0.029)
Hispanic		-0.340***	0.23	-0.0842	0.0118
		(0.089)	(0.169)	(0.115)	(0.025)
Married		-0.825***	0.634***	1.237***	-0.115***
		(0.083)	(0.163)	(0.109)	(0.024)
Income		0.0272**	0.0549**	0.0460***	0.00184
		(0.012)	(0.025)	(0.017)	(0.004)
Working		0.253***	0.370**	0.0223	0.00888
		(0.076)	(0.160)	(0.100)	(0.024)
Greater than HS		0.141*	-0.0259	0.187*	0.0520**
		(0.082)	(0.168)	(0.110)	(0.025)
Number of children					
1		-0.252***	0.680***	0.611***	-0.0133
		(0.094)	(0.210)	(0.125)	(0.033)
2		-0.288***	0.807***	0.886***	-0.000584
		(0.105)	(0.221)	(0.141)	(0.034)

Table 35 Continued

3+	-0.400***	0.922***	0.893***	-0.0266
	(0.128)	(0.263)	(0.167)	(0.040)
Limiting fertility	0.179**	0.123	0.269**	0.0292
	(0.082)	(0.156)	(0.111)	(0.023)
Condition	0.141	0.326*	-0.427***	-0.0478*
	(0.092)	(0.183)	(0.122)	(0.029)
Usual Care	0.529***	-0.547***	-0.154	0.0859***
	(0.094)	(0.200)	(0.116)	(0.029)
Area of residence				
Metropolitan	-0.453***	0.345	0.424***	-0.0428
	(0.112)	(0.225)	(0.152)	(0.035)
Suburban	-0.364***	0.147	0.291*	-0.0159
	(0.110)	(0.218)	(0.150)	(0.034)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 9,594 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, zero for number of children, and rural for area of residence. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010

One barrier to the use of long-acting method among childless women is that providers sometimes believe that IUDs are not appropriate for women without children (Luchowski et al., 2014). The coefficients on having children are positive and statistically significant for LARC alternatives (with the exception of implants among women with one child), as are the effects of having children on the utility of using a contraceptive that is a device. Because it is possible that these results are picking up barriers to LARC use among women without children, I reestimate the primary specification for the alternative and attributes models using a sample of mothers. These results are reported in Tables 36 and 37 and show that the main effects of devices and alternative-specific constants of LARC methods remain negative.

Finally, it is possible that women consider the perfect use failure rate when choosing a contraceptive method rather than the typical use rate. To explore this, I estimated the attributes models using a reduction in risk of pregnancy calculated with perfect use failure rates. I only estimate these results for the attributes model, as I am changing the definition of one of the attributes. I also reestimate the model among contracepting women only. The results are reported in Table 38 and Table 39. The directions of the results are largely similar to those in primary specifications, though the magnitude on the coefficient of pregnancy risk reduction is much larger than in Table 28. There are also some differences in which variables are significant. For example, the coefficient on hormonal is negative, but no longer statistically different from zero.

Table 36. Contraceptive Choice Logistic Regression Results with Women's Characteristics: Mothers Only

Price ($10)	-0.103***					
	(0.012)					
Alternative Specific Constant	Implant	Non-hormonal IUD	Hormonal IUD	SARC	Condoms	Traditional
	-1.564**	-1.566***	-0.660*	0.384	-0.794***	-1.788***
	(0.677)	(0.515)	(0.370)	(0.267)	(0.304)	(0.379)
Interactions						
Age						
19-23	0.812***	0.354	0.0856	0.406**	0.351*	-0.0496
	(0.231)	(0.271)	(0.209)	(0.161)	(0.181)	(0.248)
29-33	-1.195***	-0.189	-0.332**	-0.230*	-0.158	-0.106
	-0.277	-0.21	-0.148	-0.122	-0.133	-0.161
34-38	-1.975***	-0.494**	-0.914***	-0.438***	-0.419***	-0.371**
	(0.395)	(0.237)	(0.271)	(0.135)	(0.145)	(0.179)
39-44	-1.775***	-0.914***	-1.111***	-1.012***	-0.722***	-0.435**
	(0.420)	(0.271)	(0.184)	(0.153)	(0.158)	(0.188)
Black	-0.119	-0.867***	-0.749***	-0.177*	-0.11	-0.522***
	(0.208)	(0.216)	(0.141)	(0.107)	(0.116)	(0.152)
Hispanic	0.537**	0.511***	0.00246	-0.109	0.034	-0.227
	(0.213)	(0.169)	(0.130)	(0.108)	(0.116)	(0.142)
Married	-0.0877	0.224	0.155	-0.171	0.307***	0.454***
	(0.233)	(0.178)	(0.130)	(0.105)	(0.105)	(0.131)
Income	0.0435	0.101***	0.103***	0.0617***	0.0258	0.0427*
	(0.041)	(0.029)	(0.022)	(0.018)	(0.019)	(0.022)
Working	0.328*	0.337**	0.691***	0.106	-0.14	0.0461
	(0.188)	(0.165)	(0.123)	(0.093)	(0.098)	(0.118)
Greater than HS	-0.258	0.278	0.427***	0.168	0.237**	0.08
	(0.308)	(0.202)	(0.133)	(0.108)	(0.113)	(0.141)
Number of children						
2	0.377*	0.549***	0.350***	0.138	0.165	0.167
	(0.216)	(0.182)	(0.124)	(0.100)	(0.109)	(0.130)
3+	0.526**	0.304	0.128	-0.148	0.0941	0.0638
	(0.257)	(0.222)	(0.150)	(0.121)	(0.128)	(0.153)
Limiting fertility	0.350*	0.742***	0.843***	0.627***	0.508***	0.276**
	(0.211)	(0.167)	(0.119)	(0.098)	(0.104)	(0.125)

Table 36 Continued

Condition	0.0601	-1.125***	-0.323**	-0.514***	-0.434***	-0.371**
	(0.256)	(0.275)	(0.141)	(0.118)	(0.127)	(0.151)
Usual care	0.0454	0.172	0.145	0.258**	0.00516	-0.0806
	(0.252)	(0.219)	(0.160)	(0.126)	(0.124)	(0.152)
Place of residence						
Metropolitan	-0.475*	-0.045	-0.0877	-0.514***	0.0549	0.515***
	(0.257)	(0.241)	(0.170)	(0.128)	(0.148)	(0.198)
Suburban	-0.622**	0.054	0.178	-0.391***	0.0901	0.558***
	(0.257)	(0.234)	(0.164)	(0.125)	(0.146)	(0.195)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 4,606 mothers between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured during the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Base alternative is no method use. Includes set of year controls. Base category for age is 24-28, one for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses.

* $p<0.10$, ** $p<0.05$, *** $p<0.010$

Table 37. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions: Mothers Only

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.0998***	1.509***	-1.285***	-1.698***	0.0641
Interactions	(0.010)	(0.294)	(0.398)	(0.415)	(0.069)
Age group					
19-23		0.0433	0.222	0.483*	-0.0349
		(0.172)	(0.301)	(0.260)	(0.047)
29-33		-0.0606	-0.619***	-0.222	0.0567*
		(0.132)	(0.230)	(0.188)	(0.034)
34-38		-0.00313	-0.920***	-0.601***	0.0742**
		(0.147)	(0.261)	(0.206)	(0.038)
39-44		-0.329**	-0.426	-0.908***	0.00087
		(0.162)	(0.294)	(0.220)	(0.043)
Black		0.0246	-0.114	-0.305*	-0.0495
		(0.120)	(0.217)	(0.165)	(0.033)
Hispanic		-0.0829	0.12	-0.0498	0.0352
		(0.117)	(0.199)	(0.164)	(0.029)
Married		-0.580***	0.478**	0.572***	-0.0746***
		(0.108)	(0.196)	(0.151)	(0.028)
Income		0.0227	0.0381	0.0476*	0.0175
		(0.018)	(0.033)	(0.026)	(0.029)
Working		0.272***	0.412**	-0.194	-0.031
		(0.099)	(0.189)	(0.138)	(0.035)
Greater than HS		-0.00533	0.196	0.255	-0.00103
		(0.116)	(0.208)	(0.163)	(0.031)
Number of children					
2		-0.026	0.158	0.227	0.0175
		(0.108)	(0.195)	(0.153)	(0.029)
3+		-0.220*	-0.426	0.118	-0.031
		(0.131)	(0.294)	(0.178)	(0.035)
Limiting fertility		0.172*	-0.0859	0.617***	0.0374
		(0.103)	(0.183)	(0.147)	(0.027)

Table 37 Continued

Condition	-0.00357	0.818***	-0.645***	-0.112***
	(0.133)	(0.231)	(0.176)	(0.035)
Usual Care	0.289**	-0.306	-0.0544	0.0522
	(0.133)	(0.251)	(0.175)	(0.036)
Place of residence				
Metropolitan	-0.689***	0.626**	0.278	-0.0808**
	(0.145)	(0.266)	(0.211)	(0.041)
Suburban	-0.575***	0.580**	0.3	-0.0642*
	(0.141)	(0.251)	(0.209)	(0.039)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 4,606 mothers between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured during the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Base alternative is no method use. Includes set of year controls. Base category for age is 24-28, one for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses.

* p<0.10, ** p<0.05, *** p<0.010

Table 38. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions: Perfect Use Failure Rates

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.120***	1.224***	-1.752***	-1.184***	0.0333
Interactions	(0.009)	(0.216)	(0.375)	(0.260)	(0.064)
Age					
19-23		0.240**	0.0946	0.234*	-0.0295
		(0.097)	(0.233)	(0.128)	(0.037)
29-33		-0.0887	-0.582***	-0.311***	0.0547*
		(0.094)	(0.198)	(0.115)	(0.029)
34-38		-0.182*	-0.619***	-0.665***	0.0426
		(0.108)	(0.230)	(0.129)	(0.033)
39-44		-0.506***	-0.266	-0.909***	-0.0167
		(0.123)	(0.261)	(0.140)	(0.038)
Black		-0.272***	0.159	-0.183*	-0.111***
		(0.084)	(0.190)	(0.100)	(0.029)
Hispanic		-0.301***	0.324*	-0.0474	-0.00304
		(0.084)	(0.175)	(0.100)	(0.025)
Married		-0.553***	0.590***	0.195**	-0.0752***
		(0.078)	(0.169)	(0.092)	(0.024)
Income		0.0361***	0.0443*	0.0298**	0.00407
		(0.012)	(0.026)	(0.015)	(0.004)
Working		0.233***	0.404**	-0.0157	0.00529
		(0.073)	(0.166)	(0.087)	(0.024)
Greater than HS		0.142*	0.0158	0.295***	0.0406
		(0.078)	(0.175)	(0.095)	(0.025)
Number of children					
1		-0.147*	0.671***	-0.0434	-0.0116
		(0.087)	(0.214)	(0.106)	(0.032)
2		-0.129	0.736***	0.178	0.0152
		(0.098)	(0.226)	(0.120)	(0.033)
3+		-0.273**	0.948***	0.087	-0.0218
		(0.121)	(0.272)	(0.141)	(0.039)

Table 38 Continued

Limiting fertility	0.215***	0.16	0.567***	0.0231
	(0.080)	(0.166)	(0.101)	(0.024)
Condition	-0.0291	0.625***	-0.577***	-0.0952***
	(0.089)	(0.191)	(0.102)	(0.029)
Usual Care	0.454***	-0.439**	-0.126	0.0630**
	(0.091)	(0.209)	(0.102)	(0.030)
Place of residence				
Metropolitan	-0.467***	0.464**	0.333**	-0.0493
	(0.105)	(0.234)	(0.130)	(0.035)
Suburban	-0.379***	0.321	0.281**	-0.0307
	(0.103)	(0.226)	(0.129)	(0.034)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,487 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured during the past 12 months. indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, zero for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses. * p<0.10, ** p<0.05, *** p<0.010

Table 39. Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions Among Women Using Contraception: Perfect Use Failure Rates

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.129***	-0.714	-1.219***	81.05***	-0.159**
Interactions	(0.010)	(0.434)	(0.377)	(16.150)	(0.071)
Age					
19-23		0.00682	0.171	11.43	-0.0536
		(0.203)	(0.227)	(7.570)	(0.040)
29-33		-0.0133	-0.593***	-3.484	0.0615*
		(0.194)	(0.199)	(6.707)	(0.034)
34-38		-0.219	-0.613***	1.204	0.0394
		(0.223)	(0.232)	(7.670)	(0.038)
39-44		-0.317	-0.41	-9.103	0.00953
		(0.252)	(0.266)	(8.501)	(0.044)
Black		-0.770***	0.238	21.45***	-0.164***
		(0.167)	(0.184)	(6.191)	(0.032)
Hispanic		-0.636***	0.389**	16.61***	-0.0429
		(0.171)	(0.176)	(6.053)	(0.029)
Married		-0.398**	0.466***	-6.291	-0.0580**
		(0.159)	(0.172)	(5.475)	(0.028)
Income		0.0633**	0.0292	-1.178	0.00756*
		(0.025)	(0.027)	(0.889)	(0.004)
Working		0.631***	0.265	-17.51***	0.0557**
		(0.148)	(0.165)	(5.244)	(0.027)
Greater than HS		0.0244	0.0752	5.59	0.0277
		(0.161)	(0.175)	(5.677)	(0.029)
Number of children					
1		0.604***	0.401*	-31.07***	0.0774**
		(0.185)	(0.209)	(6.553)	(0.035)
2		0.780***	0.420*	-35.79***	0.121***
		(0.208)	(0.226)	(7.163)	(0.038)
3+		0.584**	0.648**	-33.62***	0.0774*
		(0.250)	(0.271)	(8.471)	(0.045)

Table 39 Continued

Limiting fertility	0.038	0.25	9.723*	0.00225
	(0.169)	(0.168)	(5.735)	(0.028)
Condition	0.233	0.496***	-11.51*	-0.0619*
	(0.185)	(0.192)	(6.382)	(0.034)
Usual Care	0.203	-0.31	11.37*	0.0312
	(0.174)	(0.210)	(6.017)	(0.033)
Place of residence				
Metropolitan	-0.0383	0.346	-18.41**	-0.0035
	(0.219)	(0.231)	(8.150)	(0.040)
Suburban	0.13	0.177	-21.72***	0.0257
	(0.219)	(0.223)	(8.120)	(0.039)

Unweighted data from 201-2013, 2013-2015 and 2015-2017 NSFG. N = 5,327 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. Greater than HS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, zero for number of children, and rural for place of residence. Standard errors (clustered at woman-level) are in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.010$

4.6 Discussion

My results suggest that women prefer methods that do not require the insertion of a device, as seen in the results of both models with alternative-specific constants and with contraceptive attributes. This is true even when the attributes model is estimated among women who have decided to use contraception.

Women with more children find LARC methods and attributes as a better match. It is possible that the coefficients on the device and number of children variables are picking up on barriers to LARC use for women without children. However, implants are also associated with a negative effect on utility of the method, though they would not be subject to the same concerns as IUDs regarding insertion in nulliparous patients. Further, the results of a set of sensitive analyses indicate that the negative effect is still present when the results are estimated only for mothers.

In specifications that include women who choose to not use a contraceptive, more effective methods are associated with a negative effect on utility. The coefficients are also much smaller magnitude than the results for contracepting women only. It is possible that women have different preferences for the use of effective contraceptives, resulting in the negative effect. Some women (particularly those choosing to use contraception) place high importance on effectiveness, while others (such as women attempting to become pregnant) would find a great disutility from using contraception. Others might be ambivalent about pregnancy (Kaye et al., 2009).

Among contraceptive users, methods that provide greater protection are more attractive, however the fact that LARCs are devices may discourage women from using the most effective reversible methods. Additionally, duration of use also has a negative effect on utility when estimated among a group of contracepting women only. Thus, while increasing LARC access may be an important goal that will benefit some women, there are likely some women who would prefer to use more effective methods but will find LARCs as an unattractive option. A more effective woman-controlled contraceptive would likely be a better alternative for these women.

There are a number of different possible reasons that the coefficients on the device attribute is negative. For example, some women may be uncomfortable having a device inserted into their bodies or do not like methods that they cannot easily discontinue if they want to become pregnant or if they experience side-effects. Addressing the first concern would require developing new methods, though concerns over having a device placed in the body could be potentially reduced by contraceptive counseling (Sundstrom et al., 2016). Providing instructions on self-removal of IUDs may be able to address the latter concern (Foster et al., 2012, 2014).

In 2018, the FDA approved a contraceptive ring that could be used up to a year (U.S. Food & Drug Administration, 2018). The ring was developed to follow a 21-day-on-7-day-off regimen which would still allow room for user error. If the ring can be used continuously (as women have been doing with the pill for many years), then such a ring may be a step in the direction of long-lasting contraception that does not require a doctor's visit for discontinuation.

4.6.1 Limitations

Train (2009) discusses three limitations of logit models, two of which are applicable to this paper. The first is the property of Independence from Irrelevant Alternatives (IIA) and the resulting substitution patterns. The IIA results from assuming that the error terms are distributed iid type I extreme value, which implies that the ratio of the log probabilities of two options does not depend on other available alternatives. If a model is not correctly specified such that utility is well represented, then the IIA may lead to unrealistic substitution patterns. By estimating logit models, I am assuming that the decision to choose one method compared to no method is unrelated to the other contraceptives available. It seems likely that the choice to use a contraceptive would be related to the availability other methods, particularly if those methods are very similar. For example, one could imagine that the availability of hormonal IUDs may have little influence the decision to use a traditional method, but that the choice of a hormonal method like the implant may depend on the availability of IUDs and SARCs.

The second limitation of the logit model is that it cannot account for unobserved heterogeneity in taste preferences. My models assume that for a contraceptive (or set of attributes) the effects on utility are constant. While adding the characteristics and interactions can account for some observed taste preferences, it is possible that preferences for attributes vary by woman in ways that I cannot capture adequately.

Beyond the restrictions of the model, the data I use create other limitations. Because the NSFG does not gather information on the out-of-pocket expenses paid for contraceptives, I use a price variable constructed from the literature which adds measurement error. Because my approach to the price variable requires knowledge of a woman's insurance status, I can only use the most recent (relative to the interview) 12 months of data in the contraceptive histories. I also do not account for protection against sexually transmitted diseases due to multicollinearity.

Finally, in order to interpret the results as effects on utility, it is necessary to control for barriers to use, such as supply-side factors. I included if a woman lives in a metropolitan, suburban or rural area, and indicator for if she has a usual place of care, and a set of year controls to control for such access issues. These variables may still not completely capture LARC-related barriers. A limitation of the National Survey of Family Growth is that the public use datasets do not include information on the state, county, or region of residence. Further analysis should be performed using regional or state-level data to ascertain that the negative effect of the method being a device is not due to supply-side barriers.

4.7 Conclusion

The rate of unplanned pregnancies in the United States is high, with as many as 45% of pregnancies being unplanned. Forty-one percent of these pregnancies are among women who are using contraceptives, but not using their method consistently. Long-acting reversible contraceptives have been advocated as a way to decrease the rate of unintended pregnancies as they do not rely on user compliance, however LARC specific attributes—such as being a device that is inserted in the body—may make LARCs an unattractive option for many women.

It is likely that barriers to access have slowed the adoption of LARCs. It is also likely that the attributes of LARCs themselves inhibit their uptake. Thus, policies should be implemented to both increase LARC access and to encourage research and development of contraceptives that better fit the needs of women.

CHAPTER V

CONCLUSION

In this dissertation I used a variety of econometric techniques and data from the National Survey of Family Growth to assess the duration, effect on pregnancies, and decision to use long-acting reversible contraception. Using duration analysis including a competing risk model, I find that LARC methods are used longer than other reversible methods, but that spells of contraceptives that are more sensitive to user error are not more at risk of ending due to a switch to LARC use. Using an instrumental variables approach using variation from the release of provider recommendations to account for selection into LARC use, I find that LARCs decrease the probability of becoming pregnant in the current and subsequent year, at least among young mothers affected by the recommendation. I also find evidence of selection into LARC use by women who would have otherwise been more likely to become pregnant in the following year.

LARC methods have the potential to positively affect women's welfare by reducing the possibility of user error, but some women may find long-acting methods as unattractive alternatives. In my third essay, I find that being a physical device may reduce the utility of LARC methods and may prevent some women from choosing a LARC. Thus, to help women have greater control over their fertility, it is essential to both decrease barriers to access for LARC methods and to invest in the development of other effective methods that better fit women's needs.

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APPENDIX A

CHAPTER II CONTRACEPTIVE SPELL CONSTRUCTION

For the data used in Chapter II, the 2006-2010, 2011-2013, and 2013-2015 NSFG datasets were combined resulting in a dataset with 23,579 observations, each representing one female respondent. Additionally, the three corresponding pregnancy interval files were combined resulting in a pregnancy-level dataset with information on 14,517 pregnancies.

The NSFG questionnaire is completed using a life-table calendar to record contraceptive methods and sexual activity month by month; this information was exploited to create longitudinal data. The calendars begin in January of three years before the survey and ask a woman about her contraceptive use that month (up to four methods) and whether she was sexually active for every month up to when the survey was administered. At a maximum, a woman contributed 48 months of data if she were surveyed in December, though the months of data contributed were on average 42.2. The start and end dates for marriages and pregnancies and dates of births of children are also recorded, but not in a question-per-month fashion. The dates from these variables were matched up to corresponding months in the calendar to build a more detailed longitudinal dataset consisting of contraceptive use, marriage spells, sexual activity, and childbirth.

The contraceptive questions allowed for a range of detailed responses (e.g., pills, patches, rings and shots were listed separately), which were grouped into contraceptive types during data cleaning (e.g., pills, patches, rings, or shots were all in the "short-acting reversible contraceptives (SARC)" category). The categories of methods are listed in Table A.1 below.

Table A.1 Categories of Contraceptives

Category	Method in Questionnaire
No method	No method used (current); no method used (ever)[1]
Emergency Contraception	Emergency contraception (EC)
Traditional Method	Withdrawal/pulling out; rhythm or safe period by calendar; safe period by temperature or cervical mucous, natural family planning
Barrier Method	Condoms (male or female); diaphragm, foam; jelly or cream; suppository or insert
Short-Acting Reversible Contraception (SARC)	Birth control pills; patches; rings; injectables
Long-Acting Reversible Contraception (LARC)	Intrauterine device (IUD), coil, or loop; hormonal implant
Male Sterilization	Partner's vasectomy
Female Sterilization	Female sterilizing operation, such as tubal sterilization and hysterectomy
Other Method	Other method; male sterility; female sterility[2]

[1]A woman who never used a method and was not sexually active was not within the NSFG's universe for the contraceptive calendar and was simply recorded as a missing value; during data construction these women were included into the calendar and grouped into "no method".
[2]Non-contraceptive sterility was not included as part of the sterilization methods because it is presumably not chosen and is thus fundamentally different.

After assigning the NSFG responses each month to a category, binary variables that indicated whether a type of method was used across any of the four mentions were created. Because a woman may use more than one method each month, these indicator variables were used to construct a “main method” variable which reported the most effective method or longest acting method used in that month. The hierarchy for constructing the main method variable is as follows:

1. *Female sterilization*
2. *Male sterilization*
3. *LARC method*
4. *SARC method*
5. *Barrier method*
6. *Traditional method*
7. *Other method*
8. *Emergency contraception*
9. *No method*

If a woman listed female sterilization across any of her mentions, it was recorded as her main method; if not, then the next category (male sterilization) was checked and recorded as the main method if listed; if male sterilization was not listed, then the next method checked was LARC. If a LARC method was not listed, then the next category was considered. This continued until the options were exhausted.

While constructing the panel data, some observations were missing necessary information and thus needed to be edited or excluded. Some women had missing information regarding her contraceptive use during months within the calendar. If the same method was used on either side of the missing month, the value was imputed to the value from surrounding months. If the missing value was at the end of the calendar, the data for that woman was removed from the sample.[33]

[33] In practice this resulted in the exclusion of one observation.

If women did not know or refused to provide information on their first month of contraceptive use, they were assigned a starting month of contraceptive use before the start of the survey, so that they could still be included in the calendar.[34] As the month of first method use is not included in my analysis (unless it occurred within the calendar), this did nothing more than to allow women who did not remember this date to remain in the data during the data cleaning process. Women who replied that they did not know or refused information on contraceptive use or sexual activity for any month within the calendar were removed from the sample.

For all but the very first year of the 2006-2010 NSFG, the sexual activity calendar applied to all respondents; during that first year, however, there were 36 individuals who were not in the universe for the sexual activity calendar, and 43 individuals without information on the reference month for the calendar entry. Observations of individuals who fell into these groups were excluded. Additionally, if women reported not knowing the beginning and end dates of their marriages, or if they reported sterilization or LARC use within the calendar but claimed to have never been sterilized or to never have used a LARC, the observations were removed.[35] A total of 377 women were excluded, leaving

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[34] Century months (CM) are used in the NSFG and the earliest century month in any calendar is 1237; century months can be calculated using the following formula: CM= 12(year – 1900) + month. (https://demographicestimation.iussp.org/content/dhs-century-month-codes). I imputed a calendar month before this date.

[35] The NSFG contains "perturbed data" in order to keep the respondents unidentifiable; while the documentation assures that the changes were done in such a way that it would not affect descriptive statistics or coefficient estimates, the lack of detail on the process of perturbing the data resulted in the need for particularly aggressive data cleaning.

23,202 women who contributed 979,896 women-months in the dataset.[36] After making these exclusions, I removed spells of use that were left censored, and women who were adolescents (<20 years old).

In Table A.2, I report descriptive statistics of the NSFG before excluding teenagers and women with left censored spells. The proportion of women relying on female sterilization is greater than it is after removing left censored spells (13% versus 8.2%), though this proportion is still lower than results reported in Kavanaugh and Jerman (2018). This difference is likely due to Kavanaugh and Jerman (2018) using weights to adjust for the oversampling of young women who are unlikely to be sterilized. The mean number of spells is also lower compared to the results after removing left censored spells, likely because left censored spells are likely to be long spells.

[36] Initially, 380 women were excluded. After reviewing the data, I was able to determine enough information on 3 women to keep them in the sample.

Table A.2 Descriptive Statistics of National Survey of Family Growth at Time of Survey

Variable	Mean
Age during calendar month	28.628
Under 20 years old	0.185
Respondent is Black	0.226
Respondent is Hispanic	0.236
Currently married	0.314
Has children	0.544
Number of children (among mothers)	2.156
Currently working	0.622
Household income is below the poverty level	0.306
Respondent is insured	0.799
Less than high school education	0.253
Has high school diploma or equivalent	0.459
Greater than high school education (any level)	0.289
Number of spells	3.349

Unweighted data from the 2006-2010, 2011-2013, and 2013-2015 NSFG. N = 23,202 (12,616 mothers) ages 20-45.

In Table A.3, I summarize how spells are censored by method for women who are over the age of 19 at the start of the spell. Over two thirds of sterilization spells are left censored or both left and right censored.

Table A.3 How Spells are Censored by Method

Method	Only Left Censored	Only Right Censored	Both Left and Right Censored	Uncensored	Total
Sterilization (F)	2	934	2,187	0	3,123
LARC	318	828	460	334	1,940
SARC	2,427	1,882	1,482	2,954	8,745
Barrier	1,514	1,593	481	7,869	11,457
Traditional	577	698	207	2,999	4,481
Sterilization (M)	26	538	563	14	1,141
Other method	13	26	9	185	233
EC	3	5	0	155	163
No method	3,255	3,393	1,602	11,355	19,605
Pregnancy	1,132	917	0	4,974	7,023
Total	9,267	10,814	6,991	30,839	57,911

APPENDIX B

CHAPTER II KAPLAN-MEIER AND COMPETING RISK ANALYSIS WITH WEIGHTS

In Chapter II, I make the choice to not use the weights provided in the NSFG. The weights for each wave were constructed to adjust for the sampling scheme and nonresponse in order to make the cross-sectional data from the time of the survey representative of the US at the midpoint of the respective waves. Since I am using panel data rather than cross-section data, these weights are not correct for my analysis. There may, however, be value in using these weights, even though that are not designed for my purposes. As a robustness check, I reestimate selected models using the survey weights provided in the NSFG.

The first set of results I present are the Kaplan-Meier survival probabilities. As seen in Table B.1, the results with weights tend to be a few percentage points higher than the unweighted results, at the exception of for IUD (and LARCs overall) starting at 24 months. While there are gaps between the weighted and unweighted results ranging from less than one percentage point to over 5 percentage points, the same general patterns hold. LARCs spells have higher rates of continuation than SARCs.

Table B.1 Kaplan-Meier Survival Probabilities of Long-Acting Reversible Contraceptives with Weights

Method	6 months	12 months	18 months	24 months	30 months	36 months
All LARC	87.68	77.64	71.72	63.85	60.83	53.80
IUD	86.77	77.23	71.04	63.98	61.86	55.00
Implant	93.19	79.89	76.07	62.54	52.80	45.26
SARC	67.41	50.08	40.81	34.45	29.31	23.35

Data from the 2006-2010, 2011-2013, and 2013-2015 National Survey of Family Growth. Results are weighted using the survey weights provided by the NSFG. Survival probabilities are estimated using the Kaplan-Meier Survival curve.

I also reestimate the competing risk model from Table 9 with weights. When using the weights, there is no significant difference in the baseline hazards of a spell ending due to LARC use for SARC and barrier methods during the 4-6 month interval or during the first six months of traditional method spells. Traditional method spells have a statistically significantly lower hazard of switching into LARC use compared to SARC methods after the first nine months. The overall conclusion that spells of less effective methods do not have a greater hazard for switching into LARC use remains.

Table B.2 Competing Risk Contraceptive Spell Exit Results: Time-Method Interactions with Weights

Variable	(1) LARC	(2) No Method	(3) Other Flexible Method	(4) Pregnancy	(5) Sterilization
Baseline hazard (SARC use) month					
1 - 3	-6.600***	-2.675***	-4.510***	-5.245***	-6.429***
	(0.596)	(0.123)	(0.230)	(0.389)	(0.573)
4 - 6	-6.218***	-3.431***	-5.160***	-5.543***	-7.166***
	(0.457)	(0.164)	(0.250)	(0.404)	(0.551)
7 - 9	-7.531***	-3.357***	-5.341***	-5.979***	-6.995***
	(0.592)	(0.172)	(0.268)	(0.423)	(0.695)
10 - 12	-6.437***	-3.312***	-5.223***	-5.676***	-7.395***
	(0.546)	(0.217)	(0.288)	(0.441)	(0.667)

Table B.2 Continued

13 - 18	-6.450***	-3.540***	-5.736***	-5.832***	-6.626***
	(0.542)	(0.178)	(0.269)	(0.415)	(0.576)
19 - 24	-6.839***	-4.310***	-5.783***	-6.015***	-7.201***
	(0.734)	(0.211)	(0.322)	(0.455)	(0.625)
25 +	-8.185***	-4.000***	-5.840***	-6.366***	-7.810***
	(0.674)	(0.242)	(0.366)	(0.482)	(0.838)
Barrier ×Time months					
1 - 3	0.798**	1.537***	0.488***	0.869**	0.0345
	(0.382)	(0.095)	(0.112)	(0.348)	(0.341)
4 -6	-0.521	1.278***	-0.0702	0.812***	0.794*
	(0.437)	(0.138)	(0.156)	(0.228)	(0.448)
7 - 9	0.198	0.609***	-0.0542	1.017***	0.0838
	(0.577)	(0.174)	(0.248)	(0.283)	(0.654)
10 - 12	-0.254	0.447**	-0.0343	0.801**	0.134
	(0.541)	(0.219)	(0.270)	(0.341)	(0.703)
13 - 18	-0.916	0.333*	-0.143	0.724**	0.171
	(0.560)	(0.174)	(0.272)	(0.304)	(0.702)
19 - 24	-0.629	0.764***	-0.532	0.721*	0.933
	(0.818)	(0.265)	(0.337)	(0.391)	(0.803)
25 +	-0.459	0.603**	-1.108*	1.023**	0.206
	(1.129)	(0.287)	(0.575)	(0.460)	(0.956)
Traditional ×Time months					
1 - 3	0.529	1.329***	0.389***	1.432***	-0.235
	(0.477)	(0.121)	(0.141)	(0.355)	(0.443)

Table B.2 Continued

4 - 6	0.49	0.724***	0.580***	1.129***	0.607
	(0.650)	(0.152)	(0.176)	(0.278)	(0.540)
7 - 9	1.054	0.0152	-0.321	1.350***	-0.914
	(0.785)	(0.217)	(0.308)	(0.303)	(0.789)
10 - 12	-1.342*	-0.0157	-0.0893	1.255***	1.404*
	(0.686)	(0.264)	(0.338)	(0.390)	(0.788)
13 - 18	-25.86***	0.108	0.161	1.319***	-0.855
	(0.363)	(0.262)	(0.350)	(0.307)	(0.860)
19 - 24	-1.907*	0.747**	-0.526	1.752***	0.428
	(1.150)	(0.310)	(0.487)	(0.421)	(0.891)
25 +	-24.26***	0.308	0.0514	1.947***	-1.058
	(0.559)	(0.442)	(0.475)	(0.522)	(1.054)
Black	-0.551**	0.285***	0.074	0.325***	-0.581**
	(0.228)	(0.059)	(0.106)	(0.094)	(0.255)
Hispanic	-0.144	0.0213	0.239*	0.0775	-0.994***
	(0.245)	(0.076)	(0.134)	(0.095)	(0.256)

Table B.2 Continued

Age Group					
20-24	-0.235	0.00521	0.116	0.0979	-0.177
	(0.238)	(0.061)	(0.091)	(0.101)	(0.342)
25-29	Omitted	Omitted	Omitted	Omitted	Omitted
30-34	0.0336	0.218***	-0.132	0.019	-0.242
	(0.273)	(0.075)	(0.123)	(0.152)	(0.279)
35-39	0.0577	0.643***	-0.181	-0.417**	0.479*
	(0.375)	(0.103)	(0.175)	(0.176)	(0.282)
40-45	-1.444**	0.755***	0.383	-1.070***	0.998***
	(0.607)	(0.129)	(0.276)	(0.343)	(0.369)
Parity					
0	Omitted	Omitted	Omitted	Omitted	Omitted
1	0.816***	-0.165**	-0.115	0.361**	0.626
	(0.294)	(0.066)	(0.115)	(0.147)	(0.384)
2	1.232***	-0.413***	-0.178	0.274	1.732***
	(0.299)	(0.096)	(0.119)	(0.172)	(0.324)
3+	1.028***	-0.427***	-0.0543	0.372**	2.279***
	(0.362)	(0.110)	(0.203)	(0.176)	(0.345)
Marriage duration in years					
Not married	Omitted	Omitted	Omitted	Omitted	Omitted
1-3 years	0.078	-0.470***	-0.440***	0.521***	-0.247
	(0.277)	(0.079)	(0.110)	(0.133)	(0.402)
4-6 years	-6.218***	-3.431***	-5.160***	-5.543***	-7.166***
	(0.457)	(0.164)	(0.250)	(0.404)	(0.551)
7+ years	-7.531***	-3.357***	-5.341***	-5.979***	-6.995***
	(0.592)	(0.172)	(0.268)	(0.423)	(0.695)
Postpartum	1.115***	-0.943***	-0.375**	0.045	-0.373
	(0.325)	(0.150)	(0.181)	(0.215)	(0.399)
Sexually active	0.0533	-0.220**	1.490***	0.2	-0.281
	(0.350)	(0.107)	(0.208)	(0.378)	(0.351)

Unweighted data from 2006-2010, 2011-2013, and 2013-2015 NSFG. Includes 120,485 months of data from spells of SARCs, barrier, or traditional method use. “Other flexible” includes SARCs, barrier, and traditional. Also includes a set of year controls. Standard errors are in parenthesis and clustered at the woman-level. * p<.10, ** p<.05, *** p<.01

APPENDIX C

CHAPTER III DATA

Table C. 1 Main Method Hierarchy

Method
(1) Sterilization
(2) Implant or IUD
(3) Male Sterilization
(4) SARC
(5) Male Condom
(6) Other Barrier
(7) Traditional
(8) Emergency Contraception
(9) Other
(10) No Method

Table C.2 Proportion of Contraceptive Spells Initiated by Month (Non-Survey Years Only)

Month	% of contraceptive spells
January	13.48
February	6.76
March	7.06
April	7.93
May	8.08
June	8.63
July	8.04
August	8.41
September	7.99
October	8.32
November	7.63
December	7.67

APPENDIX D

CHAPTER III FULL RESULTS FOR FIRST STAGE, REDUCED FORM, AND MAIN ANALYSIS

Table D.1 Difference-in-Differences Results: The Effect of CO450 on LARC Use

	(1) Any Contraceptives	(2) LARC	(3) SARC	(4) Condoms	(5) Traditional	(6) LARC (Non-survey years)	(7) LARC (Probit)[a]
Any contraceptive status							
PostxTreatment	-0.021	0.078***	-0.060**	-0.053**	-0.032	0.071***	0.060**
	(0.025)	(0.020)	(0.029)	(0.026)	(0.021)	(0.022)	(0.025)
Black	-0.037**	-0.037***	-0.016	0.082***	-0.037***	-0.033**	-0.036***
	(0.015)	(0.013)	(0.018)	(0.016)	(0.012)	(0.014)	(0.013)
Hispanic	-0.017	0.021	-0.031*	0.032*	-0.022	0.027*	0.020
	(0.016)	(0.014)	(0.018)	(0.017)	(0.013)	(0.015)	(0.014)
Less than HS	-0.082***	-0.052***	-0.099***	0.011	0.010	-0.049***	-0.051***
	(0.020)	(0.014)	(0.020)	(0.020)	(0.016)	(0.015)	(0.014)
Married	-0.063***	-0.007	-0.050***	-0.037***	0.006	-0.003	-0.005
	(0.013)	(0.012)	(0.016)	(0.014)	(0.011)	(0.013)	(0.012)
Sexually active	0.525***	0.033***	0.151***	0.278***	0.123***	0.023	0.036***
	(0.023)	(0.013)	(0.020)	(0.009)	(0.007)	(0.015)	(0.013)
Age							
22	-0.036**	-0.016	-0.016	-0.016	-0.020	-0.011	-0.017
	(0.018)	(0.013)	(0.021)	(0.020)	(0.015)	(0.016)	(0.013)
23	0.002	-0.033*	0.002	0.024	-0.023	-0.025	-0.031*
	(0.019)	(0.017)	(0.025)	(0.023)	(0.017)	(0.020)	(0.016)
24	-0.015	-0.033*	-0.002	-0.008	-0.035**	-0.027	-0.031*
	(0.020)	(0.018)	(0.026)	(0.023)	(0.017)	(0.021)	(0.018)
25	-0.017	-0.036*	-0.032	-0.002	-0.006	-0.027	-0.035*
	(0.021)	(0.019)	(0.026)	(0.024)	(0.018)	(0.021)	(0.018)
26	0.001	-0.028	-0.039	0.010	-0.022	-0.036*	-0.027
	(0.020)	(0.019)	(0.026)	(0.024)	(0.018)	(0.021)	(0.018)

Table D.1 Continued

27	-0.018	-0.053***	-0.068***	0.025	-0.012	-0.037*	-0.050***
	(0.021)	(0.019)	(0.026)	(0.024)	(0.018)	(0.021)	(0.018)
31	-0.055**	-0.037*	-0.103***	-0.040	-0.026	-0.030	-0.039*
	(0.025)	(0.020)	(0.030)	(0.027)	(0.021)	(0.022)	(0.023)
32	-0.054**	-0.036*	-0.115***	-0.057**	-0.025	-0.028	-0.037
	(0.026)	(0.020)	(0.031)	(0.027)	(0.021)	(0.022)	(0.023)
33	-0.074***	-0.045**	-0.114***	-0.059**	-0.025	-0.042**	-0.049**
	(0.026)	(0.020)	(0.030)	(0.027)	(0.021)	(0.021)	(0.023)
34	-0.065**	-0.045**	-0.130***	-0.038	-0.036*	-0.045**	-0.049**
	(0.026)	(0.020)	(0.030)	(0.028)	(0.021)	(0.021)	(0.023)
35	-0.060**	-0.056***	-0.152***	-0.052*	-0.040*	-0.049**	-0.060***
	(0.027)	(0.020)	(0.030)	(0.028)	(0.021)	(0.022)	(0.023)
Year							
2005	-0.022	-0.077***	0.059**	-0.025	0.009	-0.063***	-0.088***
	(0.020)	(0.014)	(0.025)	(0.022)	(0.016)	(0.016)	(0.017)
2006	-0.024	-0.070***	0.045**	-0.012	0.007	-0.054***	-0.082***
	(0.018)	(0.013)	(0.022)	(0.020)	(0.014)	(0.016)	(0.015)
2007	-0.033*	-0.048***	0.007	-0.016	0.003	-0.030*	-0.055***
	(0.018)	(0.013)	(0.021)	(0.019)	(0.014)	(0.016)	(0.015)
2008	-0.030*	-0.018	-0.024	0.016	-0.003	-0.004	-0.020
	(0.017)	(0.012)	(0.020)	(0.018)	(0.013)	(0.017)	(0.013)
2010	-0.008	-0.032*	0.017	-0.015	0.047**	-0.006	-0.027
	(0.024)	(0.018)	(0.027)	(0.024)	(0.019)	(0.020)	(0.021)
2011	0.006	-0.018	0.014	-0.001	0.045**	0.004	-0.015
	(0.025)	(0.019)	(0.028)	(0.026)	(0.020)	(0.021)	(0.023)
2012	-0.004	-0.011	0.004	-0.009	0.056***	0.007	-0.009
	(0.025)	(0.019)	(0.028)	(0.026)	(0.020)	(0.023)	(0.024)
2013	0.014	0.002	-0.003	-0.016	0.060***	0.018	0.001
	(0.026)	(0.021)	(0.029)	(0.027)	(0.022)	(0.026)	(0.025)
N	7,628 (3,647)		7,628 (3,647)			5,891(3,261)	7,628 (3,647)
Contraceptive users only							
PostxTreatment		0.096***	-0.069*	-0.055	-0.039	0.089***	0.083***
		(0.026)	(0.036)	(0.033)	(0.027)	(0.028)	(0.031)

Table D.1 Continued

Black	-0.043**	-0.002	0.121***	-0.042***	-0.037**	-0.042**
	(0.017)	(0.022)	(0.021)	(0.015)	(0.017)	(0.017)
Hispanic	0.030	-0.032	0.050**	-0.025	0.035*	0.029
	(0.018)	(0.023)	(0.021)	(0.017)	(0.019)	(0.018)
Less than HS	-0.057***	-0.089***	0.056**	0.030	-0.054***	-0.056***
	(0.019)	(0.027)	(0.027)	(0.022)	(0.020)	(0.019)
Married	0.003	-0.032*	-0.022	0.021	0.006	0.006
	(0.016)	(0.019)	(0.018)	(0.015)	(0.016)	(0.015)
Sexually active	-0.103***	-0.235***	0.326***	0.148***	-0.133***	-0.103***
	(0.035)	(0.041)	(0.013)	(0.011)	(0.043)	(0.035)
Age						
22	-0.009	0.002	-0.008	-0.020	-0.011	-0.010
	(0.016)	(0.024)	(0.023)	(0.018)	(0.020)	(0.016)
23	-0.039*	-0.001	0.030	-0.028	-0.032	-0.037*
	(0.021)	(0.028)	(0.027)	(0.021)	(0.024)	(0.020)
24	-0.037*	0.009	-0.003	-0.042**	-0.030	-0.034
	(0.022)	(0.030)	(0.028)	(0.021)	(0.025)	(0.022)
25	-0.041*	-0.028	0.003	-0.005	-0.037	-0.039*
	(0.023)	(0.030)	(0.029)	(0.023)	(0.025)	(0.022)
26	-0.035	-0.045	0.013	-0.030	-0.048*	-0.034
	(0.023)	(0.030)	(0.028)	(0.022)	(0.025)	(0.022)
27	-0.062***	-0.070**	0.034	-0.015	-0.043*	-0.058***
	(0.023)	(0.030)	(0.029)	(0.023)	(0.026)	(0.022)
31	-0.039	-0.102***	-0.026	-0.025	-0.034	-0.038
	(0.025)	(0.036)	(0.033)	(0.027)	(0.027)	(0.028)
32	-0.038	-0.121***	-0.048	-0.024	-0.030	-0.036
	(0.025)	(0.037)	(0.034)	(0.027)	(0.028)	(0.029)
33	-0.048*	-0.106***	-0.046	-0.020	-0.046*	-0.048*
	(0.025)	(0.037)	(0.035)	(0.027)	(0.027)	(0.029)
34	-0.049*	-0.132***	-0.019	-0.038	-0.055**	-0.050*
	(0.025)	(0.037)	(0.035)	(0.027)	(0.027)	(0.029)
35	-0.064**	-0.169***	-0.039	-0.046*	-0.058**	-0.065**
	(0.026)	(0.037)	(0.035)	(0.028)	(0.028)	(0.029)

Table D.1 Continued

Year							
2005		-0.096***	0.097***	-0.026	0.012	-0.074***	-0.110***
		(0.018)	(0.030)	(0.028)	(0.021)	(0.020)	(0.021)
2006		-0.087***	0.079***	-0.007	0.011	-0.062***	-0.101***
		(0.017)	(0.026)	(0.025)	(0.018)	(0.020)	(0.019)
2007		-0.057***	0.032	-0.006	0.008	-0.030	-0.066***
		(0.016)	(0.025)	(0.024)	(0.018)	(0.020)	(0.018)
2008		-0.017	-0.010	0.033	-0.002	0.003	-0.019
		(0.016)	(0.024)	(0.022)	(0.017)	(0.021)	(0.017)
2010		-0.035	0.034	-0.020	0.062**	0.002	-0.032
		(0.023)	(0.034)	(0.032)	(0.026)	(0.026)	(0.027)
2011		-0.023	0.020	-0.002	0.059**	0.009	-0.023
		(0.025)	(0.035)	(0.033)	(0.026)	(0.027)	(0.029)
2012		-0.008	0.012	-0.008	0.076***	0.011	-0.010
		(0.025)	(0.035)	(0.033)	(0.027)	(0.029)	(0.030)
2013		0.002	-0.005	-0.025	0.077***	0.018	-0.001
		(0.027)	(0.036)	(0.034)	(0.028)	(0.032)	(0.032)
N	5,832 (2,958)	5,832 (2,958)				4,552 (2,629)	5,832 (2,958)

Number of woman-years (number of women). Unweighted data. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 with one child while control group includes women ages 31-35 with one child. Standard errors are clustered on the woman level. *, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

[a] Average marginal effect.

Table D.2 Reduced Form Results: The Effect of CO450 on Pregnancies

	(1) Pregnant This Year (OLS)	(2) Pregnant next year (OLS)	(3) Birth next year (OLS)
PostxTreatment	-0.052***	-0.052***	-0.039**
	(0.018)	(0.020)	(0.018)
Black	0.015	0.013	0.006
	(0.011)	(0.013)	(0.011)
Hispanic	-0.020*	0.001	0.013
	(0.012)	(0.013)	(0.012)
Less than HS	0.053***	0.026	0.031**
	(0.015)	(0.017)	(0.016)
Married	0.058***	0.038***	0.061***
	(0.010)	(0.011)	(0.010)
Sexually active	0.094***	0.032	0.076***
	(0.014)	(0.027)	(0.012)
Age			
22	-0.024	-0.032	0.042*
	(0.024)	(0.026)	(0.024)
23	-0.057**	0.011	0.004
	(0.024)	(0.027)	(0.023)
24	-0.058**	-0.011	-0.006
	(0.023)	(0.027)	(0.023)
25	-0.060**	-0.056**	-0.009
	(0.024)	(0.026)	(0.023)
26	-0.076***	-0.057**	-0.020
	(0.023)	(0.025)	(0.022)
27	-0.088***	-0.071***	-0.021
	(0.023)	(0.025)	(0.022)
31	-0.135***	-0.117***	-0.058**
	(0.024)	(0.027)	(0.025)
32	-0.145***	-0.116***	-0.065***
	(0.025)	(0.028)	(0.024)
33	-0.165***	-0.094***	-0.095***
	(0.024)	(0.029)	(0.023)
34	-0.167***	-0.160***	-0.089***
	(0.024)	(0.026)	(0.024)
35	-0.169***	-0.135***	-0.100***
	(0.024)	(0.028)	(0.023)
Year			
2005	0.004	0.001	0.019
	(0.021)	(0.024)	(0.021)
2006	0.024	-0.012	0.029
	(0.019)	(0.023)	(0.020)
2007	-0.015	0.029	0.010
	(0.018)	(0.024)	(0.020)
2008	0.012	-0.051**	0.008
	(0.020)	(0.024)	(0.021)
2010	0.035	0.059**	0.037
	(0.022)	(0.028)	(0.024)

Table D.2 Continued

2011	0.072***	0.007	0.040*
	(0.022)	(0.025)	(0.022)
2012	0.023	0.009	0.028
	(0.021)	(0.025)	(0.022)
2013	0.031	0.010	0.038
	(0.021)	(0.027)	(0.024)
Constant	0.099***	0.155***	0.018
	(0.026)	(0.038)	(0.025)
N	5,832 (2,958)	4,552 (2,629)	4,552 (2,629)

Number of woman-years (number of women). Unweighted data. Contraceptive users only. N indicates the number of woman-years (number of women). Pre-period is 2005-2009; post-period is 2010-2013. Columns 2 and 3 do not include observations from the survey year. Treatment indicates women ages 21-27 while control group includes women ages 31-35. Standard errors are clustered on the woman-level.
*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table D.3 Instrumental Variables Results: The Effect of LARC Use on Pregnancies

Pregnant This Year					
	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate Probit[a]
PostxTreatment	-0.106***	-0.536**	-0.389**	-0.104***	-0.240***
	(0.010)	(0.226)	(0.160)	(0.009)	(0.061)
Black	0.011	-0.007	-0.001	0.013	-0.008
	(0.011)	(0.017)	(0.014)	(0.011)	(0.021)
Hispanic	-0.017	-0.004	-0.008	-0.016	-0.001
	(0.011)	(0.016)	(0.014)	(0.011)	(0.019)
Less than HS	0.048***	0.023	0.031*	0.049***	0.017
	(0.015)	(0.022)	(0.019)	(0.015)	(0.031)
Married	0.059***	0.060***	0.060***	0.062***	0.063***
	(0.010)	(0.012)	(0.011)	(0.010)	(0.015)
Sexually active	0.083***	0.039	0.054**	0.107***	0.089
	(0.014)	(0.032)	(0.025)	(0.016)	(0.060)
Age					
22	-0.025	-0.029	-0.028	-0.028	-0.030
	(0.024)	(0.024)	(0.024)	(0.025)	(0.024)
23	-0.062***	-0.078***	-0.073***	-0.066***	-0.080***
	(0.024)	(0.026)	(0.025)	(0.024)	(0.025)
24	-0.062***	-0.078***	-0.072***	-0.068***	-0.080***
	(0.023)	(0.026)	(0.025)	(0.024)	(0.025)
25	-0.064***	-0.081***	-0.075***	-0.068***	-0.083***
	(0.023)	(0.027)	(0.025)	(0.024)	(0.025)
26	-0.080***	-0.095***	-0.090***	-0.085***	-0.097***
	(0.023)	(0.026)	(0.024)	(0.024)	(0.026)
27	-0.095***	-0.121***	-0.112***	-0.100***	-0.124***
	(0.023)	(0.028)	(0.026)	(0.023)	(0.025)
31	-0.121***	-0.156***	-0.144***	-0.126***	-0.160***
	(0.023)	(0.030)	(0.027)	(0.023)	(0.025)
32	-0.130***	-0.165***	-0.153***	-0.134***	-0.168***
	(0.024)	(0.031)	(0.028)	(0.024)	(0.026)
33	-0.151***	-0.190***	-0.177***	-0.152***	-0.192***
	(0.023)	(0.032)	(0.028)	(0.023)	(0.026)
34	-0.153***	-0.193***	-0.179***	-0.156***	-0.196***
	(0.023)	(0.032)	(0.028)	(0.023)	(0.025)
35	-0.158***	-0.204***	-0.188***	-0.160***	-0.207***
	(0.023)	(0.035)	(0.030)	(0.023)	(0.028)
Year					
2005	-0.006	-0.047	-0.033	-0.005	-0.052
	(0.021)	(0.031)	(0.026)	(0.020)	(0.039)
2006	0.015	-0.023	-0.010	0.015	-0.029
	(0.019)	(0.028)	(0.024)	(0.018)	(0.038)
2007	-0.022	-0.046**	-0.037*	-0.019	-0.046*
	(0.018)	(0.023)	(0.020)	(0.017)	(0.025)
2008	0.011	0.003	0.006	0.010	0.002
	(0.020)	(0.021)	(0.020)	(0.019)	(0.022)

Table D.3 Continued

2010	0.003	0.016	0.012	0.007	0.023
	(0.019)	(0.021)	(0.020)	(0.020)	(0.023)
2011	0.042**	0.060***	0.054***	0.046**	0.066***
	(0.019)	(0.022)	(0.021)	(0.020)	(0.021)
2012	-0.005	0.019	0.011	-0.004	0.024
	(0.018)	(0.023)	(0.020)	(0.018)	(0.028)
2013	0.004	0.032	0.022	0.004	0.036
	(0.019)	(0.025)	(0.022)	(0.020)	(0.030)
Pregnant Next Year					
PostxTreatment	-0.075***	-0.587**	-0.395**	-0.074***	-0.080
	(0.012)	(0.278)	(0.186)	(0.012)	(0.164)
Black	0.010	-0.009	-0.002	0.009	0.009
	(0.012)	(0.018)	(0.015)	(0.013)	(0.015)
Hispanic	0.003	0.021	0.015	0.005	0.005
	(0.013)	(0.019)	(0.015)	(0.013)	(0.015)
Less than HS	0.022	-0.005	0.005	0.023	0.022
	(0.017)	(0.025)	(0.020)	(0.016)	(0.021)
Married	0.039***	0.042***	0.041***	0.041***	0.041***
	(0.011)	(0.014)	(0.012)	(0.011)	(0.012)
Sexually active	0.022	-0.045	-0.020	0.028	0.027
	(0.028)	(0.053)	(0.042)	(0.032)	(0.043)
Age					
22	-0.034	-0.039	-0.037	-0.035	-0.035
	(0.026)	(0.028)	(0.027)	(0.027)	(0.028)
23	0.008	-0.007	-0.002	0.007	0.006
	(0.027)	(0.030)	(0.028)	(0.027)	(0.029)
24	-0.014	-0.029	-0.023	-0.016	-0.016
	(0.027)	(0.031)	(0.028)	(0.027)	(0.029)
25	-0.059**	-0.078***	-0.071**	-0.062**	-0.062**
	(0.025)	(0.030)	(0.028)	(0.026)	(0.029)
26	-0.060**	-0.085***	-0.076***	-0.062**	-0.063**
	(0.025)	(0.031)	(0.028)	(0.026)	(0.030)
27	-0.074***	-0.096***	-0.088***	-0.076***	-0.077***
	(0.025)	(0.031)	(0.028)	(0.026)	(0.030)
31	-0.099***	-0.137***	-0.123***	-0.102***	-0.102***
	(0.025)	(0.035)	(0.030)	(0.026)	(0.034)
32	-0.097***	-0.134***	-0.120***	-0.098***	-0.099***
	(0.026)	(0.035)	(0.031)	(0.027)	(0.034)
33	-0.077***	-0.121***	-0.105***	-0.081***	-0.082**
	(0.027)	(0.038)	(0.033)	(0.027)	(0.036)
34	-0.143***	-0.193***	-0.174***	-0.144***	-0.145***
	(0.024)	(0.038)	(0.031)	(0.024)	(0.035)
35	-0.119***	-0.170***	-0.151***	-0.120***	-0.121***
	(0.026)	(0.040)	(0.033)	(0.026)	(0.037)
Year					
2005	-0.005	-0.042	-0.028	-0.008	-0.009
	(0.024)	(0.032)	(0.028)	(0.023)	(0.029)
2006	-0.018	-0.048*	-0.037	-0.019	-0.020
	(0.022)	(0.029)	(0.025)	(0.022)	(0.026)

Table D.3 Continued

2007	0.026	0.012	0.017	0.023	0.023
	(0.024)	(0.027)	(0.025)	(0.024)	(0.025)
2008	-0.051**	-0.049*	-0.050**	-0.052**	-0.052**
	(0.024)	(0.026)	(0.025)	(0.023)	(0.023)
2010	0.028	0.061*	0.048*	0.028	0.029
	(0.024)	(0.031)	(0.028)	(0.024)	(0.031)
2011	-0.024	0.012	-0.002	-0.025	-0.025
	(0.022)	(0.030)	(0.025)	(0.022)	(0.027)
2012	-0.021	0.015	0.002	-0.021	-0.021
	(0.022)	(0.031)	(0.026)	(0.022)	(0.028)
2013	-0.019	0.021	0.006	-0.019	-0.018
	(0.024)	(0.034)	(0.029)	(0.025)	(0.031)
Birth Next Year					
PostxTreatment	-0.069***	-0.443*	-0.246	-0.067***	-0.043
	(0.011)	(0.241)	(0.156)	(0.010)	(0.203)
Black	0.003	-0.011	-0.003	0.004	0.005
	(0.011)	(0.015)	(0.013)	(0.011)	(0.014)
Hispanic	0.015	0.029*	0.022	0.016	0.015
	(0.012)	(0.017)	(0.014)	(0.012)	(0.015)
Less than HS	0.028*	0.008	0.018	0.028*	0.030
	(0.016)	(0.022)	(0.018)	(0.015)	(0.020)
Married	0.061***	0.064***	0.062***	0.064***	0.064***
	(0.010)	(0.012)	(0.011)	(0.011)	(0.011)
Sexually active	0.066***	0.017	0.043*	0.092***	0.092***
	(0.012)	(0.039)	(0.026)	(0.015)	(0.015)
Age					
22	0.040*	0.037	0.039	0.044*	0.044*
	(0.024)	(0.024)	(0.024)	(0.025)	(0.025)
23	0.002	-0.010	-0.004	0.002	0.003
	(0.023)	(0.025)	(0.024)	(0.024)	(0.025)
24	-0.009	-0.020	-0.014	-0.008	-0.007
	(0.023)	(0.025)	(0.024)	(0.024)	(0.025)
25	-0.012	-0.026	-0.019	-0.011	-0.010
	(0.023)	(0.026)	(0.024)	(0.024)	(0.026)
26	-0.023	-0.041	-0.031	-0.024	-0.022
	(0.022)	(0.026)	(0.024)	(0.023)	(0.026)
27	-0.025	-0.040	-0.032	-0.026	-0.024
	(0.022)	(0.026)	(0.024)	(0.023)	(0.026)
31	-0.046**	-0.074**	-0.059**	-0.047**	-0.044
	(0.023)	(0.030)	(0.026)	(0.023)	(0.030)
32	-0.052**	-0.079***	-0.065**	-0.053**	-0.051*
	(0.023)	(0.029)	(0.026)	(0.023)	(0.029)
33	-0.083***	-0.115***	-0.098***	-0.081***	-0.079***
	(0.022)	(0.031)	(0.026)	(0.022)	(0.028)
34	-0.078***	-0.114***	-0.095***	-0.077***	-0.074**
	(0.022)	(0.033)	(0.027)	(0.022)	(0.030)
35	-0.090***	-0.126***	-0.107***	-0.087***	-0.084***
	(0.022)	(0.033)	(0.027)	(0.022)	(0.029)

Table D.3 Continued

Year					
2005	0.014	-0.014	0.001	0.011	0.013
	(0.021)	(0.028)	(0.024)	(0.020)	(0.025)
2006	0.024	0.002	0.014	0.022	0.024
	(0.020)	(0.025)	(0.022)	(0.019)	(0.024)
2007	0.007	-0.004	0.002	0.005	0.006
	(0.020)	(0.023)	(0.021)	(0.020)	(0.020)
2008	0.007	0.009	0.008	0.004	0.004
	(0.021)	(0.023)	(0.022)	(0.021)	(0.021)
2010	0.014	0.037	0.025	0.013	0.011
	(0.021)	(0.026)	(0.023)	(0.021)	(0.025)
2011	0.018	0.044*	0.030	0.016	0.014
	(0.019)	(0.026)	(0.022)	(0.019)	(0.026)
2012	0.007	0.033	0.019	0.006	0.003
	(0.019)	(0.026)	(0.022)	(0.019)	(0.026)
2013	0.017	0.046	0.031	0.013	0.011
	(0.022)	(0.029)	(0.024)	(0.022)	(0.029)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. Less than HS indicates less than high school education. Standard errors are clustered on the woman-level.
N: 5,832 woman-years from 2,958 women (top panel) and 4,552 woman-years from 2,629 women (bottom two panels)
F-stats for 2SLS first stage (column 2): 13.32 (top panel); 9.86 (bottom two panels)
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively. Standard
[a] Average marginal effects

Table D.4 Instrumental Variables Results: The Effect of LARC Use on Pregnancies Among Women Who Use Contraception 9+ Months

Pregnant This Year	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate Probit[a]
PostxTreatment	-0.064***	-0.484**	-0.226*	-0.062***	-0.117***
	(0.009)	(0.239)	(0.131)	(0.008)	(0.031)
Black	0.015	-0.008	0.006	0.013	0.006
	(0.012)	(0.020)	(0.015)	(0.011)	(0.015)
Hispanic	-0.019*	-0.002	-0.012	-0.016	-0.013
	(0.011)	(0.019)	(0.013)	(0.010)	(0.014)
Less than HS	0.038**	0.005	0.025	0.036**	0.027
	(0.017)	(0.028)	(0.020)	(0.016)	(0.019)
Married	0.007	0.004	0.006	0.009	0.009
	(0.010)	(0.014)	(0.011)	(0.010)	(0.012)
Sexually active	0.046***	0.012	0.033**	0.059***	0.073***
	(0.010)	(0.030)	(0.016)	(0.011)	(0.022)
Age					
22	-0.002	-0.024	-0.010	-0.005	-0.017
	(0.027)	(0.031)	(0.027)	(0.027)	(0.033)
23	-0.040	-0.063**	-0.049*	-0.045*	-0.064*
	(0.025)	(0.031)	(0.026)	(0.026)	(0.033)
24	-0.026	-0.059*	-0.039	-0.028	-0.048
	(0.026)	(0.036)	(0.029)	(0.027)	(0.034)
25	-0.057**	-0.087***	-0.068***	-0.059**	-0.084**
	(0.024)	(0.033)	(0.026)	(0.025)	(0.033)
26	-0.034	-0.075**	-0.050*	-0.037	-0.062*
	(0.025)	(0.038)	(0.029)	(0.026)	(0.034)
27	-0.039	-0.078**	-0.054*	-0.042	-0.067**
	(0.025)	(0.036)	(0.029)	(0.026)	(0.034)
31	-0.039	-0.098**	-0.062*	-0.042	-0.075**
	(0.026)	(0.044)	(0.032)	(0.026)	(0.036)
32	-0.077***	-0.131***	-0.098***	-0.078***	-0.116***
	(0.024)	(0.041)	(0.030)	(0.025)	(0.036)
33	-0.089***	-0.155***	-0.114***	-0.090***	-0.134***
	(0.023)	(0.045)	(0.031)	(0.024)	(0.037)
34	-0.094***	-0.154***	-0.117***	-0.096***	-0.140***
	(0.022)	(0.042)	(0.029)	(0.023)	(0.038)
35	-0.096***	-0.169***	-0.124***	-0.098***	-0.146***
	(0.023)	(0.050)	(0.033)	(0.040)	(0.023)
Year					
2005	-0.024	-0.071**	-0.042	-0.021	-0.042
	(0.021)	(0.036)	(0.027)	(0.019)	(0.026)
2006	-0.008	-0.050	-0.024	-0.010	-0.028
	(0.020)	(0.032)	(0.024)	(0.018)	(0.025)
2007	-0.021	-0.039*	-0.028	-0.021	-0.032
	(0.018)	(0.024)	(0.020)	(0.017)	(0.022)
2008	0.014	0.016	0.015	0.012	0.014
	(0.023)	(0.026)	(0.024)	(0.022)	(0.026)

Table D.4 Continued

2010	0.012	0.029	0.018	0.012	0.022
	(0.022)	(0.026)	(0.023)	(0.022)	(0.027)
2011	0.000	0.026	0.010	0.003	0.015
	(0.019)	(0.026)	(0.021)	(0.020)	(0.025)
2012	-0.014	0.020	-0.001	-0.014	-0.004
	(0.019)	(0.029)	(0.021)	(0.019)	(0.025)
2013	0.001	0.037	0.015	0.001	0.016
	(0.021)	(0.032)	(0.024)	(0.022)	(0.029)
Pregnant Next Year					
PostxTreatment	-0.064***	-0.484**	-0.226*	-0.062***	-0.117***
	(0.009)	(0.239)	(0.131)	(0.008)	(0.031)
Black	0.015	-0.008	0.006	0.013	0.006
	(0.012)	(0.020)	(0.015)	(0.011)	(0.015)
Hispanic	-0.019*	-0.002	-0.012	-0.016	-0.013
	(0.011)	(0.019)	(0.013)	(0.010)	(0.014)
Less than HS	0.038**	0.005	0.025	0.036**	0.027
	(0.017)	(0.028)	(0.020)	(0.016)	(0.019)
Married	0.007	0.004	0.006	0.009	0.009
	(0.010)	(0.014)	(0.011)	(0.010)	(0.012)
Sexually active	0.046***	0.012	0.033**	0.059***	0.073***
	(0.010)	(0.030)	(0.016)	(0.011)	(0.022)
Age					
22	-0.002	-0.024	-0.010	-0.005	-0.017
	(0.027)	(0.031)	(0.027)	(0.027)	(0.033)
23	-0.040	-0.063**	-0.049*	-0.045*	-0.064*
	(0.025)	(0.031)	(0.026)	(0.026)	(0.033)
24	-0.026	-0.059*	-0.039	-0.028	-0.048
	(0.026)	(0.036)	(0.029)	(0.027)	(0.034)
25	-0.057**	-0.087***	-0.068***	-0.059**	-0.084**
	(0.024)	(0.033)	(0.026)	(0.025)	(0.033)
26	-0.034	-0.075**	-0.050*	-0.037	-0.062*
	(0.025)	(0.038)	(0.029)	(0.026)	(0.034)
27	-0.039	-0.078**	-0.054*	-0.042	-0.067**
	(0.025)	(0.036)	(0.029)	(0.026)	(0.034)
31	-0.039	-0.098**	-0.062*	-0.042	-0.075**
	(0.026)	(0.044)	(0.032)	(0.026)	(0.036)
32	-0.077***	-0.131***	-0.098***	-0.078***	-0.116***
	(0.024)	(0.041)	(0.030)	(0.025)	(0.036)
33	-0.089***	-0.155***	-0.114***	-0.090***	-0.134***
	(0.023)	(0.045)	(0.031)	(0.024)	(0.037)
34	-0.094***	-0.154***	-0.117***	-0.096***	-0.140***
	(0.022)	(0.042)	(0.029)	(0.023)	(0.038)
35	-0.096***	-0.169***	-0.124***	-0.098***	-0.146***
	(0.023)	(0.050)	(0.033)	(0.023)	(0.040)
Year					
2005	-0.024	-0.071**	-0.042	-0.021	-0.042
	(0.021)	(0.036)	(0.027)	(0.019)	(0.026)
2006	-0.008	-0.050	-0.024	-0.010	-0.028
	(0.020)	(0.032)	(0.024)	(0.018)	(0.025)

Table D.4 Continued

2007	-0.021	-0.039*	-0.028	-0.021	-0.032
	(0.018)	(0.024)	(0.020)	(0.017)	(0.022)
2008	0.014	0.016	0.015	0.012	0.014
	(0.023)	(0.026)	(0.024)	(0.022)	(0.026)
2010	0.012	0.029	0.018	0.012	0.022
	(0.022)	(0.026)	(0.023)	(0.022)	(0.027)
2011	0.000	0.026	0.010	0.003	0.015
	(0.019)	(0.026)	(0.021)	(0.020)	(0.025)
2012	-0.014	0.020	-0.001	-0.014	-0.004
	(0.019)	(0.029)	(0.021)	(0.019)	(0.025)
2013	0.001	0.037	0.015	0.001	0.016
	(0.021)	(0.032)	(0.024)	(0.022)	(0.029)
Birth Next Year					
PostxTreatment	-0.064***	-0.484**	-0.226*	-0.062***	-0.117***
	(0.009)	(0.239)	(0.131)	(0.008)	(0.031)
Black	0.015	-0.008	0.006	0.013	0.006
	(0.012)	(0.020)	(0.015)	(0.011)	(0.015)
Hispanic	-0.019*	-0.002	-0.012	-0.016	-0.013
	(0.011)	(0.019)	(0.013)	(0.010)	(0.014)
Less than HS	0.038**	0.005	0.025	0.036**	0.027
	(0.017)	(0.028)	(0.020)	(0.016)	(0.019)
Married	0.007	0.004	0.006	0.009	0.009
	(0.010)	(0.014)	(0.011)	(0.010)	(0.012)
Sexually active	0.046***	0.012	0.033**	0.059***	0.073***
	(0.010)	(0.030)	(0.016)	(0.011)	(0.022)
Age					
22	-0.002	-0.024	-0.010	-0.005	-0.017
	(0.027)	(0.031)	(0.027)	(0.027)	(0.033)
23	-0.040	-0.063**	-0.049*	-0.045*	-0.064*
	(0.025)	(0.031)	(0.026)	(0.026)	(0.033)
24	-0.026	-0.059*	-0.039	-0.028	-0.048
	(0.026)	(0.036)	(0.029)	(0.027)	(0.034)
25	-0.057**	-0.087***	-0.068***	-0.059**	-0.084**
	(0.024)	(0.033)	(0.026)	(0.025)	(0.033)
26	-0.034	-0.075**	-0.050*	-0.037	-0.062*
	(0.025)	(0.038)	(0.029)	(0.026)	(0.034)
27	-0.039	-0.078**	-0.054*	-0.042	-0.067**
	(0.025)	(0.036)	(0.029)	(0.026)	(0.034)
31	-0.039	-0.098**	-0.062*	-0.042	-0.075**
	(0.026)	(0.044)	(0.032)	(0.026)	(0.036)
32	-0.077***	-0.131***	-0.098***	-0.078***	-0.116***
	(0.024)	(0.041)	(0.030)	(0.025)	(0.036)
33	-0.089***	-0.155***	-0.114***	-0.090***	-0.134***
	(0.023)	(0.045)	(0.031)	(0.024)	(0.037)
34	-0.094***	-0.154***	-0.117***	-0.096***	-0.140***
	(0.022)	(0.042)	(0.029)	(0.023)	(0.038)
35	-0.096***	-0.169***	-0.124***	-0.098***	-0.146***
	(0.023)	(0.050)	(0.033)	(0.023)	(0.040)

Table D.4 Continued

Year					
2005	-0.024	-0.071**	-0.042	-0.021	-0.042
	(0.021)	(0.036)	(0.027)	(0.019)	(0.026)
2006	-0.008	-0.050	-0.024	-0.010	-0.028
	(0.020)	(0.032)	(0.024)	(0.018)	(0.025)
2007	-0.021	-0.039*	-0.028	-0.021	-0.032
	(0.018)	(0.024)	(0.020)	(0.017)	(0.022)
2008	0.014	0.016	0.015	0.012	0.014
	(0.023)	(0.026)	(0.024)	(0.022)	(0.026)
2010	0.012	0.029	0.018	0.012	0.022
	(0.022)	(0.026)	(0.023)	(0.022)	(0.027)
2011	0.000	0.026	0.010	0.003	0.015
	(0.019)	(0.026)	(0.021)	(0.020)	(0.025)
2012	-0.014	0.020	-0.001	-0.014	-0.004
	(0.019)	(0.029)	(0.021)	(0.019)	(0.025)
2013	0.001	0.037	0.015	0.001	0.016
	(0.021)	(0.032)	(0.024)	(0.022)	(0.029)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child who have used contraception for at least 9 months of a year. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.
N: 3,121 woman-years from 1,816 women (row 1); 2,877 woman-years from 1,734 women (rows 2 and 3)
F-stats for 2SLS first stage (column 2): 7.29 (row 1); 6.76 (rows 2 and 3)
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.
[a] Average marginal effects

Table D.5 Control Function Results: The Effect of LARC Use on Pregnancies

	(1) Pregnant this year	(2) Pregnant this year	(3) Pregnant next year (CF)	(4) Pregnant next year	(5) Birth next year	(6) Birth Next Year
LARC	-0.313***	-0.349***	-0.123	-0.268*	-0.106	-0.190
	(0.117)	(0.131)	(0.136)	(0.156)	(0.124)	(0.142)
$\hat{v}$	0.115*	0.180	0.027	0.274*	0.020	0.164
	(0.065)	(0.125)	(0.075)	(0.151)	(0.068)	(0.137)
LARC$\times \hat{v}$		-0.056		-0.202*		-0.117
		(0.091)		(0.107)		(0.097)
Black	0.002	-0.002	0.009	-0.004	0.002	-0.006
	(0.012)	(0.014)	(0.013)	(0.015)	(0.012)	(0.014)
Hispanic	-0.011	-0.008	0.005	0.017	0.017	0.024*
	(0.012)	(0.012)	(0.014)	(0.015)	(0.012)	(0.014)
Less than HS	0.036**	0.030*	0.020	0.001	0.026*	0.015
	(0.015)	(0.017)	(0.017)	(0.020)	(0.016)	(0.018)
Married	0.060***	0.060***	0.039***	0.042***	0.061***	0.063***
	(0.010)	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)
Sexually active	0.062**	0.054*	0.016	-0.023	0.061**	0.039
	(0.027)	(0.030)	(0.034)	(0.040)	(0.031)	(0.036)
Age						
22	-0.027	-0.028	-0.034	-0.038	0.040*	0.038*
	(0.021)	(0.021)	(0.024)	(0.024)	(0.021)	(0.022)
23	-0.070***	-0.073***	0.007	-0.002	0.001	-0.005
	(0.021)	(0.022)	(0.024)	(0.024)	(0.022)	(0.022)
24	-0.070***	-0.072***	-0.015	-0.023	-0.010	-0.014
	(0.021)	(0.022)	(0.024)	(0.024)	(0.022)	(0.022)
25	-0.072***	-0.076***	-0.061**	-0.071***	-0.014	-0.020
	(0.021)	(0.022)	(0.024)	(0.025)	(0.022)	(0.023)
26	-0.087***	-0.090***	-0.063**	-0.078***	-0.025	-0.033
	(0.021)	(0.022)	(0.024)	(0.026)	(0.022)	(0.023)
27	-0.107***	-0.112***	-0.076***	-0.089***	-0.026	-0.033
	(0.022)	(0.024)	(0.025)	(0.025)	(0.022)	(0.023)
31	-0.138***	-0.144***	-0.103***	-0.126***	-0.049*	-0.062**
	(0.024)	(0.027)	(0.027)	(0.030)	(0.025)	(0.027)

Table D.5 Continued

32	-0.147***	-0.153***	-0.101***	-0.122***	-0.054**	-0.067**
	(0.025)	(0.027)	(0.028)	(0.030)	(0.026)	(0.028)
33	-0.170***	-0.177***	-0.081***	-0.109***	-0.086***	-0.102***
	(0.026)	(0.028)	(0.029)	(0.032)	(0.026)	(0.029)
34	-0.172***	-0.180***	-0.148***	-0.179***	-0.081***	-0.099***
	(0.026)	(0.029)	(0.029)	(0.033)	(0.026)	(0.030)
35	-0.180***	-0.189***	-0.124***	-0.155***	-0.093***	-0.111***
	(0.027)	(0.031)	(0.030)	(0.034)	(0.027)	(0.031)
Year						
2005	-0.026	-0.036	-0.009	-0.039	0.011	-0.006
	(0.023)	(0.029)	(0.025)	(0.029)	(0.023)	(0.027)
2006	-0.003	-0.013	-0.021	-0.045*	0.022	0.008
	(0.021)	(0.026)	(0.023)	(0.027)	(0.021)	(0.024)
2007	-0.033*	-0.039*	0.025	0.013	0.006	-0.001
	(0.020)	(0.022)	(0.023)	(0.024)	(0.021)	(0.022)
2008	0.007	0.006	-0.051**	-0.049**	0.007	0.008
	(0.020)	(0.020)	(0.024)	(0.024)	(0.022)	(0.022)
2010	0.009	0.012	0.031	0.052*	0.016	0.028
	(0.020)	(0.021)	(0.025)	(0.027)	(0.022)	(0.025)
2011	0.051***	0.054***	-0.020	0.002	0.021	0.033
	(0.020)	(0.020)	(0.024)	(0.026)	(0.022)	(0.024)
2012	0.006	0.011	-0.017	0.005	0.010	0.022
	(0.020)	(0.021)	(0.024)	(0.027)	(0.022)	(0.024)
2013	0.017	0.022	-0.015	0.009	0.020	0.034
	(0.021)	(0.023)	(0.026)	(0.029)	(0.024)	(0.027)

Unweighted data. Contraceptive users only. N = 5,832 woman-years from 2,958 women with one child (columns 1 and 2); N = 4,552 woman-years from 2,629 women with one child (columns 3 through 6). Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. ν indicates generalized residuals. All specifications include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls.
*, **, and *** indicate significance at the 0.10 ,0.05 and 0.01 levels, respectively.
Bootstrap standard errors forthcoming.

APPENDIX E

CHAPTER III INTRUMENTAL VARIABLES ROBUSTNESS CHECKS

Table E.1 Instrumental Variables Results: The Effect of LARC Use on Pregnancies Among Contracepting and Non-Contracepting Women

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.132***	-0.384*	-0.315*	-0.124***	-0.196***
	(0.010)	(0.227)	(0.171)	(0.009)	(0.047)
Pregnant next year					
LARC use	-0.080***	-0.611**	-0.408**	-0.077***	-0.090
	(0.012)	(0.298)	(0.205)	(0.011)	(0.100)
Birth next year					
LARC use	-0.084***	-0.516*	-0.344*	-0.080***	-0.093
	(0.010)	(0.275)	(0.189)	(0.010)	(0.118)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Mothers of one child only. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.
N: 7,628 woman-years from 3,647 women (row 1) and 5,891 woman-years from 3,261 women (rows 2 and 3)
F-stats for 2SLS first stage (column 2): 14.53 (row 1); 10.40 (row 2 and 3)
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.
[a] Average marginal effects

Table E.2 Instrumental Variables Results: The Effect of LARC Use on Pregnancies Among Sexually Active Women

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate Probit [a]
Pregnant this year					
LARC use	-0.110***	-0.501**	-0.378**	-0.138***	-0.440***
	(0.011)	(0.213)	(0.168)	(0.017)	(0.129)
Pregnant next year					
LARC use	-0.078***	-0.510**	-0.340*	-0.090***	-0.085
	(0.013)	(0.252)	(0.193)	(0.017)	(0.222)
Birth next year					
LARC use	-0.073***	-0.407*	-0.251	-0.088***	-0.118
	(0.011)	(0.225)	(0.175)	(0.017)	(0.511)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.
N: 5,612 woman-years from 2,897 women (row 1) and 4,403 woman-years from 2,582 women (rows 2 and 3)
F-stats for 2SLS first stage (column 2): 15.13 (row 1); 11.27 (row 2 and 3)
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively
[a] Average marginal effects

Table E.3 Instrumental Variables Results: The Effect of LARC Use on Pregnancies (Women Ages 18-27 vs. 31-38)

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.483**	-0.358***	-0.483**	-0.358***	-0.483**
	(0.232)	(0.128)	(0.232)	(0.128)	(0.232)
Pregnant next year					
LARC use	-0.084***	-0.529*	-0.243*	-0.079***	-0.056
	(0.010)	(0.310)	(0.139)	(0.010)	(0.095)
Birth next year					
LARC use	-0.075***	-0.396	-0.196	-0.072***	-0.012
	(0.009)	(0.269)	(0.123)	(0.008)	(0.111)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 18-27 while control group includes women ages 31-38. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.
N: 7,847 woman-years from 3,718 women (row 1) and 6,145 woman-years from 3,401 women (rows 2 and 3)
F-stats for 2SLS first stage (column 2): 11.86 (row 1); 7.43 (row 2 and 3)
[a] Average marginal effects

Table E.4 Instrumental Variables Results: The Effect of LARC Use on Pregnancies (Women Ages 23-27 vs. 31-35)

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.098***	-0.659**	-0.474*	-0.096***	-0.253***
	(0.011)	(0.318)	(0.243)	(0.010)	(0.008)
Pregnant next year					
LARC use	-0.071***	-0.235	-0.090	-0.068***	0.075
	(0.014)	(0.334)	(0.266)	(0.013)	(0.189)
Birth next year					
LARC use	-0.056***	-0.491	-0.210	-0.055***	0.228
	(0.012)	(0.357)	(0.239)	(0.011)	(0.223)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 23-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.

*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

N: 4,761 woman-years from 2,491 women (row 1) and 3,713 woman-years from 2,183 women (rows 2 and 3)

F-stats for 2SLS first stage (column 2): 8.08 (row 1); 4.86 (row 2 and 3)

[a] Average marginal effects

Table E.5 Instrumental Variables Results: The Effect of LARC Use on Pregnancies (Women Ages 23-28 vs 32-36)

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.098***	-0.407*	-0.333**	-0.096***	-0.235
	(0.010)	(0.215)	(0.155)	(0.009)	(0.663)
Pregnant next year					
LARC use	-0.082***	-0.483**	-0.335**	-0.080***	-0.049
	(0.012)	(0.246)	(0.167)	(0.011)	(0.164)
Birth next year					
LARC use	-0.073***	-0.375*	-0.239*	-0.071***	-0.041
	(0.010)	(0.212)	(0.144)	(0.009)	(0.203)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 23-28 while control group includes women ages 32-36. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.
*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.
N: 5,168 woman-years from 2,616 women (row 1) and 4,031 woman-years from 2,312 women (rows 2 and 3)
F-stats for 2SLS first stage (column 2): 7.42 (row 1); 6.07 (row 2 and 3)
[a] Average marginal effects

Table E.6 Instrumental Variables Results: The Effect of LARCs on Pregnancy Using Non-Survey Years Only

	(1) LARC use OLS	(2) LARC use Direct 2SLS	(3) LARC use Probit 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.122***	-0.563**	-0.365*	-0.119***	-0.284***
	(0.012)	(0.285)	(0.188)	(0.011)	(0.009)
Pregnant next year					
LARC use	-0.075***	-0.587**	-0.395**	-0.074***	-0.080
	(0.012)	(0.278)	(0.186)	(0.012)	(0.164)
Birth next year					
LARC use	-0.069***	-0.443*	-0.246	-0.067***	-0.043
	(0.011)	(0.241)	(0.156)	(0.010)	(0.203)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.

*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively

N: 4,552 woman-years from 2,629 women

F-stats for 2SLS first stage (column 2): 9.86

[a] Average marginal effects

Table E.7 Instrumental Variables Results: The Effect of LARC Use on Pregnancies Using NSFG Weights

	(1) LARC use OLS	(2) LARC use 2SLS	(3) LARC use 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.130***	-0.567*	-0.468**	-0.123***	-0.246***
	(0.014)	(0.342)	(0.204)	(0.012)	(0.033)
Pregnant next year					
LARC use	-0.062***	-0.821*	-0.644***	-0.061***	-0.260***
	(0.022)	(0.477)	(0.240)	(0.021)	(0.014)
Birth next year					
LARC use	-0.066***	-0.551	-0.417*	-0.063***	N/A[b]
	(0.016)	(0.411)	(0.217)	(0.015)	

Weighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.

*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively

N: 5,832 woman-years from 2,958 women (row 1) and 4,552 woman-years from 2,629 women (rows 2 and 3)

F-stats for 2SLS first stage (column 2): 13.32 (row 1); 9.86 (row 2 and 3)

[a] Average marginal effects

[b] Bivariate probit results unavailable as model did not converge.

Table E.8 Instrumental Variables Results: The Effect of LARC Use on Pregnancies Including Income and Insurance Controls

	(1) LARC use OLS	(2) LARC use 2SLS	(3) LARC use 2SLS	(4) LARC use Probit [a]	(5) LARC use Bivariate probit [a]
Pregnant this year					
LARC use	-0.106***	-0.527**	-0.376**	-0.104***	-0.223***
	(0.010)	(0.220)	(0.162)	(0.009)	(0.044)
Pregnant next year					
LARC use	-0.075***	-0.552**	-0.396**	-0.073***	-0.037
	(0.012)	(0.261)	(0.187)	(0.012)	(0.216)
Birth next year					
LARC use	-0.069***	-0.423*	-0.258	-0.067***	-0.035
	(0.011)	(0.229)	(0.160)	(0.010)	(0.204)

Unweighted data from the 2006-2010, 2011-2013, 2013-2015 NSFG. Contraceptive users only with one child. Pre-period is 2005-2009; post-period is 2010-2013. Treatment indicates women ages 21-27 while control group includes women ages 31-35. All models include indicators for if the woman used private insurance in the survey year, if the woman used public insurance in the survey year, and controls for her total income level. Each model also includes indicators of if the woman is Black, Hispanic, married, sexually active, has less than a high school education and year and age controls. Standard errors are clustered on the woman-level.

*, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels, respectively.

N: 5, woman-years from 2,958 women (row 1) and 4,552 woman-years from 2,629 women (rows 2 and 3)

F-stats for 2SLS first stage (column 2): 3.93 (row 1); 3.60 (row 2 and 3)

[a] Average marginal effects

APPENDIX F

CHAPTER IV CONTRACEPTIVE ATTRIBUTES CONDITIONAL LOGISTIC REGRESSION RESULTS INCLUDING STERILIZATION ALTERNATIVES

In my main analysis, I do not include women who choose to rely on sterilization (either male or female) as very few women choose sterilization during the 12 months when I observe them. However, as sterilization is a popular contraceptive option, I reestimate the results for the attributes specification allowing women to choose between 9 contraceptive options: no method, female sterilization, male sterilization, the contraceptive implant, hormonal IUD, non-hormonal IUD, SARCs, condoms, or traditional methods.

In Tables F.1 and F.2 I report the cost data and attributes data including information on sterilization outcomes. In Table F.3, I report the results of the attributes model including sterilization options. I also estimate the attribute specification among contracepting women only and report the results in F.4. In both tables, the utility of using a longer lasting method is negative. This may reflect how infrequently sterilization (which is much longer lasting that other methods) is chosen. The main effect of device is negative in both tables, though the coefficient on device is less negative in Table F.3.

Table F.1. Summary of Contraceptive Out-Of-Pocket Costs Including Sterilization Alternatives

	Uninsured ($)	Public ($)	Private (Pre-ACA) ($)	Private (Post-ACA) ($)
Female Sterilization	2912[a]	0[h]	582.4[f]	174.72[f, g]
Implant	749.45[a]	0[h]	320.31[c]	91.01[c]
Non-Hormonal IUD	718[a]	0[h]	262.38[c]	84.3[c]
Hormonal IUD	844[a]	0[h]	262.38[c]	84.3[c]
Male Sterilization	707.97[a]	0[h]	141.59[f]	141.59[f, d]
SARC	52.81[a]	0[h]	16.37[c, e]	10.19[c, e]
Condoms	9[a, g]	9[a, g]	9[a, g]	9[a, g]
Traditional	0	0	0	0
No Method	0	0	0	0

[a] Source: Trussell et al (2010); Source: [b]Trussell et al. (2009). [c] Source: Becker and Polsky (2015); the authors note that the out-of-pocket expenses reported from their data are sometimes women filling 2-3 month prescriptions(Becker & Polsky, 2015), thus I have divided the amount reported by 2; the resulting number is in line with 2010 and 2013 estimates from Kim and Look (2018) (Kim & Look, 2018) ; [d] Expenses for 1 month of condoms, assuming couple purchases one 12-count box a month, or uses 9 condoms a month at a price of $1 each as in Trussell et al. [e] Family planning expenses are generally covered by Medicaid; thus, I have assumed $0 out-of-pocket expenses for all methods other than condoms. However, there is variation by state in family planning coverage by state (Walls et al., 2016.). Since the NSFG does not release state identifiers in their public-use files, I cannot account for these state-by-state differences. [f] Using "Uninsured" price and assuming 20% co-insurance rate. [f] Assuming female sterilization experienced a similar percentage fall in price as LARCs (~ 70 percentage points). [g] Male sterilization is not covered by the ACA contraceptive mandate.

Table F.2 Contraceptive Attribute Data Summary Including Sterilization Alternatives

Alternative	Price* ($)	Hormonal	Device	Reduction of Pregnancy Risk x 100	Maximum Duration of Use (Years)
Female Sterilization	0 - 2,912	No	No	84.5	30
Implant	0- 749.45	Yes	Yes	84.95	3
Non-Hormonal IUD	0 - 718	No	Yes	84.2	10
Hormonal IUD	0 - 844	Yes	Yes	84.8	5
Male Sterilization	0- 707.97	No	No	84.85	30
SARC	0 - 52.81	Yes	No	76	0.083
Condoms	9	No	No	67	0.003
Traditional	0	No	No	62	0.003
No Method	0	No	No	0	0

*Price varies by insurance status (see Table F.1)

Table F.3 Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions Including Sterilization Alternatives

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.114***	1.364***	-0.733***	-1.531***	-0.114***
Interactions	(0.009)	(0.234)	(0.224)	(0.327)	(0.032)
Age group					
19-23		0.239**	-0.0898	0.293*	-0.0112
		(0.105)	(0.120)	(0.161)	(0.011)
29-33		-0.0986	-0.189*	-0.375***	0.000769
		(0.100)	(0.106)	(0.143)	(0.008)
34-38		-0.116	-0.270**	-0.859***	0.00553
		(0.114)	(0.127)	(0.159)	(0.010)
39-44		-0.340***	-0.233*	-1.239***	0.0111
		(0.129)	(0.139)	(0.174)	(0.011)
Black		-0.13	-0.298***	-0.325***	-0.0281***
		(0.090)	(0.105)	(0.125)	(0.009)
Hispanic		-0.362***	0.397***	-0.0364	0.00138
		(0.089)	(0.093)	(0.123)	(0.007)
Married		-0.511***	0.267***	0.168	-0.0118*
		(0.083)	(0.093)	(0.114)	(0.007)
Income		0.0320**	0.0441***	0.0397**	0.00247**
		(0.013)	(0.015)	(0.019)	(0.001)
Working		0.217***	0.320***	-0.00985	0.0174***
		(0.078)	(0.090)	(0.109)	(0.007)
Greater than HS		0.071	0.107	0.419***	0.0179**
		(0.083)	(0.096)	(0.118)	(0.008)
One child		-0.246***	0.617***	-0.00503	0.0139
		(0.094)	(0.110)	(0.132)	(0.009)
Two children		-0.344***	0.791***	0.333**	0.0235**
		(0.103)	(0.120)	(0.149)	(0.009)
Three children		-0.433***	0.798***	0.17	0.0285***
		(0.127)	(0.144)	(0.175)	(0.011)

Table F.3 Continued

Limiting fertility	0.0931	0.11	0.782***	0.0184***
	(0.085)	(0.090)	(0.125)	(0.006)
Condition	0.137	0.0995	-0.823***	0.00822
	(0.094)	(0.107)	(0.127)	(0.010)
Usual Care	0.412***	-0.137	-0.0843	0.00373
	(0.096)	(0.116)	(0.128)	(0.010)
Metropolitan Area	-0.499***	0.239**	0.388**	-0.00251
	(0.113)	(0.120)	(0.161)	(0.009)
Suburban Area	-0.407***	0.172	0.324**	0.00401
	(0.111)	(0.117)	(0.159)	(0.009)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,509 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization as of 12 months before survey date, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. GTHS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, and zero for number of children. Standard errors (clustered at woman-level) are in parentheses.

* p<0.10, ** p<0.05, *** p<0.010

Table F.4 Contraceptive Attributes Conditional Logistic Regression Results with Attribute-Characteristic Interactions Among Women Using Contraception Including Sterilization Alternatives

Attributes	Birth Control Price	Hormonal Method	Device	Reduction in Risk of Pregnancy	Maximum Duration of Use
	-0.122***	-1.052**	-2.596***	21.80***	-0.268***
Interactions	(0.011)	(0.531)	(0.397)	(4.553)	(0.049)
Age group					
19-23		-0.124	-0.26	3.932	-0.0464*
		(0.271)	(0.235)	(2.508)	(0.026)
29-33		-0.218	-0.299	0.74	-0.00555
		(0.238)	(0.209)	(2.177)	(0.019)
34-38		-0.376	-0.483*	1.598	-0.00991
		(0.274)	(0.248)	(2.497)	(0.022)
39-44		-0.255	-0.213	-2.502	0.0207
		(0.307)	(0.271)	(2.764)	(0.024)
Black		-0.572***	-0.622***	3.847*	-0.0651***
		(0.221)	(0.199)	(2.041)	(0.021)
Hispanic		-0.790***	-0.111	5.326***	-0.0375**
		(0.205)	(0.189)	(1.919)	(0.017)
Married		-0.131	0.482***	-3.613**	0.00651
		(0.199)	(0.179)	(1.815)	(0.016)
Income		0.0693**	0.0716**	-0.357	0.00525**
		(0.032)	(0.028)	(0.290)	(0.003)
Working		0.766***	0.756***	-5.610***	0.0619***
		(0.188)	(0.173)	(1.735)	(0.016)
Greater than HS		-0.0411	0.00765	1.703	0.012
		(0.206)	(0.183)	(1.879)	(0.017)
One child		0.870***	1.306***	-10.26***	0.0949***
		(0.240)	(0.210)	(2.186)	(0.020)
Two children		0.879***	1.488***	-10.36***	0.111***
		(0.253)	(0.228)	(2.314)	(0.022)
Three children		0.932***	1.559***	-11.75***	0.127***
		(0.299)	(0.273)	(2.714)	(0.025)

Table F.4 Continued

Limiting fertility	0.0782	0.0414	1.672	0.0181
	(0.199)	(0.178)	(1.809)	(0.015)
Condition	0.756***	0.566***	-7.089***	0.0536***
	(0.235)	(0.201)	(2.079)	(0.019)
Usual Care	-0.0754	-0.460**	5.006**	-0.0339*
	(0.222)	(0.208)	(2.018)	(0.019)
Metropolitan Area	0.25	0.732***	-6.905***	0.0500**
	(0.286)	(0.251)	(2.678)	(0.023)
Suburban Area	0.407	0.723***	-7.697***	0.0648***
	(0.283)	(0.247)	(2.652)	(0.022)

Unweighted data from 2011-2013, 2013-2015 and 2015-2017 NSFG. N = 7,509 between the ages of 19 and 44 who are not currently pregnant, not relying on sterilization as of 12 months before survey date, have been sexually active at least 3 of the past 12 months, and have had private or public insurance or have been uninsured for the past 12 months. GTHS indicates woman has greater than a high school education, condition indicates woman has a condition that may benefit from hormonal contraception. Includes set of year controls. Base category for age is 24-28, and zero for number of children. Standard errors (clustered at woman-level) are in parentheses.
* p<0.10, ** p<0.05, *** p<0.010