THE ROLE OF CONTRACEPTION IN PREVENTING ABORTION, NONMARITAL CHILDBEARING, AND CHILD POVERTY

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Abstract. We simulate the effects of changes in contraceptive behavior among unmarried young women and men on rates of nonmarital childbearing, abortion, and child poverty. These simulations are motivated by previous studies showing, first, that disadvantaged women are disproportionately likely to experience unplanned and nonmarital pregnancies and, second, that many individuals at risk of unintended pregnancy do not use contraception or do not use it consistently and correctly. Our simulations are performed using FamilyScape 2.0, a microsimulation model of family formation. We simulate both increases in contraceptive use among non-contraceptors and improvements in the consistency and effectiveness of contraceptive use among existing contraceptors. Our results show that changes in either margin of behavior are likely to produce sizeable effects. For example, we find that, if 25 percent of non-contracepting unmarried women under the age of 30 were to begin using contraception, abortion and nonmarital birth rates among unmarried women in this age group would fall by about 25 percent and about 13 percent, respectively. We also find that this simulated increase in contraceptive use would reduce the poverty rate among newborn children by about a half of a percentage point. We obtain very similar results in another specification in which we assume that all currently contracepting women in our target population begin to use their chosen methods consistently and correctly. We conclude that increases in contraceptive use among non-contraceptors and improvements in the consistency and correctness of contraceptive use among existing contraceptors both represent promising and potentially cost-effective avenues for reducing the incidences of abortion, nonmarital childbearing, and child poverty.

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I. Introduction

Unintended pregnancy and nonmarital childbearing among young adults continue to stand out as important public policy issues. Over 40 percent of all births now occur outside of marriage, and that number rises to over half among women under the age of 30. One reason for the high number of nonmarital births is the fact that unintended pregnancy is quite common. Although teen pregnancy has declined over the past two decades, unintended pregnancy among women in their twenties rose modestly during the same period, and seven in ten pregnancies among unmarried women under 30 were reported as unintended in 2008.[1]

The disconnect between family planning goals and outcomes is a source of potential concern. Nonmarital childbearing and unintended pregnancy are associated with a variety of adverse outcomes for mothers, their children, and society as a whole.[2] For example, research has shown there to be a strong link between nonmarital childbearing and child poverty (Thomas and Sawhill, 2002). Moreover, women who experience an unintended pregnancy are more likely to have mental health problems and to delay the initiation of prenatal care than women who intended to become pregnant (Logan et al., 2007). Compared to their "intended" counterparts, children whose conception was unintended tend to suffer from poorer physical and mental health and are more likely to engage in delinquent behavior during adolescence (Logan et al., 2007).

[1] Between 1994 and 2006, rates of unintended pregnancy among all women rose slightly, even though unintended teen pregnancy, which has garnered substantial public attention, declined by 27 percent (Thomas, 2012c). The qualitative trend for unintended pregnancy rates among women in their twenties can be pieced together using data reported by Henshaw (1998), Finer and Henshaw (2006), and Zolna and Lindberg (2012). For the share of pregnancies that are unintended, see Zolna and Lindberg (2012). The share of births among unmarried women under 30 that are unintended can be calculated using data reported by Zolna and Lindberg (2012).

[2] See, for example, Thomas (2012b) and Logan et al. (2007) on the relationship between pregnancy intentions and maternal, child, and societal outcomes. See also Haskins and Sawhill (2009).

Moreover, research has shown that lowering the incidence of unintended childbearing would significantly reduce expenditures on public programs such as Medicaid (Thomas, 2012a and 2012b).[3] Finally, with approximately a third of unintended pregnancies ending in abortion, reducing the risk of unintended pregnancy would lower overall abortion rates—an outcome that most agree would be desirable.[4]

For some demographic subgroups, such as disadvantaged teens, the causal nature of these associations has been called into question. For instance, controlling for family background through sibling or twin fixed-effects models has been found to weaken (and sometimes eliminate) the observed correlations between teenage childbearing and negative maternal and child outcomes.[5] Other research has exploited the quasi-randomness of miscarriages to identify the causal effects of teen childbearing.[6] With a few exceptions, these miscarriage studies find the effects of teen births to be negative, but small.[7] It is important to note, however, that these findings apply to a specific subpopulation: teens who experience a pregnancy. Because teens who are at high risk of pregnancy also tend to be highly disadvantaged, the adolescents examined

[3] One study, for instance, suggests that existing publicly funded contraceptive services save taxpayers an estimated $7.6 billion per year by averting an estimated 2.2 million unwanted pregnancies per year (Frost et al., 2013). In addition, Monea and Thomas (2011) estimate that the elimination of all remaining unintended births would reduce expenditures on publicly financed medical care by $6 billion, while Thomas (2012a and 2012b) shows that a mass media campaign encouraging condom use, an effective teen pregnancy prevention program, and an expansion in access to Medicaid-subsidized contraception all have benefit-cost ratios that are comfortably greater than one, even under conservative assumptions about the benefits produced by these interventions.

[4] The proportion of unintended pregnancies ending in abortion was calculated using data reported in Finer and Zolna (2011).

[5] See, for example, Webbink et al. (2011), Fletcher (2012), and Holmlund (2005) for studies related to maternal outcomes. For examples of studies related to child outcomes, see Joyce et al. (2000), Turley (2003), Levine et al. (2007), and Francesconi (2007).

[6] For a detailed review of this literature, see Kearney and Levine (2012).

[7] Hotz et al. (2005, 2008), the pioneers of this identification strategy, found that teen childbearing had negligible, or even positive, effects on maternal employment and earnings. Results from subsequent studies, which address some of the methodological shortcomings of the Hotz et al. paper, tend to suggest that teen childbearing has small but negative effects on a woman's life trajectory (Ashcraft et al., 2013; Fletcher and Wolfe, 2009; Fletcher, 2012; Hoffman, 2008).

in the miscarriage and fixed-effects studies may not have the skills, networks, or opportunities to benefit from the prevention of an unplanned birth (Miller, 2011).

In contrast, research into the historical expansion of oral contraception suggests that many women have benefited significantly from better family planning. These studies, which base their claims of causality on exogenous variation in state laws governing the sale of birth control to older teenagers, find that increased access to the pill raised college attendance and graduation rates (Hock, 2007), boosted the numbers of women pursuing graduate degrees (Goldin and Katz, 2002), and led to higher female earnings (Bailey et al., 2012). Relevantly, these benefits appear to have accrued primarily to mid- and high-skilled women (as measured by aptitude tests and educational attainment), suggesting that family planning is particularly important for women who have the background and opportunities to take advantage of delays in childbearing. Of equal importance, separate research suggests that many children benefit from being born to older mothers. For example, Miller (2009) uses information on biological fertility shocks to instrument for maternal age at first birth and finds that small delays in childbearing significantly improve child test scores.

Taken as a whole then, these studies suggest that efforts to reduce unintended pregnancy continue to serve important public policy goals. However, while it is generally acknowledged that more and better contraceptive use would lower the incidence of unintended pregnancy, there are few studies that have examined in a rigorous and detailed way the extent to which various shifts in contraceptive behavior would change rates of unintended pregnancy, abortion,

nonmarital childbearing, and child poverty. Much of the research into the effectiveness of contraceptive interventions focuses on teen pregnancy prevention programs, despite the fact that 82 percent of all unintended pregnancies accrue to non-teens.[8] Moreover, initiatives aimed at altering the contraceptive behaviors of older women often produce varying or imprecise results due to differences in target populations and small sample sizes.[9] Even the promising results from the Contraceptive CHOICE Project—a program that provides no-cost contraception to nearly 10,000 thousand women in the St. Louis region—are limited in their generalizability due to the program's reliance on convenience sampling.[10]

To fill some of these research gaps and inform the broader discussion about efforts to prevent unintended pregnancy, this paper uses FamilyScape 2.0, a microsimulation model of family formation, to estimate the effects of increasing and improving contraceptive use among a nationally representative sample of unmarried men and women under 30. Results from these simulations show that both increasing contraceptive use and improving contraceptive efficacy yield sizeable reductions in unintended pregnancy, abortion, nonmarital births, and child poverty. For instance, shifting 25 percent of non-contracepting unmarried women under 30 onto Long-Acting Reversible Contraceptive methods (LARCs) or the pill is predicted reduce abortion rates for this group by 25 percent and nonmarital birth rates by 13 percent. In addition, we find that

[8] For a detailed overview of teen pregnancy prevention programs and policies, see Kirby (2008) and Kearney (2010). The proportion of unintended pregnancies occurring to adult women can be calculated using data published in Zolna and Lindberg (2012).
[9] For a review of interventions aimed at increasing contraceptive use among adult women, see Kirby (2008).
[10] Kittur et al. (2011) find systematic differences between participants in the Contraceptive CHOICE Project and comparable samples of women from state and national data. While the authors argue that many of these statistically significant demographic differences may be too small to be clinically meaningful, women participating in the CHOICE project were in fact notably more likely to be Black, young, and poor than the comparison sample of women in the National Survey of Family Growth (NSFG).

inducing current users of LARCs and female-specific hormonal methods to use their methods continuously reduces nonmarital pregnancy, birth, and abortion rates among women under 30 by 11 percent, 16 percent, and 9 percent, respectively. We also find that, under either of these specifications, the poverty rate among newborn children would be reduced about a half of a percentage point. While this estimated effect size may seem small, it is more sizeable when viewed in the context of existing anti-poverty programs. For example, the nation's biggest and broadest anti-poverty program, SNAP (formerly known as the Food Stamp program), only reduces the overall poverty rate by 1.2 percentage points and costs $80 billion a year (Tiechen et al., 2013).

The rest of the paper is organized as follows. Section II provides an up-to-date portrait of unintended pregnancy in the United States, focusing in particular on unmarried women aged 15–29. Section III follows with an overview of the data and literature on contraceptive use (and misuse) and its relationship to unintended pregnancy. In section IV, we describe the simulation model and the underlying data used to parameterize it, and in section V, we report results from our simulations. We then conclude by discussing the policy implications of our findings.

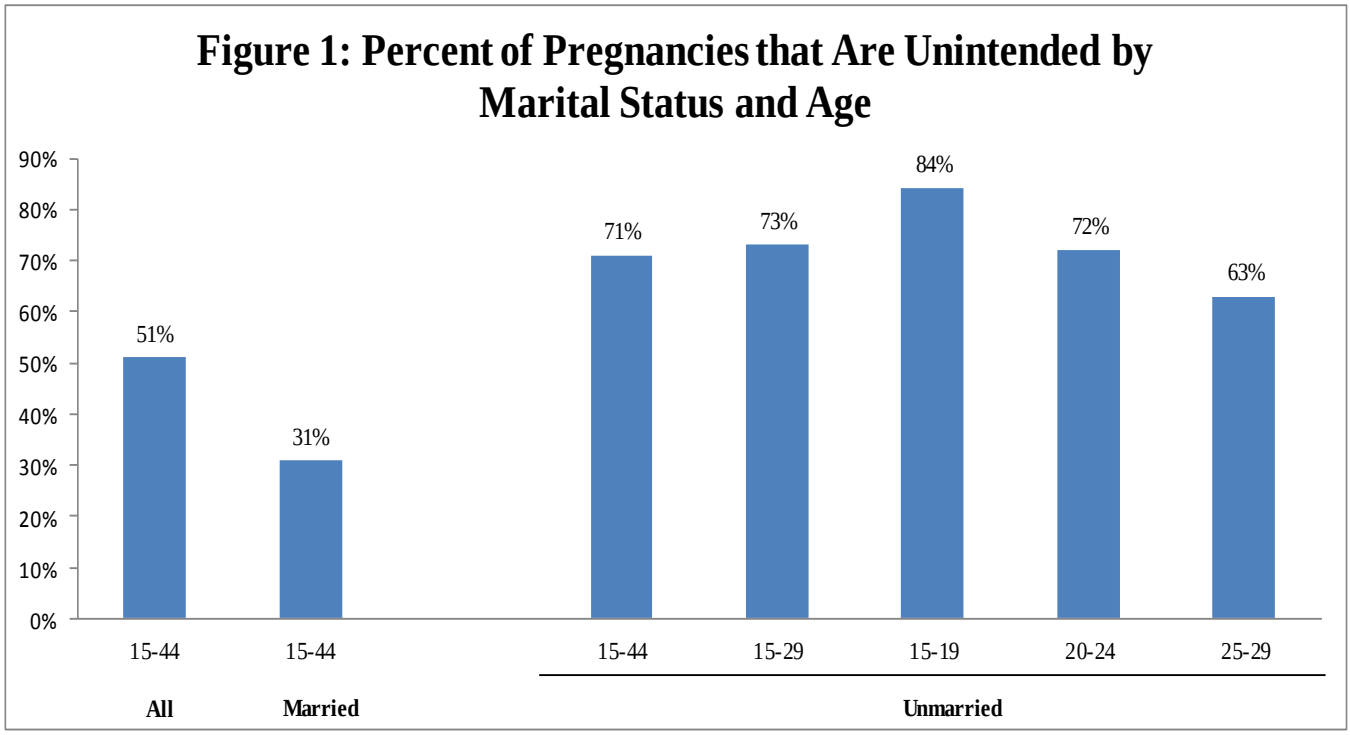
II. A Portrait of Unintended Pregnancy in the United States

Roughly half of all pregnancies in the United States are reported as being unintended—that is, unwanted or mistimed (Thomas, 2012c). Perhaps unsurprisingly given the topic's sensitivity, research has determined that asking women about the "wanted-ness" or timing of their pregnancies is fraught with difficulty (Thomas, 2012c). The main survey on pregnancy intentions—the National Survey of Family Growth (NSFG)—asks women to characterize retrospectively the intentionality of all of their previous pregnancies at the time they learned they were pregnant (Lepkowski et al., 2010). Although surveyors have become sophisticated about ensuring that respondents have as much privacy as possible in answering these questions, it is difficult to assess the extent to which mothers provide honest reports about whether they would have preferred not to have become pregnant. Perhaps a bigger methodological challenge is the fact that intentionality is itself an ambiguous concept (Santelli et al., 2003). If, for example, a mother reports that her child was the result of an unintended pregnancy but that she was not using birth control when she became pregnant, what are we to conclude? This situation describes 29 percent of unwanted births.[11] At the same time, these mothers are often talking about children who have already been born and with whom they may have already formed a bond, making it less likely that they will refer to the relevant pregnancies as "unwanted."

Despite their imperfections, the data on unintended pregnancy provide useful insights. Most unplanned conceptions occur to unmarried women. A striking seven in ten nonmarital pregnancies are unintended, as compared to a little less than a third of pregnancies among

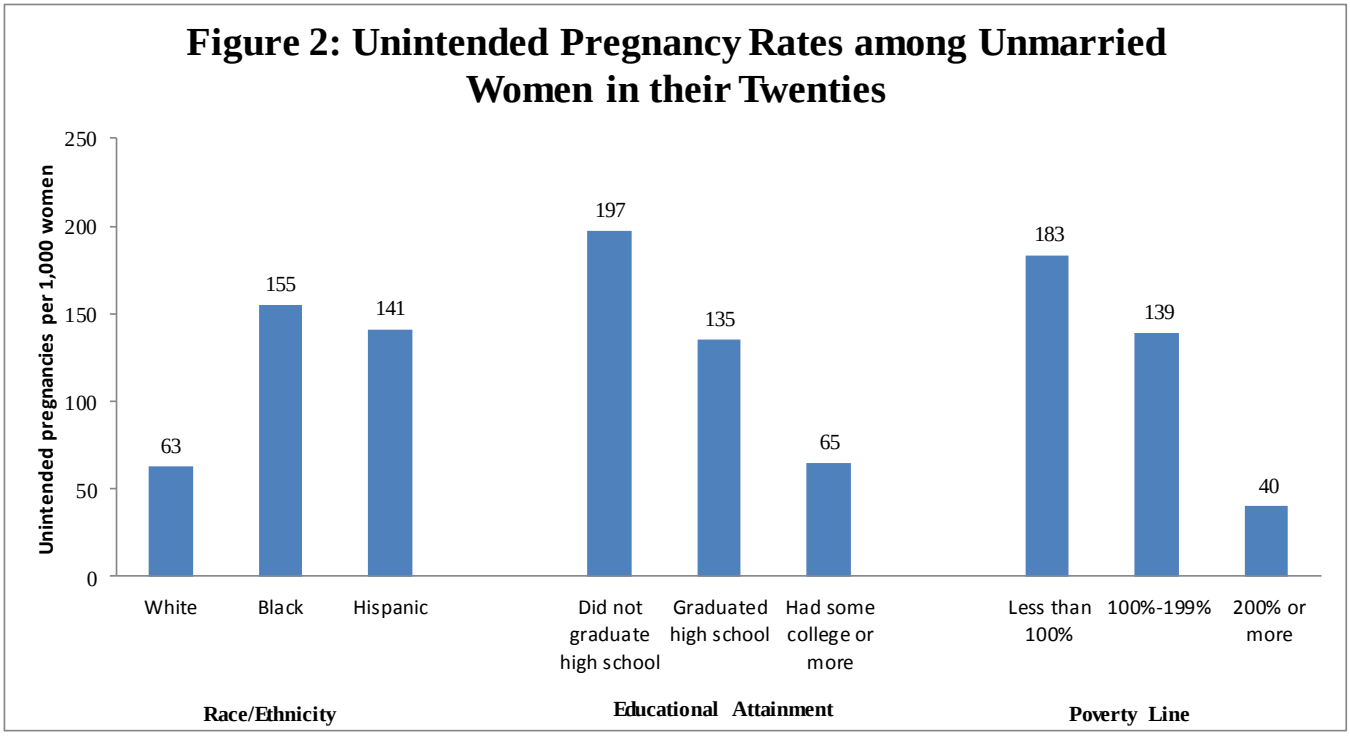
[11] Sources: Henshaw (1998) and the authors' analyses of the 2006-2010 cycle of the NSFG.

married women. Focusing just on the unmarried population, the share of pregnancies that is unplanned tends to decrease with age, but, even among women in their late twenties, it is well over half (Figure 1).[12]



While the proportion of nonmarital pregnancies that are unintended remains high across a variety of demographic subgroups, the incidence of unplanned pregnancy among unmarried women in their twenties varies substantially by race, educational attainment, and income (Figure 2).[13] Unmarried college-educated women in their twenties, for instance, are two-thirds less likely to experience an unintended pregnancy than unmarried high school drop outs, while unmarried women in their twenties who live at 200 percent above the poverty line nearly 80 percent less likely to experience an unintended pregnancy than comparable women who live below the poverty line.

[12] Based on the authors' tabulations of data published in Zolna and Lindberg (2012).
[13] The estimates reported in Figure 2 are based on the authors' tabulations of data reported in Zolna and Lindberg (2012).

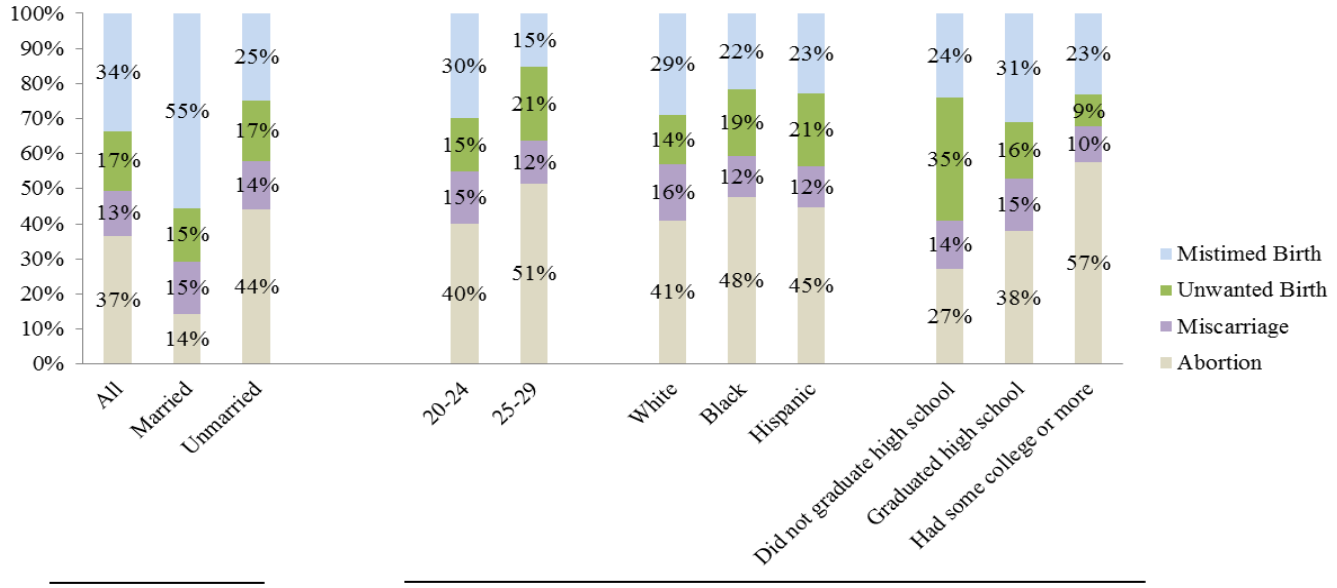


Once pregnant, a woman may carry the unintended pregnancy to term, she may have an abortion, or she may miscarry. The outcome of an unintended pregnancy is strongly related to the marital status of the mother. Figure 3 below shows that unmarried women in their twenties are more than three times as likely to abort an unintended pregnancy as their married counterparts.[14] In part, these differences may reflect the fact that a much higher proportion of unintended births among married women are mistimed than are unwanted. The data presented in Figure 3 suggest that about 20 percent of unintended births among married women in their twenties are unwanted (meaning that the mother did not want the baby when the birth occurred or at any point in the future) and about 80 percent are mistimed (meaning that the mother wanted to have a baby, but not at the time that the birth occurred), while about 40 percent of unintended births to unmarried women in the same age range are unwanted.

[14] The estimates reported in Figure 3 are based on the authors' tabulations of data reported in Zolna and Lindberg (2012) and of data from the 2006-2010 cycle of the NSFG.

An examination of unintended pregnancy outcomes by educational attainment illustrates why reducing unintended pregnancy might be expected to improve the opportunities of women and their children. Figure 3 shows that, among unmarried women in their twenties who experience an unplanned pregnancy, less-educated women are more likely to carry the pregnancy to term. In other words, higher educated women—for whom the opportunity cost of an unplanned birth is greater—are more likely to abort unintended pregnancies. And among unintended pregnancies carried successfully to term, less-educated women are more likely to indicate that a pregnancy was unwanted. Consequently, two thirds of all unintended births among unmarried women aged 20–29 occur to women with no college experience, while only 7 percent occur among women with baccalaureate degrees.[15]

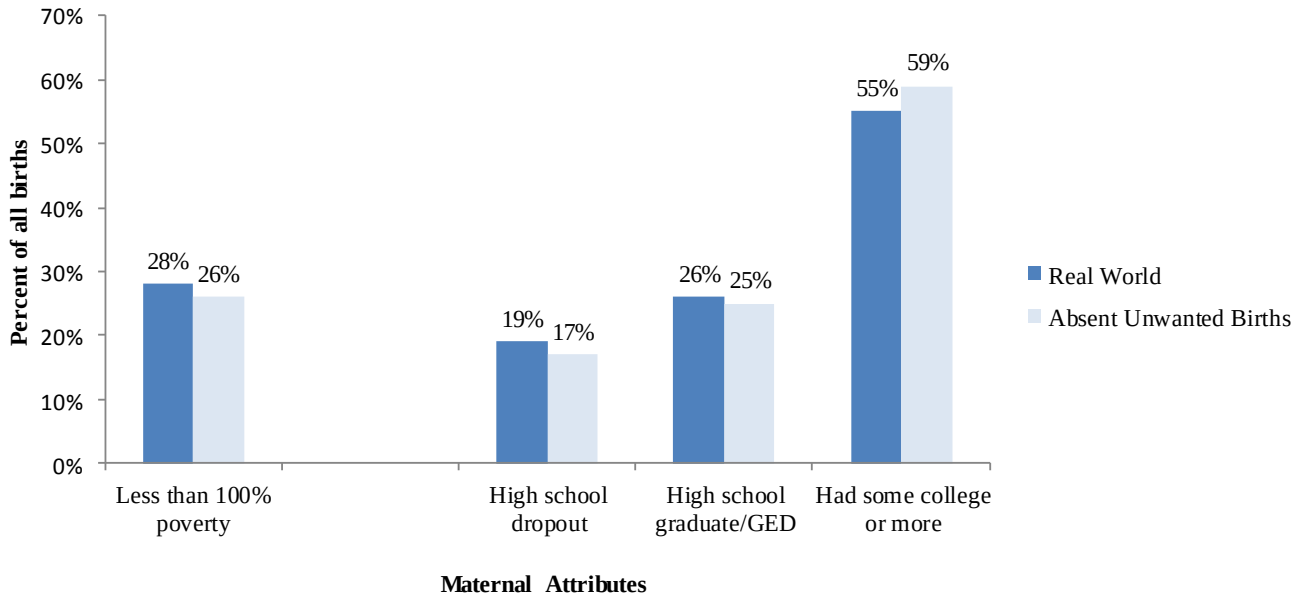
Figure 3: Resolution of Unintended Pregnancies Among Women Aged 20-29



[15] This set of estimates is based on the authors' tabulations of data from the 2006-2010 cycle of the NSFG.

A series of shift-share tabulations of data taken from the 2006—2010 NSFG, the results of which are reported in Figure 4 below, reinforce the implications of the other data discussed in this section. Our analysis predicts that eliminating all unwanted births would lower the poverty rate among newborns by 2 percentage points and increase the percentage of children born to college educated mothers by 4 percentage points. [16]

Figure 4: The Effects of Reducing Unwanted Births on the Birth Circumstance of the Next Generation



[16] These shift-share analyses were conducted using 2006–2010 NSFG data. To estimate the effects of reductions in the number of unwanted births on newborn poverty rates, we first disaggregated births by intention status (intended, mistimed, and unwanted) and household poverty status (relative to the federal poverty line). Post-intervention newborn poverty rates were then calculated using the following formula:

$$(\%\ \boldsymbol{of\ all\ births\ that\ are\ poor})_{\boldsymbol{post}} = \frac{(\%\ of\ all\ births\ that\ are\ poor)_{pre} - (\%\ of\ all\ births\ that\ are\ unwanted\ and\ poor)_{pre}}{1 - (\%\ of\ all\ births\ that\ are\ unwanted)_{pre}}$$

A parallel set of calculations was used to estimate the effects of reductions in the number of unwanted births on the distribution of maternal education at birth.

III. Contraceptive Use and Unintended Pregnancy

Many young adults do not use contraception, and those who do often use it ineffectively (Gold et al., 2009). Around one-third of women at risk of unintended pregnancy are either not using contraception (16 percent) or are not using contraception consistently and correctly (19 percent).[17] Despite constituting a minority of all at-risk women, non-contraceptors and poor contraceptors account for 95 percent of unintended pregnancies, suggesting that initiatives which make contraceptive use easier could be important for reducing unwanted pregnancy (Gold et al., 2009).

Why are so many people not using contraception or using it inconsistently? Condoms are often forgotten in the heat of the moment or are used inconsistently or incorrectly. Even oral contraception produces a relatively high number of user-related failures if a woman forgets to take her pills or stops using them for some reason. Table 1 below, drawn from Hatcher et al.'s (2011) *Contraceptive Technology*, reports typical-use and perfect-use failure rates for the male condom; the pill, patch, and ring; injectables, and LARCs.[18] A failure rate is defined as the probability of experiencing a pregnancy over the course of a year for a woman using a given contraceptive method. The typical-use failure rate for the male condom is 18 percent, which is twice that of the pill, patch, or ring (9 percent) and is significantly higher than the typical-use failure rates for injectables (6 percent) and long-acting methods (<1 percent). It should also be

[17] A woman is considered to be "at risk of unintended pregnancy" if she is between the ages of 13 and 44 and is sexually active and able to become pregnant, but does not wish to become pregnant.

[18] Perfect use occurs when couples employ their method both consistently and correctly, while typical-use failure rates represent weighted averages of perfect and imperfect-use failure rates. For more details on the way in which perfect, imperfect, and typical-use failure rates are calculated, see Trussell (2011).

noted that the typical-use failure rates for non-LARC hormonal methods are quite a bit higher than perfect-use rates (for instance, while less than 1 percent of women using the pill perfectly experience a pregnancy within the first year of use, this figure jumps to 9 percent among all users), indicating that imperfect use of these methods is quite common. Typical-use failure rates for LARCs, however, are well below one percent and are essentially identical to their perfect-use rates, highlighting the fact that user behavior has little influence on the efficacy of these methods.

It is worth noting that, with marriage being increasingly delayed and the average age at first marriage now exceeding the average age at first birth, unmarried women are often at risk of pregnancy for many years. A rough back-of-the-envelope calculation suggests that a woman who relied on the pill for, say, five years would face a chance of becoming pregnant of approximately 38 percent.[19]

[19] According to table 1, 9 percent of typical users of the pill become pregnant in a single year. Hence, assuming that typical-use failure rates remain constant over time, the chances that a typical user of the pill becomes pregnant in five years is $(1 - (1 - 0.09)^5)$, or 37.6 percent.

Table 1. Typical-use and perfect-use failure rates for condoms and hormonal and long-acting methods of contraception

Method	% of typical users[a] who experienced an unintended pregnancy within the first year of use	% of perfect users[b] who experienced an unintended pregnancy within the first year of use
Male Condom	18	2
Pill/Patch/Ring	9	0.3
Injectables (Depo)	6	0.2
LARCs (Mirena)[c]	0.2	0.2

[a]Among typical users who initiate use of a method, the percentage who experience an accidental pregnancy during the first year if they do not stop use for any other reason.

[b]Among couples who initiate use of a method and who use it *perfectly* (both consistently and correctly), the percentage who experience an accidental pregnancy during the first year if they do not stop use for any other reason.

[c] These failure rates are based on Mirena (hormonal IUD).

Many assumed that the introduction of the birth control pill would reduce the incidence of unplanned pregnancy and, as noted in our introduction, this appears to have been the case. However, even the pill is not an ideal contraceptive. Some hormonal methods cause unpleasant side effects, at least for some women, although worries about side effects tend to be overstated. Kaye et al. (2009) found that 27 percent of unmarried young women think that it is extremely

likely or quite likely that using hormonal birth control will result in a severe health problem such as cancer. These misperceptions result in comparatively high rates of nonuse or discontinuation among users of methods such as the pill, which in turn leaves many people unprotected from the risk of unintended pregnancy.

Research suggests that increases in LARC use could help to combat the problems encountered with other methods of contraception. LARCs, such as intrauterine devices (IUDs) and implants, have much lower failure rates than other forms of contraception, such as the condom, the pill, the patch, and the ring. One analysis of data on CHOICE Project participants, for instance, finds that the risk of contraceptive failure (i.e., the probability of becoming pregnant while using a given method) is twenty times higher among users of the pill, transdermal ring, and hormonal patch than among LARC users (Winner et al., 2012).[20] The characteristics of the study participants who used LARCs suggested that they were actually more likely than women using other methods to experience an unintended pregnancy, which further strengthens the study's finding that LARCs are unusually effective.

[20] In this study, participants were read a standardized script about birth control which stated that IUDs and the subdermal implant were the most effective methods of contraception. Women also received contraceptive counseling regarding all reversible contraceptive methods. They were then allowed to choose which birth control they wanted to use and were provided with the method of their choice at no cost for 2 to 3 years. It should be noted that, since this study was not a randomized controlled trial, there were some demographic differences across contraceptive type. Women who chose the pill, patch, or ring were more likely not to have previously had a child; were more likely to have private health insurance; and were less likely to have had a previous unintended pregnancy, abortion, or sexually transmitted disease. These demographic differences only strengthen the authors' findings: those who chose IUDs or DMPA injections were more likely to be part of demographic groups that are generally at higher risk of unintended pregnancy, making the lower pregnancy rates under IUDs and injections all the more noteworthy.

LARCs are unusually effective in large measure because they are more likely to be used consistently than other forms of contraception. Although a relatively high percentage of young adult women have used a hormonal method such as the pill at some point, many of them subsequently switch to a less effective method or no method. Recent research has found that method discontinuation is fairly common. For example, Vaughan et al. (2008), using data from the 2002 National Survey of Family Growth, found that over a third of women discontinued use of hormonal contraceptives within a year of starting. More recent analyses conducted by Child Trends, using 2006–10 NSFG data, found that, for women younger than age 30, the expected probability of discontinuing contraceptive methods was fairly low among women using LARCs (17 percent likelihood of discontinuing), but that discontinuation probabilities were close to one-third among women using the pill, patch or ring (29 percent) and among couples using condoms (31 percent), and were as high as 51 percent among women using injectable methods of contraception (Manlove et al., 2013).

These findings highlight the need for providers to help improve method continuation among women using hormonal methods. Some research has found that return visits and follow-up counseling that address women's concerns have the potential to improve continuation rates (Madden et al., 2012). Others have found that providing a one-year supply of oral contraceptives (vs. a standard 3-month supply) may also improve method continuation (Foster et al., 2011). LARCs are especially effective among groups that have high rates of unintended pregnancy due to poor compliance with other methods. An editorial in the journal *Contraception* argues that LARCs "have a proven record of very high effectiveness, many years of effectiveness,

convenience, cost effectiveness, suitability for a wide variety of women and, in general, high user satisfaction" (Speidel et al., 2008, p. 197).

One reason that the U.S. has higher rates of teen and unintended pregnancy than other industrialized countries is because of lower contraceptive use. This is particularly true of hormonal and long acting contraceptive methods (Darroch et al., 2001). For example, LARCs represent a small fraction of contraceptive use in the U.S.: only 8.5 percent of all contraceptors use long-acting reversible methods (Finer et al., 2012). Comparable LARC usage rates are much higher in other countries (Clifton et al., 2008). LARCs are used, for instance, by 40 percent of Chinese married women who use family planning and by 17 percent of French female contraceptors.

What accounts for the comparatively infrequent utilization of LARCs and other hormonal methods in the U.S.? First, some research suggests that higher contraceptive use among teens in European countries is due in part to a greater tolerance of adolescent sexual activity and more freely available contraceptives (Darroch et al. 2001). Second, poor knowledge of hormonal methods and their effectiveness is also a barrier to use (Frost et al., 2012). Forty percent of women surveyed in the United States incorrectly believe that surgery is required to implant an IUD and nearly half think that IUDs can move around inside a woman's body. Over half of women (54 percent) state that they are less likely to use IUDs because they believe that they are somewhat likely to contract an infection from an IUD (Kaye et al., 2009). Third, many young women, particularly low-income women and racial and ethnic minorities, expect to have children

at a young age (East, 1998) or express ambivalence about pregnancy (Higgins et al., 2012; Kaye et al., 2009). Finally, the upfront cost of LARCs is quite high, ranging from $200 to $436 at public-sector prices. Prices are even higher in the private sector (Speidel, et al., 2008). Moreover, these prices only cover the cost of the initial insertion of the device. With follow-up doctor visits included, the total price tag typically ranges from $500 to $1000 (Planned Parenthood, 2013). However, it should be noted that, spread over the useful life of the device, LARCs are less expensive than the birth control pill, suggesting that subsidies which reduce upfront costs may be a good investment.

A recent study of women at high risk of unintended pregnancy found that the three most important features that they would like to see in a contraceptive method were effectiveness, lack of side effects, and affordability (Lessard et al., 2012). These desires can be seen in practice in the St. Louis demonstration program described above. In this study, LARCs were offered for free and study participants also received counseling on how LARCs worked, greatly enhancing the willingness of women to choose them over other forms of contraception. Three-quarters of women participating in the study chose LARCs over other methods such as oral contraception, the transdermal patch, the contraceptive vaginal ring, and depot medroxyprogesterone acetate (DMPA) (Secura et al., 2010).

With sufficient motivation and contraception that is readily and cheaply available, some of these difficulties can be overcome, and the number of unplanned pregnancies could thereby be reduced. The analyses that follow use the FamilyScape 2.0 simulation model to simulate what

might happen if more unmarried men and women aged 15–29 used contraception and if they used their methods more effectively.

IV. The FamilyScape 2.0 Simulation Model: Description and Application

FamilyScape 2.0 is a microsimulation tool that allows the user to model the impacts of behavioral changes on family-formation outcomes.[21] It simulates the key antecedents of pregnancy (sexual activity, contraceptive use, and female fecundity) and many of its most important outcomes (e.g., pregnancy and childbearing within and outside of marriage, children's chances of being born into poverty, and abortion). The model's parameters were developed through extensive analysis of a wide range of real-world data sources, although most parameters were estimated using data from the 2006–2008 cycle of the National Survey of Family Growth. Behaviors and outcomes are simulated at the individual level and are then aggregated to produce population-wide estimates of various phenomena of interest. The members of the model's simulation population are heterogeneous: each of them is assigned a set of demographic and behavioral characteristics that help to govern the various decisions that they will make over the course of the simulation. More specifically, the model is populated with a group of men and women aged 15 to 44 whose gender, age, race, education, socioeconomic-status (SES), and marital-status profiles are consistent with the characteristics of the members of a nationally representative dataset.[22]

[21] For a more detailed technical description of FamilyScape 2.0, see Thomas et al. (2013).

[22] Members of the simulation population are assigned to one of four age categories (15–19, 20–24, 25–29, and 30–44), to one of four race categories (white, black, Hispanic, and other), and to one of three educational-attainment categories (less than high school, high-school degree only, more than high school). Socioeconomic status is measured as a function of maternal educational attainment: individuals are designated as low-SES if their demographic profiles indicate that their mothers did not graduate from high school, and all other individuals are designated as high-SES. These specifications were selected based on the results of a series of goodness-of-fit analyses that attempted to determine how to express as parsimoniously as possible the most important features of these variables' distributions.

FamilyScape 2.0 has a daily periodicity, which is to say that each increment in analysis time corresponds to a single day. As is the case in the real world, individuals within the simulation behave autonomously and often inconsistently. For example, some individuals in the model will be more inclined than others to have sex on a given day, and a given individual will be willing to have sex on some days but not on others. Each of FamilyScape's inputs (relationship formation, sexual activity, contraceptive use, etc.) is simulated so as to ensure that aggregate measures of the resulting behaviors are consistent with demographically specific benchmarks that were produced via extensive analysis of several different data sources. As will be discussed shortly, the model can be validated by comparing its outputs (rates of pregnancy among teens and adults, the incidence of childbearing within and outside of marriage, the frequency of abortion, etc.) to their equivalent real-world benchmarks.

Figure 5 diagrams FamilyScape's overall structure and delineates the various stages of the simulation. During the first stage, the model is populated with a group of 10,000 individuals whose demographic characteristics match those of the members of the 2006–2008 NSFG.[23] In the second stage, opposite-sex relationships of varying duration are formed among some individuals. In the third stage, sexual activity (or lack thereof) is simulated among married and unmarried couples, and contraceptive use (or lack thereof) is simulated among couples who have sex. With regard to the contraceptive-use module, the model simulates the use of condoms, sterilization, or no method among men; and of hormonal methods, LARCs, sterilization, or no

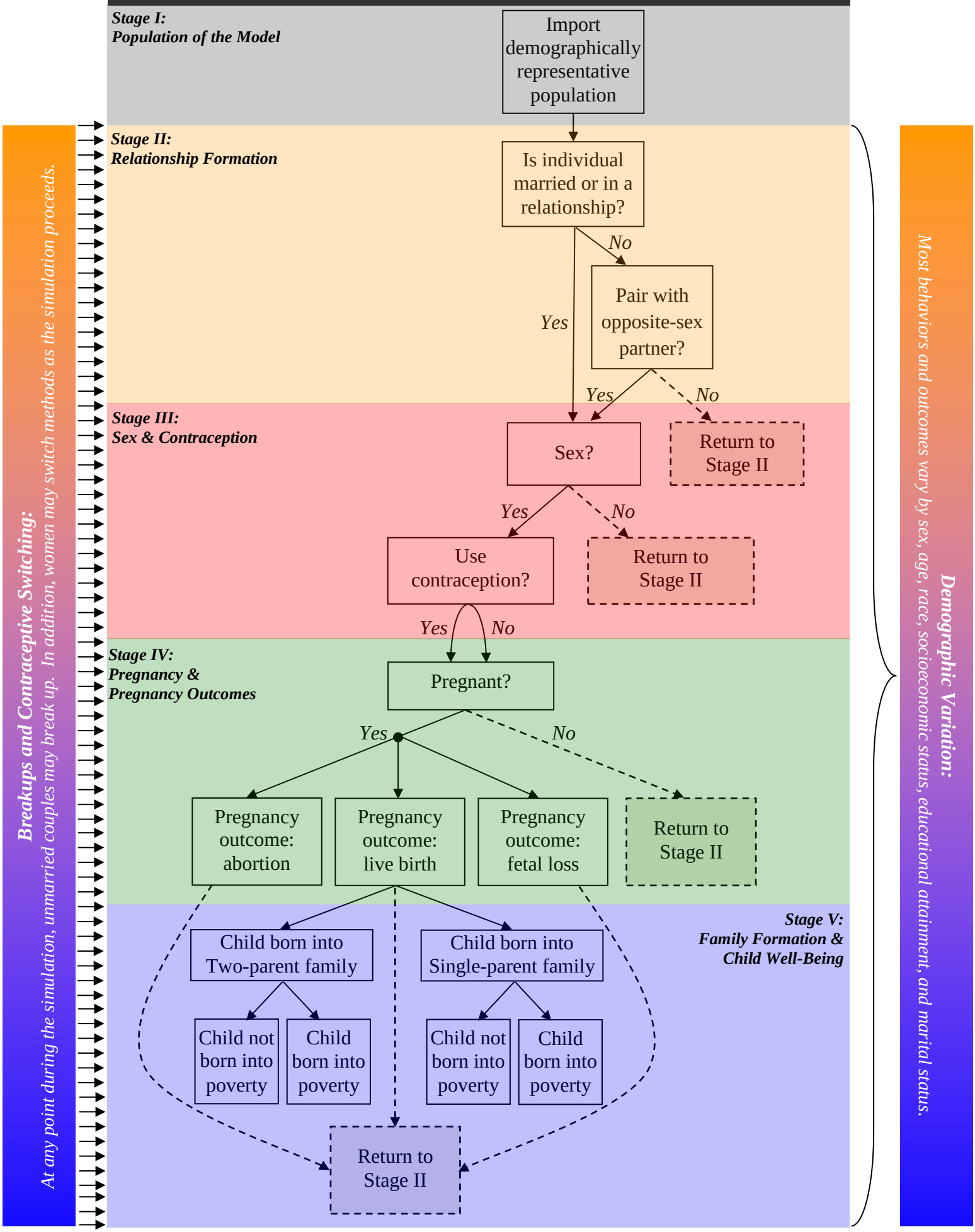
[23] More specifically, the model's simulation population is created by sampling with replacement from the 2006–2008 NSFG's male and female respondent files. Because the NSFG is nationally representative and the dataset's weights were used during the extraction process, the demographic characteristics of the members of the simulation population are representative of the characteristics of the national population from which the NSFG's sample was drawn.

method among women.[24] FamilyScape 2.0 also contains a contraceptive switching module that allows women to change from the use of one method to another (including switching to or from the use of no method) as the simulation proceeds. In addition, the model captures heterogeneity in the consistency and correctness of contraceptive use. This heterogeneity is simulated by allowing for variation in the efficacy levels of various contraceptive methods.

In FamilyScape's fourth stage, some sexually active couples become pregnant, and each pregnancy eventually results either in a birth, an abortion, or a fetal loss (miscarriage). The model's fifth and final stage accounts for the fact that each birth is either to a married couple or to a single mother. Largely as a function of the mother's demographic characteristics and the structure of the family into which a child is born, a poverty status is also assigned to each newborn child during the model's fifth and final stage. Because these behaviors and outcomes are simulated on a daily basis, they may or may not occur on each new day. Thus, an unattached individual who did not enter into a relationship yesterday may do so today; a couple that does not have sex today may do so tomorrow; a sexually active couple that will not become pregnant tomorrow may conceive on the day after; and so forth.

[24] FamilyScape's LARC category includes intrauterine devices, hormonal implants, and injectables. Hormonal methods encompass oral contraception, the contraceptive patch, the NuvaRing, emergency contraception, and the small proportion of women who use non-hormonal, female-specific contraceptive methods, including diaphragms, female condoms, foams, jellies/creams, suppositories/inserts, the Today sponge, and natural family planning.

Figure 5: Summary Diagram of the FamilyScape 2.0 Simulation Model



As is discussed above, all of these input dynamics are aligned to real-world data. Information from a broad range of sources is used to ensure that the model realistically simulates the share of people who are married; the share of unmarried people who are in relationships; the rate at which married and unmarried couples have sex; the types of contraception that they use; the frequency with which women switch onto and off of various contraceptive methods; the frequency with which couples using various types of contraception (or none at all) become pregnant; the share of pregnancies that result in live births, abortions, and fetal losses; the typical gestation periods for each of these pregnancy outcomes; and the share of births that occur within and outside of poverty.[25] FamilyScape 2.0 is also designed to produce realistic variation in these dynamics according to individuals' demographic characteristics. The model lends itself readily to policy simulations, since any of its inputs can easily be changed under the assumption that a given intervention has a particular effect on individual behavior.

FamilyScape 2.0 is the successor to an earlier iteration of the same model ("FamilyScape 1.0"), which is described in detail in Thomas and Monea (2009). FamilyScape 1.0 was used to simulate the effects of policies such as a national evidence-based sex education program targeted on at-risk youth, an expansion in states' Medicaid family planning programs, and a nationwide mass

[25] For instance, data from the General Social Survey were used to develop the model's benchmarks for the number of single individuals in relationships; data from the NSFG were used to calibrate the model's modules on coital frequency, contraceptive use, and contraceptive switching, and to set benchmarks for the annual number of sexual partners among sexually active individuals; published pregnancy rates for typical contraceptive users were combined with the results several clinical trials and our own independent analyses of the NSFG to develop parameters governing the probability that a woman will become pregnant from a given act of intercourse as a function of her contraceptive regime, her demographic characteristics, and the day in her menstrual cycle; data from the Guttmacher Institute, the National Vital Statistics System, the Centers for Disease Control and Prevention, and the NSFG were used to develop the model's parameters that impute an outcome (live birth, abortion, or fetal loss) for each pregnancy; data from the Current Population Survey were used to parameterize the module that assigns a poverty status to each newborn child; and the results of a number of different clinical studies were used to develop the model's parameters governing the gestation periods for various pregnancy outcomes.

media campaign designed to increase contraceptive use. The results of these simulations are documented in a variety of papers and reports, including Sawhill et al. (2010), Thomas (2012a), Thomas (2012b), and Thomas (2012c). Many of FamilyScape's features as described above represent improvements to the previous version of the model. Beyond the use of more recent data to develop many of the model's parameters, the most important of these improvements include the model's capacity to simulate contraceptive method switching; to allow contraceptive failure rates to vary across demographic groups; and to model separately the use of LARCs as opposed to other hormonal methods.

As is discussed above, all of FamilyScape's simulated behaviors are modeled using real-world data that measure how often those behaviors occur as a function of individuals' demographic characteristics. However, there is a random component to such behaviors in the real world and therefore also within the simulation. For instance, random processes within the simulation model help to govern the pool of potential partners with whom a given individual might enter into a new relationship, the probability that he or she will in fact enter into a relationship, the likelihood that a given couple will have sex on a given day, the probability that a couple will use contraception if and when they have sex, and so forth. Thus, no two runs of the model are exactly alike. As such, the results reported below are averages calculated using a year's worth of simulated data from 100 different simulation runs.[26]

[26] Distributions of the model's outcomes across 100 simulation runs are unimodal and approximately symmetric. Some of the model's modules mimic real-world dynamics only after a few hundred periods of analysis time have elapsed. This is the case because, for example, time must pass in order for the appropriate number of simulated relationships to be formed; for simulated pregnancies subsequently to occur; for simulated pregnancies to result in a birth, abortion, or miscarriage; and so forth. As such, the results reported here are based on tabulations of the results

FamilyScape 2.0 can be validated by evaluating its capacity to match real-world aggregate-level outputs (e.g., rates of pregnancy and childbearing within and outside of marriage, the frequency of abortion, etc.). The model generally performs quite well in this regard. For example, simulated pregnancy, birth, and abortion rates among unmarried women—who constitute the focus of the analyses described below—are within about one percent, two percent, and one and a half percent of their respective real-world benchmarks.

Simulation Specifications and Underlying Assumptions

We use FamilyScape 2.0 to assess two broad strategies for improving contraceptive use and reducing unintended pregnancy, namely: (1) moving non-users onto contraception, and (2) improving the efficacy of methods being used by current contraceptors. Because male condom use differs from female-specific contraceptive use in terms of consistency and effectiveness, we conduct separate analyses for men and women. More specifically, we simulate five "what-if" scenarios that target the contraceptive behaviors of unmarried teens and young adults:[27]

of multiple simulation runs corresponding to a one-year period of analysis time starting on period 1000 and ending on period 1365.

[27] In particular, the simulated interventions target men and women who are at risk of experiencing an unintended pregnancy. Thus, simulation 1 moves 25 percent of unmarried women aged15–29 who are non-users and who are at risk of becoming pregnant in a given month onto pills or LARCs. Similarly, simulation 2 moves 25 percent of unmarried men aged 15–29 who are non-condom users and who are risk of impregnating a woman in a given FamilyScape month onto condoms.

1. What if 25 percent of unmarried women aged 15–29 who currently do not use any form of female-specific contraception begin using pills or LARCs continuously for a year?[28]
2. What if 25 percent of unmarried non-condom-using men aged 15–29 start using condoms continuously for a year?
3. What if all unmarried women aged 15–29 who currently use female-specific forms of contraception (e.g., LARCs or other hormonal methods) remain on their methods continuously for a year?[29]
4. What if unmarried women aged 15–29 who currently use female-specific forms of contraception remain on their methods for an entire year *and* never experience a contraceptive failure?
5. What if condom-using unmarried men aged 15–29 use condoms continuously for a year *and* never experience a contraceptive failure?

Note, then, that simulations 1 and 2 estimate the effects of changing non-users into users, while simulations 3, 4, and 5 parse out the gains from improving contraceptive efficacy among current contraceptors.[30] In particular, simulation 3 analyzes the links between unintended pregnancy and

[28] We ensure that the percentage of female contraceptors who use LARCs remains unchanged by the intervention. Thus, this specification increases the number of women using contraception but does not affect the relative share of contraceptors who use LARCs versus other hormonal methods.

[29] In this specification, women who are not initially using female-specific contraception are still allowed to switch onto some form of female-specific contraception over the course of a given year.

[30] Two principle assumptions underlie the first two simulation specifications. Specifically, we assume (1) that new contraceptors experience the average contraceptive failure rates of existing contraceptors; and (2) that they remain on their chosen method for an entire year. Due to limited data on male-specific method switching, FamilyScape 2.0 does not model contraceptive switching among men. Instead, non-sterilized men in FamilyScape are assigned to be either consistent condom users (which is to say that they use condoms every time they have sex, independent of their partner's choice of contraception), conditional condom users (which is to say that they use condoms only if their female partner does not use any form of female-specific contraception), or non-users (no use of condoms under any circumstances) for the duration of a simulation run. In order to facilitate comparisons between specifications 1 and 2, we make the assumption that all new users remain on their methods for the course of the year. While this assumption may be reasonable with regard to new LARC users (because LARC users tend to have very low rates of discontinuation), it is probably less reasonable with regard to new users of the pill or of other hormonal methods (because users of these methods tend to experience higher discontinuation rates). To assess the degree to which our continuous-use assumption causes us to overstate the effects of moving 25 percent of female non-contraceptors onto

the discontinuation of female-specific methods; simulation 4 provides an approximate upper bound on the gains from moving all current users of female-specific contraception onto IUDs—that is, a nearly perfect contraceptive method with low discontinuation rates; and simulation 5 conducts the male-specific equivalent of simulation 4.[31]

Because FamilyScape 2.0 does not explicitly model pregnancy intention, these simulations operate under the assumption that the pregnancies prevented by a given intervention would have been unintended had they occurred. One might question whether this is a reasonable assumption. Recall, however, that over 70 percent of nonmarital pregnancies among women under 30 are classified as unintended (see Figure 1). Moreover, our simulations account implicitly for pregnancy intentionality to the extent that pregnancy intentions are correlated with the model's demographic (e.g., age and marital status) and behavioral (e.g., contraceptive use, sexual frequency) inputs. For instance, FamilyScape's contraceptive interventions are implemented by proportionally scaling up women's predicted probabilities of using contraception. As a result, the non-contracepting women who are most likely to be affected by an intervention also tend to be the non-contracepting women with the highest propensity of using contraception, given their demographic characteristics. To the extent then that unintended pregnancy is correlated with non-contracepting women's predicted probabilities of using contraception, the pregnancies that are prevented by a FamilyScape intervention would have been unintended.

LARCs or the pill, we re-ran simulation 1 but instead assigned all new female contraceptors the average discontinuation rates of existing contraceptors. Under this alternative specification, the unintended pregnancy rate for unmarried women under 30 was reduced by about 14.3 percent, an effect size that is roughly 3 percentage points smaller than the 17.6 percent reduction produced by the main specification of simulation 1. We therefore conclude that our continuous-use assumption accounts for at most a quarter of the effects reported for simulation 1 in table 2.

[31] Note, then, that, in simulation 3, pregnancies can still occur due to poor or inconsistent use of female contraception. In simulation 4, however, women who use female-specific forms of contraception have no chance of becoming pregnant.

Unintended pregnancies are substantially more likely than intended pregnancies to result in an abortion (Zolna and Lindberg, 2012). FamilyScape's pregnancy-outcome parameters, which are estimated using data on all pregnancies, do not reflect this higher propensity towards abortion. Hence, under the assumption that the pregnancies averted due to a simulated intervention are unintended, too few of those averted pregnancies would have resulted in abortion within the simulation. We therefore adjust the pregnancy-outcome distribution of prevented pregnancies within the simulation using the methodology outlined in Thomas (2011). Specifically, published data on unintended pregnancy outcomes were used to derive a pregnancy-outcome distribution for unintended pregnancies. This distribution was then used to adjust interventions' simulated effect sizes.[32]

[32] Thomas (2011) reports the results of tabulations initially produced by the Guttmacher Institute showing that, among unmarried teens, 36 percent of unintended pregnancies result in an abortion while 47 of such pregnancies percent result in a live birth. Tabulations of data published in Zolna and Lindberg (2012) show that 44 percent of unintended pregnancies among unmarried women aged 20–29 result in an abortion and that 42 percent of such pregnancies end in a live birth. These percentages were applied to simulated counts of prevented pregnancies in order to derive post-intervention pregnancy outcome distributions. Finally, tabulations of NSFG 2006-2010 data show that, among children who are born to unmarried women aged 15—29 and whose births were unintended, 54 percent are born into poverty. This figure was used to develop post-intervention estimates of the poverty rate among newborn children.

V. Simulation Results

Table 2 shows that the effects of reducing non-contraception can be sizeable. Shifting 25 percent of current female non-users onto female-specific contraception is predicted to reduce the abortion rate within our target population by 25 percent, which is equivalent to eliminating 7.7 abortions per 1,000 unmarried women under 30. Nonmarital births among women under 30 are predicted to decline by nearly 13 percent, while the overall incidence of newborn poverty is predicted to fall by 0.5 percentage points.[33] Modestly smaller reductions are produced by moving a quarter of non-condom-using unmarried men under 30 onto condoms. Under this specification, abortion and birth rates among unmarried teens and young adults decline by 18 percent and 10 percent, respectively. As in simulation 1, newborn poverty rates fall by roughly 2 percent (or 0.5 percentage points).

Table 3 presents results from the simulations that improve contraceptive efficacy while holding constant the number of contracepting men and women. As illustrated in the results for

[33] All pre- and post-intervention pregnancy and pregnancy-outcome rates reported in Tables 2 and 3 were generated using simulated data produced by FamilyScape 2.0. However, the child-poverty findings reported in the table were compiled using both simulated and real-world data. This is because, while FamilyScape 2.0 closely replicates real-world pregnancy and pregnancy-outcome rates among unmarried women, the model overestimates pregnancy rates among married women (see Thomas et al., 2013). Using simulated data to calculate the overall incidence of poverty among children born to married and unmarried mothers would therefore understate the true incidence of newborn poverty, since: (1) poverty is less common among births to married women; and (2) FamilyScape's birth rate among married women is greater than the equivalent real-world rate. We therefore combine simulated data with real-world data in order to model changes in the overall incidence of newborn poverty. More specifically, we use the following equation to compute pre- and post-intervention newborn poverty rates:

$$\boldsymbol{child\ poverty\ rate} = \frac{(\%\ children\ born\ into\ poverty)_U * (\#\ of\ births)_U + (\%\ children\ born\ into\ poverty)_M * (\#\ of\ births)_M}{(\#\ of\ births)_U + (\#\ of\ births)_M}$$

where $(\%\ children\ born\ into\ poverty)_U$ and $(\%\ children\ born\ into\ poverty)_M$ are the proportions of births to unmarried and married women (respectively) that occur to poor mothers; and $(\#\ of\ births)_U$ and $(\#\ of\ births)_M$ are counts of births occurring to unmarried and married women, respectively. We use simulated data from FamilyScape 2.0 to estimate $(\%\ children\ born\ into\ poverty)_U$ for pre- and post-intervention runs; we calculate $(\#\ of\ births)_U$ and $(\#\ of\ births)_M$ using NVSS birth-count data published in Martin et al. (2013); and we use tabulations of NSFG 2006-2010 data to compute $(\%\ children\ born\ into\ poverty)_M$.

simulations 3 and 4, raising the continuation rates of female-specific methods and moving women onto more effective forms of female contraception are also important steps towards reducing unintended pregnancy. For instance, assuming that current users of female-specific contraception remain on their method for a year (but still allowing for imperfect use of contraception) lowers abortion rates and birth rates in our target population by 16.4 percent and 8.6 percent, respectively, and reduces overall newborn poverty by 0.5 percentage points (simulation 3).[34] If, in addition, these women used contraceptive methods that had the approximate typical-use failure rate of an IUD (<1 percent), the abortion rate for this group would fall by an extra 2.4 abortions per 1,000 women, nonmarital childbearing would decline further to 52.2 births per 1,000 women, and the newborn poverty rate would drop by another 0.3 percentage points to 25.8 percent (simulation 4).

Simulation 5 underscores the importance of improving the consistency of condom use. Assuming that condoms are 100 percent effective reduces nonmarital births in our target population by nearly 20 percent and eliminates approximately 11 abortions per 1,000 unmarried women under 30 (a 36 percent reduction). In this scenario, poverty among newborn children is expected to fall by roughly 1.3 percentage points (a 5 percent reduction). These effects, most of which are significantly larger than those produced by the other what-if simulations considered in this paper, reflect both the relatively high failure rates of condoms and the widespread use of condoms by unmarried men under 30. With regard to the latter point, roughly 80 percent of men who are in our simulated target population and who are at risk of fathering a child during a given month use condoms.

[34] Since even IUDs—the form of contraception with the highest continuation rate—have annual discontinuation rates of 12-15 percent (Peipert et al., 2011), the results from simulation 3 should be treated as upper bounds on the benefits associated with improvements in female-specific method continuation.

Table 2: Moving Nonusers to Users

	Simulated Baseline [a]	(1) Increasing the use of LARCs and the pill		(2) Increasing condom use	
	Pre-Intervention	Post-Intervention	Percent Reduction	Post-Intervention	Percent Reduction
Among unmarried women under 30					
Pregnancy rate [b]	104.0	85.7	17.6%	90.9	12.7%
Abortion rate	30.6	22.9	25.2%	25.1	18.0%
Birth rate	59.6	51.7	13.3%	53.9	9.6%
Percent of all children born into poverty [c]	26.6%	26.1%	2.2%	26.1%	2.0%

[a] Simulated results were generated using data from one hundred one-year runs of FamilyScape 2.0. Simulated baseline rates approximate the conditions for an average year in 2006-2008.

[b] Rates are expressed in terms of thousands of unmarried women aged 15-29.

[c] While FamilyScape 2.0 closely replicates real-world pregnancy and pregnancy-outcome rates among unmarried women, the model overestimates pregnancy rates among married women. In order to simulate changes in the incidence of poverty among all newborns, we combine simulated changes in the poverty of children born to unmarried mothers with real-world data on poverty rates among children born to married mothers. Specifically, NSFG 2006-2010 data on child poverty and birth data from Martin et al. (2010) were used to calculate pre- and post-intervention child poverty rates. For more details, see footnote 33.

Table 3: Improving Contraceptive Use among Current Contraceptors

	Simulated Baseline [a]	(3) Making LARC and pill users continuous users		(4) Making LARC and pill users continuous and perfect users		(5) Making condoms 100% effective	
	Pre-Intervention	Post-Intervention	Percent Reduction	Post-Intervention	Percent Reduction	Post-Intervention	Percent Reduction
Among unmarried women under 30							
Pregnancy rate [b]	104.0	92.2	11.4%	86.6	16.7%	77.3	25.7%
Abortion rate	30.6	25.6	16.4%	23.2	24.2%	19.7	35.7%
Birth rate	59.6	54.5	8.6%	52.2	12.5%	47.9	19.6%
Percent of all children born into poverty [c]	26.6%	26.1%	2.2%	25.8%	3.2%	25.3%	5.2%

[a] Simulated results were generated using data from one hundred one-year runs of FamilyScape 2.0. Simulated baseline rates approximate the conditions for an average year in 2006-2008.

[b] Rates are expressed in terms of thousands of unmarried women aged 15-29.

[c] While FamilyScape 2.0 closely replicates real-world pregnancy and pregnancy-outcome rates among unmarried women, the model overestimates pregnancy rates among married women. In order to simulate changes in the incidence of poverty among all newborns, we combine simulated changes in the poverty of children born to unmarried mothers with real-world data on poverty rates among children born to married mothers. Specifically, NSFG 2006-2010 data on child poverty and birth data from Martin et al. (2010) were used to calculate pre- and post-intervention child poverty rates. For more details, see footnote 33.

It is also important to note that these five simulations vary considerably in scope. Table 4 shows that simulation 5 affects roughly 41 percent of unmarried men and women who are at risk of conceiving in a given month, while simulation 1 only affects 5.4 percent of the at-risk population.

Table 4: Scope of "What-If" Intervention

	Percent of target population* affected by intervention
(1) Increasing the use of LARCs and the pill	5.4%
(2) Increasing condom use	2.3%
(3) Making LARC and pill users continuous users	28.0%
(4) Making LARC and pill users continuous and perfect users	28.0%
(5) Making condoms 100% effective	41.1%

*The target population consists of all unmarried men and women aged 15-29 who were at risk of pregnancy during at least one act of intercourse during a FamilyScape month.

VI. Discussion

This study contributes to previous research by assessing the influence of improvements in contraceptive efficacy and continuation on rates of pregnancy, abortion, and childbearing among unmarried teenaged and young adult women under age 30. We also assess the implications of these behavioral changes for the incidence of poverty among newborn children. FamilyScape 2.0 is uniquely well-equipped to perform these types of simulations. Because it simulates the determinants of contraceptive failure, including contraceptive choice, method discontinuation, and imperfect use, the model can be used to isolate specific shortcomings in contraceptive use and focus attention on those that are the most strongly related to nonmarital pregnancy. Moreover, because the model is built using a nationally-representative sample of men and women, FamilyScape 2.0 can provide unique insights into how to reduce unintended nonmarital pregnancy at the national level.

Our literature review identified several aspects of contraceptive use that are linked to unintended pregnancy and childbearing among unmarried women. These include contraceptive non-use, use of ineffective methods, imperfect use of existing methods, and discontinued use of effective methods. Based on that review, we modeled two broad approaches to reducing nonmarital births in our simulations. The first set of simulations involved moving non-users to users (simulations 1 and 2), and the second set involved increasing the consistency and effectiveness of contraceptive use among current users (simulations 3-5).

As expected, each simulation produced substantial reductions in the number of pregnancies, abortions and births to unmarried young women. Declines in nonmarital birth rates ranged from 9 to 20 percent across the simulations. As a point of comparison, nonmarital birth rates were 20 percent lower in 1987 than in 2011 (Martin et al., 2013). Abortion rates declined by between 16 and 36 percent. These findings also highlight the fact that increases in the use and effectiveness of contraception can influence the incidence of child poverty. Notably, estimated poverty rates among newborn children declined by about a half of a percentage point in these simulations. Although these changes in child poverty may appear small, it is important to note that SNAP—a program that costs an estimated $80 billion a year—reduced the poverty rate by 1.2 percentage points in 2011 and lifted about 3.7 million people out of poverty (Tiechen et al., 2013). Although we have not conducted a formal cost-benefit analysis, given the low cost of contraceptives relative to most other anti-poverty programs, we believe the strategies outlined above represent potentially cost-effective avenues for reducing child poverty.

Implications of changing non-users to users

The first two simulations highlight the potential role of both men and women in improving contraceptive method use and in reducing nonmarital pregnancies, births and abortions. Since more than half (56 percent) of women in the simulation population who were at risk of pregnancy in a given month were originally using hormonal or long-acting methods, our first simulation translates into an 11 percentage point increase in the number of women using some method of contraception. Previous interventions suggest that an increase of this magnitude is at least feasible. For example, a national evaluation of the Children's Aid Society Carrera-model program to prevent teen pregnancy found that the intervention produced a 13 percent increase in

injectable method use among females in the program (Philliber et al., 2001). Also, the St. Louis CHOICE project found evidence of a high uptake of hormonal and long acting methods among women who were seeking some type of contraceptive method, with a particular emphasis on IUDs and implants (Peipert et al., 2011)

Among men, 82 percent were already using condoms, so the effects from simulation 2 are based on moving a relatively small percentage of them (4.6 percent of men in total) from being non-users to being continuous users. Several interventions have demonstrated similar effect size increases in condom use.[35] The literature suggests that, while most men have used condoms at some point, the likelihood of using condoms declines with age and relationship length, as does the likelihood of consistent condom use (Manlove et al., 2008).

Implications of increasing the consistency and effectiveness of method use

Increases in the likelihood that women stay on highly effective methods, including both hormonal methods and LARCs, also result in reductions in nonmarital pregnancies and births. FamilyScape 2.0 allows for the possibility of method discontinuation. Simply making women continuous method users over a 12-month period (as shown in simulation 3) reduces nonmarital pregnancies by 11 percent and reduces nonmarital births by 9 percent. These findings reflect the fact that many women, even once they have started using effective methods of contraception, often switch to less effective methods. Moreover, previous research notes that discontinuation rates differ by type of method, with particularly high levels of discontinuation among women using injectables (Vaughan et al., 2008) and low discontinuation rates among women using LARCs (Peipert et al., 2011). Even after increasing method continuation, simulation 4 indicates

[35] See, for example, DiClemente et al. (2004), DiClemente et al. (2009), and Sikkema et al. (2005).

that increases in the effectiveness of existing methods are associated with additional reductions in the number of nonmarital pregnancies, births, and abortions. Simulation 4 assumes a zero percent method failure rate and is thus an upper-bound estimate of what might be accomplished by increasing effectiveness. These types of improvements would occur if women chose methods whose failure rates, even for the typical user, are close to zero. Not all hormonal methods meet this strong requirement. For example, women using injectable methods (who may delay obtaining shots) and women using oral contraception (who often miss a pill) are much more likely than women using LARCs to experience higher failure rates. In fact, LARCs are unique in that they have very low typical- and perfect-use failure rates (Trussell, 2011).

Simulated improvements in condom use are linked to substantial reductions in nonmarital pregnancies and births, as shown in simulation 5. In fact, compared to the other simulations considered in this paper, simulation 5 yielded the greatest reductions in unintended pregnancy. This is, however, partly due to differences in intervention scope: simulation 5 affected 82 percent of young unmarried men, while only 56 percent of young unmarried women were impacted by simulations 3 and 4. Moreover, simulation 5 asks what would happen if condoms were 100 percent effective, but in actuality, condoms are often used inconsistently and/or incorrectly. For example, only half of sexually active teen males in the NSFG reported using condoms consistently with their most recent partner (Manlove et al., 2008). These percentages were even lower for men and women in their twenties, which highlights the difficulty of improving the effectiveness of condoms. As noted earlier, typical-use condom failure rates are substantially higher (18 percent) than perfect-use failure rates (2 percent) because of the difficulty of achieving effective and consistent use of condoms (Trussell, 2011). Perfect condom use implies

that they would be used at every sexual act, even in the heat of the moment when comparatively few people are focused on protection.

For this reason, a better strategy may be to encourage the partners of condom users to switch to long-acting methods, such as LARCs, whose failure rates for the typical user are close to zero.[36] Thus, another interpretation of the substantial effects produced by simulation 5 is that increasing effectiveness—by switching couples from relying on coitus-dependent methods to long-acting methods—can substantially reduce rates of nonmarital pregnancy and childbearing.

How likely are interventions to influence contraceptive use?

Both sets of approaches—transforming non-contraceptors into contraceptive users and improving the consistency and effectiveness of contraceptive use—require substantial changes in individual behavior, particularly among those women (and their partners) who have the highest rates of nonmarital childbearing—i.e., low-income women, racial and ethnic minorities, and those with lower levels of education. Some of the barriers to hormonal and long-acting method use include concerns about side effects (Kaye et al., 2009); limited knowledge of hormonal methods and their effectiveness (Frost et al., 2012); barriers to access to hormonal methods of contraception because of high costs or the limited availability and accessibility of family planning providers (Secura, 2013); ambivalence about pregnancy (Higgins et al., 2012; Kay et al., 2009); and expectations, especially among low-income individuals and racial and ethnic minorities, about having children at an early age (East, 1998). As noted earlier, women at high risk of unintended pregnancy are seeking contraceptive methods that are effective, affordable,

[36] Specifically, the typical- and perfect-use failure rates for Mirena are both 0.2 percent, and the typical- and perfect-use failure rates for ParaGard are 0.8 and 0.6 percent, respectively (Trussell, 2011).

and have minimal side effects (Lessard et al., 2012). Thus, increasing contraceptive use and method effectiveness will require that interventions address women's concerns about side effects, costs, and accessibility, and that they address women's underlying motivations (or lack thereof) to avoid an unplanned pregnancy.

Condoms, oral contraception, and injectable methods have comparatively high discontinuation rates and typical-use failure rates, which can lead to increased risks of unintended pregnancy among young women. Alternatively, LARCs are reversible forms of contraception that combine both consistency and effectiveness and have the highest rates of method continuation. As a result, the American Congress of Obstetricians and Gynecologists (ACOG) lists LARCs as a first-line method of choice for women seeking to avoid unintended pregnancy, including teens (ACOG, 2009). One recent initiative—the St. Louis CHOICE project—has shown dramatic increases in the uptake of LARCs and hormonal methods among women at the highest risk of pregnancy, including those who had a recent abortion. In particular, their approach to providing free, same-day insertion of LARCs to women seeking contraception was associated with a 75 percent uptake rate of IUDs and implants—rates that are far higher than the current national percentage of women using LARCs (Peipert et al., 2012).[37] Thus, intensive efforts to increase LARC use do in fact seem possible.

Of course, a substantial proportion of non-users of contraception may be difficult to reach with any current intervention, especially if they are ambivalent about a nonmarital pregnancy and are thus less motivated to engage in the behaviors required to avoid an early or nonmarital pregnancy. However, data on retrospective measures of intendedness indicate that the majority

[37] In 2009, for instance, roughly 8.5 percent of current contraceptors used IUDs or implants (Finer et al., 2012).

of pregnancies to women under 30 are either unwanted or occur earlier than they had planned (as shown in Figure 2), which suggests that many women do not actively intend to become pregnant. Alternatively, the advantage of increasing contraceptive continuation and effectiveness among women who are currently using hormonal or long-acting methods is that these women are already committed to pregnancy prevention and have at least tried effective methods.

Limitations & Future Research

Our analyses have some limitations that could be addressed in future work. First, our simulations increase contraceptive use to varying degrees (ranging, for example, from affecting the behavior of 5 percent of men in our target population in simulation 2 to affecting the behavior of 82 percent of men in our target population in simulation 5). We anticipate conducting future analyses that switch contraceptive use for similar sample percentages in order better to assess the relative impacts different types of changes in contraceptive behavior. Second, because of sample size issues, the current FamilyScape model does not differentiate between injectables and LARCs, despite substantial differences in continuation and typical-use failure rates for these methods. With the anticipated availability of new national data from the 2012 NSFG, we plan to enhance the model by differentiating these two categories in future iterations. This update will allow us to test the relative effectiveness of moving women to pills vs. injectables vs. LARCs. Third, the current model separately identifies female methods of contraception (hormonal, injectables, LARCs) and male methods (condoms/withdrawal) and does not readily identify simultaneously what method(s) both members of a given couple may be using. A future update to the model could attempt to capture couple-level decision-making.

Finally, we recognize that contraceptive use, nonmarital childbearing, and poverty may be jointly determined by factors that are not included in our model, including perceptions of future opportunity and motivations to prevent pregnancy. Despite our focus on unintended pregnancies, we recognize that unintendedness is a somewhat subjective concept and that there is considerable ambivalence about family planning as a result, especially among the most disadvantaged women and men. For these groups, improvements in contraceptive use must be combined with enhanced opportunities in order to provide teens and young adults with a reason to delay childbearing.

VII. Conclusion

The findings reported in this study suggest that improvements in contraceptive use, consistency, and effectiveness could lead to substantial reductions in nonmarital pregnancies, abortions, and births among women under 30. Our findings also suggest that initiatives targeting contraceptive behavior are likely to be cost-effective avenues for reducing child poverty. More research is thus needed on ways of improving contraceptive use among teens and young adults. Except for the CHOICE project, there is a relatively limited evidence base on programs that might increase the use of effective methods. For example, the Office of Adolescent Health's list of evidence-based teen pregnancy prevention programs includes only one program that shows any impact on methods other than condoms. In addition, there is limited information on programs that have been designed to reduce unintended pregnancy beyond the high school years (Kirby, 2008). The roll-out of the Affordable Care Act provides an opportunity to assess whether and how increased access and delivery of effective, low-cost contraceptive methods will affect the use of effective contraceptive methods, thereby helping to reduce rates of unplanned pregnancy, abortion, nonmarital births, and child poverty.

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