Abstract

The impact of family planning programs on fertility in developing countries is contested, with empirical evidence finding negative effects on completed fertility but no consistent effect on short-run fertility. Using a lifecycle model of fertility control choice, we theoretically and empirically show that differential responses of short-run and completed fertility are consistent with a single behavioral response to improved contraceptive access — a shifting of births earlier in the lifecycle due to improved control over fertility outcomes. Women without access to modern contraceptives use traditional methods to delay wanted births because of a precautionary motive to avoid exceeding their target fertility; improved contraceptive access relaxes this precautionary motive and can increase short-run, but not completed, fertility. Using a difference-in-difference design that exploits the legalization of injectables in Zambia, we show that an expansion of the type and availability of modern contraceptives increases use of injectables and modern contraceptives by 350% and 50%, respectively; decreases use of traditional fertility control methods such as unsafe abortions, coital infrequency, and postpartum behaviors; and increases short-run fertility by 10%. Consistent with the predictions of our model, completed fertility does not increase and short-run fertility increases are confined to rural women 20–45. Our results confirm that improved control over unwanted pregnancies can produce the divergent fertility responses found in the literature and suggest that access to modern contraceptives is welfare-improving for women, despite having counterintuitive implications for fertility.
1 Introduction

Policymakers and scholars have long been concerned with fertility declines in developing countries given the potentially welfare-improving behavioral changes associated with fertility reduction — e.g., increases in women’s labor force participation (Bloom et al. (2009), Bailey (2006)) and human capital accumulation (Goldin and Katz (2002)) — and the potential for a positive feedback loop between fertility declines and macroeconomic growth (Galor and Weil (1996), Galor (2005)). However, the importance of family planning programs in facilitating fertility declines is contested between supply-side and demand-side proponents. The former emphasize that improved access to family planning reduces fertility (e.g., Bongaarts (1994), Bailey (2012)), while the latter emphasize that reductions in desired fertility, rather than improvements to family planning programs, drive fertility declines (e.g., Pritchett (1994)). Empirical evidence has yet to resolve this debate, with evaluations of supply-side interventions yielding puzzling and ambiguous results — access to family planning reduces completed fertility (e.g., Miller (2010), Angeles et al. (1998), and Bailey (2012)), but has no clear impact on short-term fertility (e.g., Ashraf et al. (2013)). Determining how family planning programs impact fertility has assumed greater importance as the fertility transition has stalled\footnote{Fertility rates in sub-Saharan Africa remain higher, and fertility declines have progressed more slowly, than the rest of the developing world.} in sub-Saharan Africa (Bongaarts and Casterline (2013)).

In this paper, we theoretically and empirically assess the impact of access to family planning on fertility control choice, completed fertility, and short-run fertility within a lifecycle framework. Specifically, we examine how women’s lifecycle fertility choices and lifecycle traditional methods use respond to a broad expansion in the type and availability of modern contraceptives (i.e., the legalization of injectables) in Zambia and surrounding countries, a region of sub-Saharan Africa typical of the stalled transition (Figure[1]). We theoretically show that correctly identifying the impact of improved access on completed and short-run fertility requires embedding the evaluation of family planning programs within a...
unified lifecycle model of fertility control choice because access to modern contraceptives changes women’s *intertemporal fertility incentives* by eliminating the risk of unwanted (future) pregnancies. Using predictions of our lifecycle model, we empirically confirm that the differential impacts of improved contraceptive access on completed and short-run fertility are *consistent* with a single behavioral response — an intertemporal substitution of births to earlier in the lifecycle.

We build a dynamic model of fertility control choice where women choose costly pre-pregnancy and post-pregnancy fertility control methods in each of their fertile periods in order to achieve their *ex ante* randomly assigned target fertilities. At the end of their fertile life, women incur symmetric penalties for exceeding or falling short of their desired number of children. These intertemporal incentives create a *precautionary motive* for women with intermediate target fertilities to delay wanted births when expected losses from overshooting target fertilities outweigh expected losses from undershooting target fertilities. Access to modern contraceptives allows women to perfectly limit unwanted births, relaxing any precautionary motives and causing: (a) substitution away from traditional methods of fertility control; (b) reductions in short-run and completed fertility among women already at or above their target fertility; and (c) increases in short-run, but not completed, fertility among women who were previously delaying having children. The latter two consequences exert *opposite forces* on short-run, but not completed, fertility, and when sufficiently many women delay wanted births in the absence of modern contraceptives, improved contraceptive access *increases short-run fertility*, while (weakly) decreasing completed fertility.

We test the predictions of our model using difference-in-difference techniques that exploit the fact that all countries surrounding Zambia had legalized injectables at least ten years prior to Zambia’s 2004 legalization. We construct four unique data sets that pool across Zambia and administrative regions bordering Zambia in five neighboring countries\(^2\) using 32 rounds of Demographic and Health Surveys (DHS), and exploit the staggered legalization of injectables to identify causal estimates for the effect of expanded modern contraceptive access on fertility, birth-spacing, abortions, and traditional methods of fer-

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\(^2\)These countries are Tanzania, Malawi, Mozambique, Zimbabwe, & Namibia.
tility control. Using legal access to injectables as our treatment variable allows us to avoid both selection into modern contraceptive use and endogeneity arising from unobserved factors (e.g., policymakers’ decisions) affecting the location of family planning programs. Our specification flexibly controls for differential time trends in the age-profile of urban and rural women’s contraceptive and fertility choices to better identify treatment effects. We supplement our analysis with within-woman estimates of treatment effects when estimating responses for outcome variables with rich panel dimensions (i.e., fertility and birth-spacing).

We find that women respond to Zambia’s 2004 legalization of injectables by: (a) increasing use of injectables (350%) and modern contraceptives (50%); (b) decreasing reliance on unsafe abortions (-30%), coital infrequency (-10%), and postpartum protection from pregnancy risk during the second year post-birth (-23%); and (c) increasing short-run fertility (10%), and decreasing birth-spacing. Importantly, completed fertility (i.e., the stock of births for women 45-49) does not increase in response to injectable legalization, confirming that fertility increases reflect changes in the timing of births across the lifecycle (i.e., tempo effects) rather than changes in the total number of births (i.e., quantum effects). These results are consistent with the predictions of our model discussed above, but cannot be explained by the existing framework for understanding the relationship between modern contraceptive access and fertility. In particular, neither supply-side (Bongaarts (1994)) nor demand-side (Pritchett (1994)) explanations for fertility reductions differentiate between short-run and completed fertility responses, and both predict that fertility decreases when contraceptive use increases, contrary to our findings.

We further exploit that rural and urban women had differential access to modern contraceptives prior to legalization and that women were at different ages and parity levels when legalization occurred, to generate empirical predictions for how adoption, substitution, and fertility responses should differ across subsamples defined by urban or rural sector, age, and parity. We find that contraceptive adoption and substitution away from abortions

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3Urban women had substantially more access to modern contraceptives than rural women prior to legalization. Correspondingly, injectable legalization was a positive shock to any contraceptive access in rural areas, but only a positive shock to method type access in urban areas.
is largest for women at higher parities, consistent with our predictions that women at or above their target fertilities switch to using modern contraceptives instead of abortions to limit unwanted births. Similarly, we find that substitutions away from traditional pre-pregnancy methods of fertility control and increases in fertility (decreases in birth-spacing) occur only for rural women, consistent with our prediction of differential impact in rural and urban areas given higher pre-legalization use of modern contraceptives by urban women. Importantly, short-run fertility increases are confined to rural women 20–45, with rural childless women older than 20 particularly likely to increase short-run fertility. These fertility responses are consistent with women shifting births earlier in their lifecycle, with women 15-19 having additional reasons to delay births (e.g., human capital formation) and women older than 45 having no reason to delay births prior to legalization.

To the best of our knowledge, we are the first to theoretically formulate how access to modern contraceptives impacts fertility when women have precautionary motives to delay wanted births and the first to empirically confirm that intertemporal incentives to increase fertility can dominate contemporaneous gains in limiting unwanted births. In doing so, we contribute to a large literature exploring how contraceptive access impacts fertility, both in the developing world and in the developed world. Specifically, we complement existing work showing that access to modern contraceptives delayed onset of childbearing (e.g., Goldin and Katz (2002)) and increased birth-spacing intervals (e.g., Cleland et al. (2006)) by showing that in a context where women can achieve lengthy birth-spacing intervals using only traditional methods, modern contraceptives can actually decrease birth-spacing and increase short-run fertility as women shift births earlier in the lifecycle. Moreover, by showing that modern contraceptive access changes women’s intertemporal fertility incentives,

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4For example, Miller (2010) shows that the rollout of family planning services in Colombia in the 1960s and 1970s (moderately) reduced completed fertility; Ashraf et al. (2013) and Ashraf et al. (2014) study the effects of a randomized contraceptive voucher program in Zambia, finding limited evidence that fertility decreases for women randomly assigned the voucher treatment; Desai and Tarozzi (2011) find no fertility effects when women are randomly assigned to increased family planning outreach programs in Ethiopia; Angeles et al. (1998) uses a random effects model to show large reductions in fertility associated with community-level family planning program placement in Tanzania. See Miller and Babiarz (2016) for a comprehensive survey of the literature.

5See, for example, Goldin and Katz (2002), Bailey (2006), and Bailey (2012).
we help reconcile the differential impacts of contraceptive access on completed fertility and short-term fertility found in the literature.

Our paper also contributes to a large literature on why the fertility transition stalled in sub-Saharan Africa\textsuperscript{6} by arguing that the uniquely high reliance on traditional methods of fertility control in sub-Saharan Africa (e.g., lengthy durations of postpartum abstinence and breastfeeding) makes the region particularly likely to have had a large fraction of women successfully delaying wanted births prior to contraceptive access, thereby suggesting larger short-term increases in fertility when contraceptive access improves relative to other regions in the world. Finally, our paper contributes to literatures studying the effect of contraceptive access on breastfeeding (e.g., Rous (2001), Jayachandran (2014)), abortions (e.g., Miller and Valente (2016), Jones (2015)), and abstinence (e.g., Cleland and Ali (2006)) by confirming that modern contraceptives are substitutes with these traditional methods of fertility control in the Zambian context.

Our paper is organized as follows. We detail the context of fertility control methods in Zambia in Section 2 and generate testable empirical predictions from a dynamic model of fertility control choice in Section 3. We describe our data and outline our empirical strategy in Sections 4 and 5 respectively. We present results regarding the impact of injectable legalization on contraceptive adoption, substitution away from traditional methods, and fertility in Section 6. We discuss the implications of our results and conclude in Section 7.

2 Background

We study the relationship between fertility declines and contraceptive access in Zambia for two reasons. First, Zambia and surrounding countries have high fertility, high desired fertility, extensive use of traditional methods of fertility control, and low baseline use of

\textsuperscript{6}A large number of explanations that have been proposed for this phenomenon, including: limited contraceptive access (Bongaarts (1994)); high desired fertility (Pritchett (1994)); high infant mortality rates (Caldwell et al. (1992)); low levels of women’s education (Lloyd et al. (2000), Kravdal (2002)); and a unique cultural model of sexual behavior and fertility in sub-Saharan Africa that rewards high fertility (Caldwell and Caldwell (1987), Caldwell et al. (1989)).
modern contraceptives. Second, the legalization of injectables in Zambia is delayed relative to all its neighboring countries, creating a shock to contraceptive access that we exploit for identification in Section 5. These features allow us to study the relationship between contraceptive access and fertility decline in a context ideal to test our model, as: (a) women are likely to be using traditional methods of fertility control to delay having children and, thereby, avoid exceeding target fertilities; and (b) a large shock to contraceptive access can eliminate precautionary motives to delay childbirth. Below, we provide details of the predominant methods of fertility control in Zambia and surrounding countries and provide details of how legal barriers affected the diffusion of injectable contraceptives throughout the region.

2.1 Methods of Fertility Control in Zambia & Surrounds

Women in the regions we study have access to a variety of fertility control technologies, both modern and traditional, with heterogeneous effectiveness at preventing births. Unlike modern methods, many of the traditional methods can only be used at certain moments in a woman’s life (e.g., post-birth). Below, we discuss the major fertility control technologies available to these women, when during their lives they can use these technologies, and the mechanisms by which these technologies reduce fertility.

The primary methods of modern contraceptives used in countries in our sample are injectables, hormonal birth control pills, and condoms. Injectable — a progestin-only form of hormonal birth control administered via injection that provide three months of protection from pregnancy risk — have unique features that render them particularly effective for fertility reduction in the sub-Saharan African context. Specifically, injectables have lower failure rates and fewer adherence concerns relative to pills and condoms because: (a) users

\footnote{For example, DHS survey data from 1995-1999 in control group countries suggests that pills, injectables, and condoms have the three highest method mix shares, respectively. Similarly, the 1996 Zambia DHS shows pills and condoms having the largest method mix share. Towards the end of the period we study, female sterilization and hormonal implants begin to increase method mix share in all countries in our sample.}

\footnote{Polis et al. (2016) estimate yearly typical use failure rates in Eastern & Southern Africa for injectables, pills, and condoms to be 1.9%, 4.7%, and 3.5%, respectively, though their sample of countries does not}
do not need to remember to use injectables daily or at time of intercourse; (b) users do not need to negotiate with male partners to use injectables; and (c) users can easily conceal injectables from male partners.

The primary methods of traditional pre-pregnancy fertility control are postponed initiation into sexual activity, coital infrequency, and prolonged durations of postpartum abstinence and breastfeeding. Postponing first intercourse, available primarily to younger women, and coital infrequency, available to women who can negotiate sexual frequency with their partners, both directly reduce pregnancy risk. Postpartum technologies are only available following a birth and reduce pregnancy risk by either delaying a woman’s return to ovulation or delaying a woman’s return to sexual activity. There are four postpartum outcomes associated with traditional methods of fertility control: breastfeeding, abstinence, amenorrhea and the protection period. Both breastfeeding duration and abstinence duration are choice variables for women post-birth that reduce pregnancy risk: breastfeeding duration delays return of menses, reduces conception probability once menses has returned, and can result in reduced coital frequency in societies (like Zambia)

include Zambia and their methodology most likely understates failure rates. Within the US, the CDC estimates yearly typical use failure rates of injectables, pills, and condoms to be 6%, 9%, and 18%, respectively. Both sets of numbers confirm that injectables have lower failure rates compared to condoms and birth control pills.

randomize access to contraceptive vouchers among women in Lusaka, Zambia, finding that women who receive contraceptive vouchers absent their husband’s knowledge are more likely to use contraceptives and choose injectables than their peers who received vouchers in the presence of their husband. Their work confirms that male surveillance of women’s behaviors is an important determinant of contraceptive use and that injectable contraceptives are one way of ameliorating that surveillance.

In the sub-Saharan African context, marriage and initiation into sexual activity are not strongly linked, making initiation into sexual activity more relevant than entering marriage. See Caldwell et al. (1989) and Caldwell et al. (1991) for discussions of African sexual practices and how they differ from Eurasian practices.

Postpartum amenorrhea refers to the period of time following a live birth when a woman does not experience her period and, hence, has (minimal) zero pregnancy risk.

The postpartum protection period is the period of time following a live birth when a woman cannot get pregnant because she is either abstaining or amenorrheic. The duration of the postpartum protection period is the maximum of the duration of abstinence and the duration of amenorrhea.

Intimate partner violence and strong social norms regarding postpartum behavior can mitigate the extent of choice women have over postpartum behavior. Nonetheless, we can view breastfeeding and abstinence as functions of household bargaining, where the degree to which a woman’s preferences are respected correspond to her bargaining power. It will only be in limit cases, then, that these behavioral outcomes are orthogonal to women’s choices.
with taboos against sexual intercourse with breastfeeding mothers\textsuperscript{14} postpartum abstinence directly reduces pregnancy risk by delaying return to sexual intercourse. Duration of amenorrhea and duration of the protection period are outcomes that are functions of women’s choice behavior and correspond to reduced pregnancy risk: postpartum amenorrhea directly prevents pregnancy and is primarily determined by duration and intensity of breastfeeding\textsuperscript{15} the postpartum protection period, by construction, corresponds to a period with zero pregnancy risk and is primarily determined by abstention and breastfeeding behaviors.

Abortions, a traditional post-pregnancy method of fertility control (Joffe (2009)), are widely used in Zambia & surrounds\textsuperscript{16}. Abortion restrictions (Table F.1) vary across the countries in our sample, but, importantly for our identification strategy, remain unchanged during the time period we consider. Voluntary abortions are illegal in all countries in our sample and substantial barriers exist to acquiring a legal abortion. For example, in Zambia abortions are permitted when there is substantial risk to the physical or mental health of the mother, but legally require the signature of multiple physicians, including a specialist, and must take place in specific government facilities\textsuperscript{17}.

The high costs to procuring legal abortions suggest that a large fraction of the abortions that do take place are illegal and unsafe\textsuperscript{18}.

\textsuperscript{14}See Blackburn (2007) for a discussion of physiological responses to breastfeeding. See Bleek (1976) for a discussion of social norms regarding sexual intercourse and breastfeeding among groups in sub-Saharan Africa. Jayachandran (2014) has an informative discussion of the mechanisms by which breastfeeding can reduce fecundity.

\textsuperscript{15}See Blackburn (2007) and McNeilly (2001) for discussions of the physiological relationship between breastfeeding behavior and postpartum amenorrhea. Intensity of breastfeeding is typically measured by number of feedings per day and intensity of suckling.

\textsuperscript{16}Sedgh et al. (2012), whose methodology is likely to underestimate abortion use in countries where women seeking abortions face legal obstacles and social stigma, estimate that Eastern Africa (which includes Zambia) has the highest abortion rates of any sub-region in the world barring Eastern Europe and the Caribbean in 2008.

\textsuperscript{17}See Likwa et al. (2010) for a discussion of abortion use in Zambia.

\textsuperscript{18}Sedgh et al. (2012) estimate that over 95% of abortions in Eastern Africa are unsafe in 2008; that estimate rises to 100% during 1995-2003. Likwa et al. (2010) provide comparable figures: the authors use hospital records from five major hospitals around Zambia to document that approximately 85 times as many women are treated for abortion-related complications as obtain safe induced abortions during 2003-2008.
2.2 Injectable Legalization in Zambia & Surrounds

The rollout of injectable contraceptives was staggered in Zambia relative to surrounding countries. Countries surrounding Zambia lifted bans on injectables and began distribution following FDA approval of injectables in 1992 (Sutherland et al. (2011)). In contrast, Zambia maintained a legal ban on injectables until late 2004, when Depo-Provera (the most common brand of injectable) was formally registered by the Zambia Drug and Poisons Board (Solo et al. (2005)).

Legalization led to a large expansion in contraceptive supply in Zambia despite imperfect enforcement of the ban on injectables. Post-legalization, the Zambian government, NGOs, and private clinics began to distribute injectables, the former two at zero cost, in a gradual country-wide rollout, with aid agencies providing large shipments of injectables directly to the Zambian Ministry of Health. Implementation of the rollout improved over time as community health workers were trained and authorized to administer injectable contraceptives to users following changes in WHO guidelines in 2009 (Chin-Quee et al. (2013)). However, documenting the precise stages of the rollout is difficult for at least two reasons: 1) injectables can be out-of-stock at local health centers (Ali et al. (2008)), making measurement of contraceptive supply at a local level difficult; and 2) a public scare in January 2008 based on rumors that injectables were contaminated with HIV led to a three-month withdrawal of injectables from health centers. For these reasons, we analyze injectable legalization, rather than rollout, as a positive shock to contraceptive access.

\[\text{Notably, some aid and donor agencies conducted interventions to expand method mix choice (including injectables) in the predominantly urban Lusaka and Copperbelt regions during the late 1990s in order to demonstrate to the Zambian government that Zambian women had strong unmet demand for injectables. These interventions suggest that urban Zambian women had (some) access to injectables prior to 2004. Rural women, particularly those residing outside of the Lusaka and Copperbelt regions, did not. See Skibiak et al. (2007) for details.}\]

\[\text{These rumors were publicly debunked by the Zambian Ministry of Health, and injectables were reintroduced to all health facilities in the months following the withdrawal.}\]

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3 A Model of Contraceptive Access & Dynamic Fertility Choice

To discipline our thoughts on how women respond to improved contraceptive access, we propose a model where women with finite opportunities to have children choose pre-pregnancy and post-pregnancy methods of fertility control each period to achieve their ex ante randomly assigned target fertilities. Women without access to modern contraceptives have asymmetric control over achieving target fertilities — their ability to restrict unwanted pregnancies without substantial disutility is poor relative to their ability to have another child. Asymmetric control causes women with intermediate target fertilities to have a precautionary motive to delay wanted births in order to avoid exceeding their target fertilities. Expanded access to modern contraceptives improves women’s ability to avoid unwanted pregnancies, changing their fertility behavior as: (a) women with intermediate target fertilities increase fertility in the short-run because they have better ability to limit unwanted pregnancies in the future; and (b) women already at their target fertility and were using traditional methods (e.g., abortions) to limit births substitute away from traditional methods towards modern contraceptives in order to more successfully limit unwanted pregnancies. These two consequences of improved contraceptive access exert opposite forces on aggregate fertility. In contrast, when women’s fertility control in the absence of modern contraceptives approaches symmetry, women have no precautionary motives to delay fertility and improved contraceptive access reduces fertility, conforming to the predictions of a repeated static model of fertility control.

Our model highlights how access to modern contraceptives can have counterintuitive implications when women make dynamic fertility control choices and contributes to exist-

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21 The CDC estimates typical-use annual failure rates for modern contraceptives such as hormonal implants and IUDs below 1%, substantially lower than comparable rates for traditional methods such as withdrawal (22%) or periodic abstinence (24%).

22 Consider a model where women are instead assigned a fertility preference (i.e. want a child now, do not want a child now) at the beginning of each period using i.i.d draws from an underlying distribution and rewarded at the end of each period based on how successful they were at achieving their preference. Then, women’s fertility choices in a given period are independent of the future (i.e. static), and access to modern contraceptives must reduce fertility.
ing models of dynamic stochastic fertility control (e.g., Rous (2001), Newman (1988)) by formalizing a precautionary motive to delay having children and analyzing how this motive is impacted by improved contraceptive access. Our model abstracts away from the trade-off between human capital formation and initiation into sexual activity and childbearing for adolescents, limiting our ability to comment on fertility behaviors for women aged 15-19. Our model also abstracts from preferences over birth-spacing, differential access to modern contraceptives prior to legalization, and infant mortality. These additional forces attenuate, but do not necessarily eliminate, precautionary motives to delay births (see Appendix A.2). Below, we present a simple three-period version of our model to provide intuition for how asymmetric fertility control can generate precautionary motives to avoid having children and can lead to ambiguous fertility responses to improved modern contraceptive access.

3.1 Description of Model

Consider a world where women live four periods, indexed by \( t \in \{0, 1, 2, 3\} \), and have three fertile periods corresponding to \( t \in \{1, 2, 3\} \). At the onset of the model \( (t = 0) \) women are randomly and independently assigned a target fertility \( n_i \in \{0, 1, 2, 3\} \) and a disutility from abortion use \( c_i \sim F(0, \infty) \), where \( F \) is a cumulative density function for a continuous random variable. A woman makes decisions about fertility control in each period based on two state variables: (a) the relationship between her stock of children and her desired target fertility, and (b) her personal cost of abortions. Denote by \( s_t \) the stock of children that a woman has at the end of period \( t \), with \( s_0 \equiv 0 \), and define the difference between a woman’s stock of children and her desired fertility target as \( \gamma_i^t \equiv s_t - n_i \). At the beginning of period \( t \), then, the state variables for individual \( i \) are \( (\gamma_i^{t-1}, c_i) \).

Within each of her fertile periods, a woman first chooses pre-pregnancy methods of fertility control \( b \in [0, 1] \) or \( m \in \{0, 1\} \) corresponding to traditional methods of fertility control (e.g., coital infrequency, postpartum behaviors, etc.) and modern contraceptives.

\[\text{These target fertilities can be construed as broader fertility categories. In the Zambian context, we correspond these target fertilities to fertility categories of 0 kids, 1-3 kids, 4-6 kids, and 7+ kids, respectively.}\]
(injectables), respectively. Conditional on a pregnancy realizing, she then chooses \( a \in \{0, 1\} \), corresponding to keeping or aborting the pregnancy, respectively. When using traditional methods \( b \), a woman conceives with probability \( p(b) \); if she chooses to use injectables \( (m = 1) \), she does not conceive. A woman utilizing no methods of fertility control will conceive with probability \( \bar{p} < 1 \). Abortions successfully terminate a pregnancy with probability one.

Women experience instantaneous disutility from use of fertility control methods and a final payoff that penalizes them from deviating from their target fertility. Within each period, women receive fixed utility \( \bar{u} \), disutility \( \phi(b) \) from using traditional pre-pregnancy methods of fertility control, disutility \( \bar{\phi} \) from using injectables, and personal disutility \( c_i \) from aborting a pregnancy. At the end of \( t = 3 \), women are penalized for deviating from their target fertility with symmetric loss function \( U(\gamma_i^t) \equiv -r(|\gamma_i^t|) \). For convenience, we normalize \( \phi(0) = 0 \) and set \( r(0) = 0 \).

### 3.2 Maximization Problem and Solution

Within each period, women maximize the sum of current and expected utility by choice of fertility control methods. We characterize how women’s fertility and fertility control behaviors change as contraceptive access expands by comparing women’s optimal behavior when they cannot use modern contraceptives (i.e., they are constrained to choose \( m = 0 \)) to women’s optimal behavior when they can use modern contraceptives (i.e., they may choose \( m \in \{0, 1\} \)). Throughout our exposition, we focus on the intuition and forces driving our results; a formal presentation of our model can be found in Appendix A.

#### 3.2.1 World without modern contraceptives

When women cannot choose modern contraceptives, women at \( t \in \{1, 2, 3\} \) solve:

\[
V_i(\gamma_{t-1}^i) = \max_{b \in [0, 1]} \left\{ \bar{u} - \phi(b) + p(b) \max \left\{ V_{t+1}(\gamma_{t-1}^i + 1), V_{t+1}(\gamma_{t-1}^i) - c_i \right\} + (1 - p(b))V_{t+1}(\gamma_{t-1}^i) \right\}
\]
where the value function $V_t(\gamma_{t-1}^i) \equiv V_t(\gamma_{t-1}^i, c_t)$ for $t = 1, 2, 3$ suppresses dependence on $c_t$ for conciseness, and $V_4(\gamma_2^i) \equiv U(\gamma_2^i)$. Women choose traditional fertility control methods $b$ while accounting for future abortion decisions in the event of pregnancy (the maximum within the maximization problem), balancing the immediate disutility from using traditional fertility control methods with (potential) disutility from pregnancy.

With standard assumptions on cost functions and probabilities, we fully characterize women’s optimal behavior when they do not have access to modern contraceptives (formalized in Lemma 1 in Appendix A). Women with high target fertilities, $n_i = 3$, will try to have children every period; they will use neither traditional methods of fertility control nor abortions and will, in expectation, have $3\bar{p}$ children. Women with low target fertilities, $n_i = 0$, will try to avoid having children every period, aborting pregnancies if and only if their abortion disutility is low and choosing an intensity of traditional method use that increases in their abortion disutility. Intuitively, women with low disutility of abortion use know they will terminate any pregnancy that arises and have less incentive to use (costly) fertility control methods to avoid pregnancy.

Women with intermediate target fertilities, $n_i \in \{1, 2\}$, choose to delay having desired births when their expected losses from overshooting outweigh their expected losses from undershooting (i.e., when their failure rate while trying to avoid pregnancy, $p(b^*)$, and their personal disutility of abortions, $c_t$, is high relative to their failure rate while trying to get pregnant, $1 - \bar{p}$), and vice-versa. As women’s control over fertility outcomes becomes increasingly asymmetric (i.e., $\bar{p}$ increases), more women delay having children to avoid potential overshooting losses (formalized in Lemma 2 in Appendix A).

24 We place smoothness restrictions on the cost functions $\phi(\cdot)$ and $r(\cdot)$ and the probability $p(\cdot)$ to ensure that solutions exist to the above maximization problems. We place convexity restrictions on all three functions to ensure that women’s optimal choice of traditional fertility control method is weakly increasing in the disutility of abortions, $c_t$. Finally, we assume that cost functions are strictly increasing, and that the probability function is strictly decreasing. We formalize these restrictions in Assumption 1 in Appendix A.

25 Women with low disutility from using abortions face minimal expected losses from overshooting as their future selves will terminate any unwanted pregnancy.
3.2.2 World with modern contraceptives

Women with access to modern contraceptives maximize:

\[
V^I_t(\gamma^i_{t-1}) = \max_{\bar{u} - \phi + V^I_{t+1}(\gamma^i_{t-1})} \left\{
\begin{array}{l}
\bar{u} - \phi(b) + p(b) \left[V^I_{t+1}(\gamma^i_{t-1} + 1) \lor \left(V^I_{t+1}(\gamma^i_{t-1}) - c_i\right)\right] \\
+(1 - p(b))V^I_{t+1}(\gamma^i_{t-1})
\end{array}
\right.
\]

where the \(\lor\) operator denotes a maximum and \(V^I_4(\gamma^i_2) \equiv U(\gamma^i_2)\). Modern contraceptive access provides women with the additional choice to forego using traditional methods in favor of modern contraceptives. Below, we characterize women’s optimal behaviors when they can utilize modern contraceptives (formalized in Lemma 3 in Appendix A).

Women with high desired fertility, \(n_i = 3\), have the same behavior as before. Women with low desired fertility, \(n_i = 0\), again try to avoid having children in each period but will switch to using modern contraceptives if the disutility of modern contraceptives, \(\bar{\phi}\), is low relative to the disutility of using traditional methods and abortions. Abortions and modern contraceptives are substitutes: modern contraceptive use is a (weakly) increasing function of abortion disutility; and the probability of a woman using abortions is a (weakly) decreasing function of modern contraceptive disutility. Women with intermediate desired fertility, \(n_i \in \{1, 2\}\), no longer delay births when the disutility of using modern contraceptives is low. Intuitively, when modern contraceptives have low disutility of use, women know that their future selves can use modern contraceptives and avoid unwanted children with certainty, relaxing any precautionary motive to avoid having children.

3.3 Empirical Predictions

We derive testable empirical predictions of the impact of injectable legalization on fertility behavior by extending our model to allow cohorts of women to age through the lifecycle.
Let time periods $t$ in the above exposition correspond to different ages for women, with $\bar{N}$ women alive in each of the three fertile ages corresponding to different birth cohorts. Let $y \in \{y_0, y_1\}$ denote years. As time progresses, $y$ increases from $y_0$ to $y_1$, and women age from $t$ to $t+1$. A complete age-profile of women are alive at each value of $y$: women at the end of their fertile lives ($t=3$) exit the model, and a new cohort of $\bar{N}$ women enter childbearing with new draws of $n_i$ and $c_i$ at $t=1$. Injectables are legalized between $y_0$ and $y_1$.

Our predictions require four assumptions: (a) the disutility of modern contraceptives is low relative to that of traditional methods; (b) sufficiently many women have intermediate target fertilities compared to the maximum number of children they are able to bear; (c) failure rates when trying to avoid pregnancy are higher than failure rates when trying to have another child; and (d) the fraction of women with access to modern contraceptives prior to legalization is low. While we cannot test the first assumption, the latter three assumptions are consistent with the Zambian context.

**Prediction 1:** Women adopt contraceptives post-legalization. Adoption is higher for women at higher parities.

**Prediction 2:** Use of traditional methods and abortions decline. Substitutions away from abortions are largest among older women and women at higher parities.

Women use modern contraceptives to reduce pregnancy risk when they do not want
to have additional children, substituting away from both traditional methods of fertility control and abortions. As women only abort when they are at or above their target fertilities, we expect larger substitutions away from abortions among subgroups of women who are more likely to have already reached their target fertilities — e.g., older women and women at higher parities. Contraceptive adoption is higher at higher levels of parity because incentives to limit births are stronger than (absent) incentives to space births in our model.

**Prediction 3:** Fertility increases and birth-spacing decreases for women prior to their final fertile period (i.e women 15-45) in response to injectable legalization.

**Prediction 4:** Childless women who desire at least one child do not adopt contraceptives and increase fertility.

**Prediction 5:** Fertility does not increase for women in their terminal fertility period (i.e. women 45-49). Completed fertility does not increase.

Intuitively, modern contraceptives increase fertility by relaxing the precautionary motive to delay having children and decrease fertility by aiding women in avoiding unwanted children. When a large enough fraction of women have intermediate target fertilities (i.e. a precautionary motive to delay births) fertility responses are positive. Childless women who desire at least one child will no longer delay wanted births, eschewing modern contraceptives and increasing fertility. Fertility for women in their final fertile period cannot increase as these women never delay wanted children. Completed fertility cannot increase because women’s ability to limit unwanted births has improved and overshooting risk outweighs undershooting risk prior to improvements in contraceptive access.

**Prediction 6:** Declines in use of traditional methods and abortions are smaller in magnitude in urban areas than rural areas.

**Prediction 7:** Fertility increases are confined to rural areas; fertility does not increase in urban areas. Decreases in birth-spacing change analogously.
We generate two additional predictions by considering an extension to our model that allows urban women to have access to modern contraceptives prior to injectable legalization. Intuitively, women with prior access to modern contraceptives would have already experienced the largest gains in fertility control relative to traditional methods. They would no longer have precautionary motives to delay births and will have already made the largest substitutions away from traditional methods and abortions. Hence, the magnitude of substitution away from traditional methods should be smaller and fertility should not increase.

4 Data

To study the relationship between contraceptive access and fertility behaviors, we use all 32 rounds of publicly available Demographic & Health Surveys (DHS) across six countries between 1988 and 2014 that collect information on birth histories or contraceptive use. All surveys we utilize are representative samples of women 15-49 at the administrative region level for both urban and rural sectors.

We use the DHS surveys to construct four unique datasets consisting of women residing at survey date in Zambia and bordering administrative regions in neighboring countries. The first is a repeated cross-section of 98,825 women that we create by pooling data across DHS rounds and countries. We study contraceptive adoption, the abortion use, and coital frequency with this cross-section. The remaining three datasets are panel datasets we use to study postpartum and fertility behaviors. We describe them in more detail below, and summarize the outcome variables we study with each dataset in Table 1.

28The countries are Zambia, Tanzania, Malawi, Mozambique, Zimbabwe, & Namibia. Our sample includes data from all countries bordering Zambia but two. We exclude Angola and the Democratic Republic of the Congo (DRC) for two reasons: (a) the DHS does not survey Angola; and (b) all women in the DRC surveyed by the DHS were interviewed post-2007, resulting in little or no pre-2004 data for most outcomes of interest.

29We use information from three types of surveys: the standard DHS survey, the AIDS Information Survey (AIS), and the Knowledge, Attitudes, & Practice (KAP) survey. The AIS and KAP do not ask all modules from the standard rounds, but include information on birth histories and contraceptive use.
Table 1: Summary Description of Datasets

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Unit of Observation</th>
<th>Outcomes Studied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeated Cross-Section</td>
<td>Woman</td>
<td>Contraceptive Use, Coital Frequency, Abortions</td>
</tr>
<tr>
<td>Postpartum Panel</td>
<td>Woman-Child-Month</td>
<td>Postpartum Behaviors</td>
</tr>
<tr>
<td>Birth-history Panel</td>
<td>Woman-Year</td>
<td>Flow Fertility</td>
</tr>
<tr>
<td>Birth-spacing Panel</td>
<td>Woman-Birth-Month</td>
<td>Birth-spacing</td>
</tr>
</tbody>
</table>

We use information collected on postpartum outcomes for each live birth during the 5-6 years prior to survey date to construct a postpartum panel — a child-level monthly frequency panel dataset that we use to study the durations of postpartum outcomes. It is inappropriate to study the duration of postpartum outcomes using a cross-section of births because of censoring that arises from mothers still breastfeeding (or abstaining, etc.) at the time of a child’s death or at the time of interview. We address this censoring by having the panel cover each month from a child’s birth to the date of survey and dropping all months following a child’s death, ensuring that all months corresponding to a living child are weighted equally. DHS survey questionnaires are careful to collect information on the month of birth and, if a child died, the age at death in months, that is complete and accurate for all births within 5-6 years of survey date.

We use the complete retrospective birth histories\(^{30}\) elicited from all interviewed women by the DHS to construct two panel datasets: a birth-history panel and a birth-spacing panel. The former is a woman-level yearly frequency panel dataset containing information on the timing, survival information, and sex of each birth that we use to study fertility. This panel covers each year from the year of a woman’s 10th birthday to the year of survey, and we drop all survey years in which women are interviewed prior to December\(^{31}\). The latter is

\(^{30}\)Though collected retrospectively, the birth histories collected by the DHS in sub-Saharan Africa are known to be accurate and complete (Pullum and Becker (2014)).

\(^{31}\)When constructing year-level measures of fertility, including incomplete years for women will result in
a birth-level monthly frequency panel dataset that we use to study birth-spacing intervals. As with our postpartum variables, it is inappropriate to study birth-spacing using a cross-section of births because of the censoring that arises from mothers being surveyed while in the middle of a birth-spacing interval. We address this censoring by having the panel cover each month following a live birth until either the subsequent live birth or the survey date, with every month following a live birth weighted equally.

5 Empirical Strategy

We use difference-in-difference techniques to exploit the staggered legalization of injectable contraceptives in Zambia and surrounding countries and identify causal estimates for the effect of expanded modern contraceptive access on a variety of fertility behaviors. Given the timing of injectable law changes discussed in Section 2.2, we classify women in Zambia prior to 2004 as untreated and classify women in Zambia post-2004 as treated. Women in countries surrounding Zambia, who form the control group, are always classified as treated because all our regression samples only include information from 1996 onwards.

Formally, our main regression specification is as follows:

\[ y_{irsat} = \alpha + \beta T_{rt} + \delta_{sar} + \gamma_{sat} + \xi X_{irsat} + \varepsilon_{irsat} \]  \hspace{0.2cm} (1)

where \( i \) indexes individuals, \( r \) indexes regions, \( s \) indexes urban or rural place of residence, \( a \) indexes age group, and \( t \) indexes time. The unit of observation in specification (1) varies with the dataset used, as summarized in Table [1] but the regression and identification strategy remain the same. We discuss specifics for different datasets and dependent variables as we present our results in later sections.

The main regressor of interest is the treatment variable, \( T_{irsat} \), an indicator variable taking value one if a woman has legal access to injectables. Using legal access to injectables as our treatment variable allows us to avoid bias due to selection into use of modern underestimates of fertility.
contraceptives. Similarly, abstracting from the specific pattern of injectable rollout in 
Zambia eliminates bias arising from the endogeneity of family planning program locations 
(i.e., programs are more likely to be placed in high fertility areas). To test predictions 
of our model, we also estimate treatment effects for subsamples defined by urbanity, age, 
parity, and education level by estimating specification \( \text{[1]} \) separately for subsamples defined 
along these dimensions.

We control for (potentially time-varying) individual characteristics such as marital sta-
tus\(^{{32}} \) years of schooling\(^{{33}} \) and parity\(^{{34}} \) using \( X_{irsat} \). The set of controls varies with our 
outcome variable, and we discuss these specifics when presenting results in later sections. 
We present all results both with and without the inclusion of controls.

Our specification flexibly controls for urbanity and age group by including space and 
time fixed effects interacted with age group \( a \) and urban or rural sector \( s \).\(^{{35}} \) Controlling 
flexibly for sector and age is necessary given that time trends for contraceptive and fertility 
behaviors differ in urban and rural areas and over the lifecycle. Sector-age-region fixed 
effects, \( \delta_{sar} \), control for time-invariant determinants of the dependent variable within each 
subsample \( sar \) (e.g., baseline measures of \( y \) in region \( r \) for women in sector \( s \) and age group 
\( a \) ). Similarly, sector-age-time fixed effects, \( \gamma_{sat} \), control for space-invariant determinants of 
the dependent variable within each subsample \( sat \) (e.g., a common shock to \( y \) at time \( t \) for 
all women in sector \( s \) and age group \( a \) ).

As Zambia and its neighboring countries do not have synchronized survey times, we 
choose regression samples and time windows for our time fixed effects carefully to ensure 
that information from Zambia and a minimum of four control group countries are present in 
each time window\(^{{36}} \). For our main regressions, we restrict regression samples to information

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\(^{32}\) There are five categories measured by the DHS: never married, currently in union, divorced, widowed, 
and separated (not living together). In panel datasets, the only time-varying measure of marital status we 
can create is a measure of ever having been married or in union.

\(^{33}\) We group years of schooling into four categories: 0 years, 1-4 years, 5-8 years, and 9+ years.

\(^{34}\) We group levels of parity into four categories: 0 births, 1-3 births, 4-6 births, and 7+ births.

\(^{35}\) Women are coded as living in a certain region and in an urban or rural place of residence based on 
their response at survey date. Women are grouped into six age buckets: 15-19, 20-24, 25-29, 30-34, 35-39, 
and 40-44.

\(^{36}\) When using the repeated cross-section dataset, we do so by constructing five-year time bins: 1990-94, 
1995-99, 2000-04, 2005-09, & 2010-2014. When using the panel datasets, we estimate specification \([1]\) with
from women aged 15-44 after the year 1996 to examine women during prime childbearing ages and to allow for the initial effects of injectable legalization in countries surrounding Zambia to take hold. We study women aged 45-49 separately because we expect women in their terminal fertile period to respond differently. We present details of the precise regression sample we use for each outcome variable when we present our results.

We cluster all standard errors at the sub-national region level. There are a total of eighteen clusters in our dataset that are unbalanced in size. It is well documented that standard cluster-robust variance estimation on a sample with both unbalanced clusters and clusters fewer than twenty in number introduces downward bias in the estimator for the variance-covariance matrix (Bertrand et al. (2004), Cameron and Miller (2015)). To address this, we confirm results are robust to estimating standard errors using the wild cluster bootstrap technique of Cameron et al. (2008).

Regression specification (1) identifies $\beta$ by comparing changes in outcomes for Zambian women in a given age group and sector at two times on either side of the 2004 legalization to changes in outcomes for non-Zambian women in the same age group and sector at the same two times. For datasets with a panel dimension, identification for $\beta$ comes from both comparisons across women and comparisons within woman. When studying fertility and birth-spacing, we complement our evidence from specification (1) by estimating individual fixed effect specifications that identify $\beta$ using only within-woman variation in fertility.

Our estimation strategy identifies the casual effect of improved contraceptive access on our outcome variables as long as the parallel trends assumption holds — as long as outcome variables for women in a given sector and age group in both Zambia and surrounding regions would have had parallel time trends in the absence of exposure to treatment. We assess the validity of the parallel time trends assumption in four ways. First, we plot event studies for all our outcome variables to determine whether or not outcomes for women in Zambia and surrounding countries are on parallel time trends prior to either group of women gaining access to injectables (i.e., prior to 1992). Second, we check that observed covariates more granular time fixed effects (i.e., year or year-month), but restrict the years or months we include in our regression samples.
(e.g., desired fertility) are on similar time trends in both Zambia and surrounding countries throughout the period we study. Third, we estimate paired-region specifications that restrict identification of $\beta$ to women living within smaller spatial units, who are more likely to have similar time trends in unobserved covariates (e.g., local shocks to access). Fourth, we address any country-specific policies in our control group that affect contraceptive access by estimating our results dropping one control-group country at a time.

When examining event studies, we ascertain: (a) that time trends in outcome variables are parallel prior to 1992; and (b) that our estimated coefficients are driven by changes in Zambia post-2004 rather than changes in control group countries. For all outcome variables we study, we construct subsamples $zsa$ of our data disaggregated by Zambia $z$, age group $a$, and urban or rural sector $s$, and regress:

$$y_{zsa}^{irt} = \alpha_{zsa} + \delta_{r}^{zsa} + \gamma_{t}^{zsa} + \xi^{zsa}X_{irt} + \epsilon_{irt}^{zsa}$$  (2)

where $i$ indexes individuals, $r$ indexes regions, $t$ indexes time, $z$ indexes living in Zambia or elsewhere, $s$ indexes sector, and $a$ indexes age group. Our event studies are plots of the time coefficients $\gamma_{t}^{zsa}$.

The two most important covariates of contraceptive use and fertility behavior are desired fertility, and level of education.\textsuperscript{37} We ascertain whether or not there are differential time trends for these covariates in Zambia and surrounding countries by estimating specification (2). Desired fertility\textsuperscript{38} is not differentially changing between control group countries and Zambia for women across age-groups and sectors of residence (see Figures D.1 and D.2). In contrast, rural women aged 15–19 in Zambia increase years of schooling post-2004 at a slightly faster rate than their counterparts in control group countries (see Figure D.3).\textsuperscript{39}

\begin{flushleft}
\textsuperscript{38}Using the repeated cross-section dataset, we measure desired fertility from women’s responses to the survey question “Would you like to have another child, or would you prefer not to have any more children?” We construct two dependent variables from women’s responses: an indicator variable taking value one if a woman responds she wants to have another child at survey date and an indicator variable taking value one if a woman responds she wants no more children at survey date. The two indicator variables are not complements: women who are sterilized, infecund, have never had sex, or have undecided fertility preferences are coded separately.
\end{flushleft}
Urban women aged 15–19 in Zambia and surrounding countries have parallel trends in years of schooling.\footnote{Examining time trends in educational attainment for adolescents informs us of changes in \textit{contemporaneous} levels of schooling; examining time trends for older women informs us of changes in \textit{past} levels of schooling (potentially pre-1990).} We cannot disentangle whether higher years of completed schooling in Zambia are due to a school construction program from 1996–2010 (Ashraf et al. \textit{(2016)}) or due to improved contraceptive access increasing perceived returns to schooling for girls. We control for this as best we can by showing all our results are robust to including education controls and showing our results are consistent (when estimated separately) across levels of educational attainment.

Specification \textit{(1)} permits comparisons of geographically distant pairs of women when identifying $\beta$. Spatially distant women can be more dissimilar in unobserved time-varying characteristics than women living close to each other (e.g. time-varying local shocks to contraceptive access), threatening identification. We ensure our results are not driven by such comparisons by confirming that all results are robust to using a paired region regression specification that estimates $\beta$ using only variation within zones on either side of the Zambian border (for details see Appendix \ref{sec:Supp}).

Other policy changes that differentially impact contraceptive use or fertility behavior during the period we study can also threaten our identification strategy. We address such concerns by confirming our results are robust to dropping each control group country one at a time, ensuring that our results are not driven by any country-specific shocks (e.g., country-specific policies) or by any country-specific responses to global shocks.\footnote{The component of global policy changes (e.g., changes in the global gag rule) that affect women of a given age and sector equally in all the regions we study are addressed by our time fixed effects.} In the paper, we only present results for samples that exclude Malawi, as Malawi is the only country that directly changes policies affecting contraceptive access during the time period we study.\footnote{In 2005, the Malawi government eased restrictions on who can perform female sterilizations and committed funding to expanding the number of health care personnel and family planning workers. Both these policy changes, by expanding contraceptive access in control group countries post-2004, should lead us to underestimate responses to injectable legalization.}
6 Results

Increased access to modern contraceptives leads to adoption of modern contraceptives, substitution away from traditional methods of fertility control, and increases in fertility. Increases in fertility are confined to rural women younger than 45, while completed fertility does not increase. Substitutions away from traditional methods of fertility control are larger for rural women, and substitutions away from abortions are larger for older women (30-44) and women at higher parities (4+ kids). Childless women eschew modern contraceptives in favor of childbearing. These results confirm Predictions 1–7 of our model.

6.1 Contraceptive Access & Modern Contraceptive Adoption

Women increase use of injectables (360%) and use of any modern contraceptive (49.5%) post-legalization. Usage of birth control pills and condoms does not change. Injectable and modern contraceptive adoption is higher for women at higher parities, consistent with Prediction 1. Time trends confirm that adoption of injectables is driven by the staggered legalization of injectables through the region, and confirm that while legalization is a positive shock to any contraceptive access in rural areas, it is only a positive shock to method type access in urban areas.

6.1.1 Methods

To study the effect of injectable legalization on contraceptive use and test Prediction 1, we estimate specification (1) on our repeated cross-section dataset. The dependent variable is an indicator variable taking value one if a woman is using one of four types of contraceptive technologies at survey date: injectables, birth control pills, condoms, and a catch-all category for modern contraceptives. Modern contraceptives include IUDs, diaphragms, female sterilizations, male sterilizations, and hormonal implants in addition to injectables, because it is superior to either either ever-use of contraceptives or contraceptive calendar information for three reasons: (a) it allows us to better determine timing of use; (b) it suffers from less recall error; and (c) it is asked in a consistent manner across all countries and survey rounds during our period of analysis.
birth control pills, and condoms.\(^{43}\) We estimate specification (1) on two samples of women: (a) all women in our sample, and (b) all women in our sample using modern contraceptives when surveyed. Analyzing the first sample informs us of how contraceptive use changes post-legalization; analyzing the second informs us of how contraceptive users’ choice among contraceptive methods changes post-legalization.

### 6.1.2 Results

We find a 6.4 percentage point increase in the use of both injectables and modern contraceptives by Zambian women post-legalization, representing 360% and 49.5% increases over pre-legalization levels (see Table 2).\(^{44}\) There is no significant change in their use of condoms or pills. Zambian users also alter their choice of method: users are 28 percentage points more likely to be using injectables and 13–14 percentage points less likely to use pills or condoms post-legalization. These results do not suggest that women who were using pills or condoms ceased doing so post-legalization. Rather, they suggest that contraceptive users make different choices with regards to method type post-legalization: when given legal access to contraceptives with lower failure rates (i.e., injectables), Zambian women using modern contraceptives are more likely to choose more effective methods of fertility control.

Contraceptive adoption is a broad phenomenon. Adoption of injectables and modern contraceptives is consistent with our pooled estimates for women in urban and rural areas (Table 3) and for women of different educational attainments (Figure B.2). Contraceptive adoption is robust to excluding control group countries one at a time (Table C.1), to including controls for marital status and years of schooling, and to using a paired-region regression specification that identifies \(\beta\) only using variation within smaller geographical areas (Table C.1). As we exclude control group countries one at a time, point estimates for injectable adoption range from 5.8 to 9.1 percentage points, and point estimates for modern contraceptive use range from 5.5 to 11.5 percentage points, consistent with strong take-up.

\(^{43}\) We do not examine IUDs, diaphragms, and male sterilizations because use of these methods is minimal (during 1992-2014, a total of 187 Zambian women report using these methods at survey date, respectively, despite the DHS interviewing 46,286 Zambian women). We do not examine female sterilizations and hormonal implants because both these methods are the subject of additional policy changes during our period of study: Malawi expanded access to female sterilizations post-2005 and USAID expanded distribution of Norplant throughout sub-Saharan Africa post-2007. As discussed in Section 5, we address these policy changes by confirming our results are robust to dropping each control group country one at a time.

\(^{44}\) Our results on contraceptive adoption are robust to excluding control group countries one at time (Table C.1), to including controls for marital status and years of schooling, and to using a paired-region regression specification that identifies \(\beta\) only using variation within smaller geographical areas (Table C.1). As we exclude control group countries one at a time, point estimates for injectable adoption range from 5.8 to 9.1 percentage points, and point estimates for modern contraceptive use range from 5.5 to 11.5 percentage points, consistent with strong take-up.
adoption is stronger for women during prime childbearing years (Figure B.1): injectable and modern contraceptive use increases by approximately 8 percentage points for women 20–39. Consistent with Prediction 5, contraceptive adoption is stronger for women at higher levels of parity (Figure B.3): injectable and modern contraceptive use does not increase for childless women, increases by 8 percentage points for women with 1–6 live births, and increases by 11 percentage points for women with more than 7 live births.

Time trends for injectable use (see Figure 2) in both rural and urban areas, and time trends of modern contraceptive use (see Figure 3) in rural, but not urban, areas, are consistent with the staggered legalization of injectables leading to staggered adoption of contraceptive technologies. From baseline rates of injectable use near zero, control group countries exhibit much sharper take-up during the 1990s compared to Zambia across age groups and place of residence. Despite lagging in injectable use during the 1990s, Zambian women “catch-up” and have similar rates of injectable use as control group countries by 2010–14. This pattern is particularly strong in rural areas, where pre-legalization use of injectables in Zambia is minimal, and for women of prime childbearing ages (20–39), where take-up is particularly strong. Rural women aged 25–39 show similar patterns for modern contraceptives. In contrast, urban women in Zambia and control group countries appear to be on the same upwards trend in modern contraceptive use throughout 1990–2014.

Together the event studies for injectables and modern contraceptives confirm that injectable legalization has different impacts in rural and urban areas. In rural areas, injectable legalization is consistent with a shock to modern contraceptive access as a whole given that both injectable use and modern contraceptive use sharply increase post-legalization. In urban areas, injectable legalization is instead consistent with a shock to access to different methods of contraception and is only a minor shock to access to modern contraceptives.

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45 Event studies for method mix changes can be found in Appendix D.
46 Low baseline rates of injectable use (fewer than 0.1% of women in Zambia in 1992 were using injectables, while 1.93% of women in control group countries during 1988–1992 used injectables) reflect parallel time trends of near zero injectable use prior to 1992 in both Zambia and control group countries: low baseline use in both areas can only reflect divergent pre-trends if injectable use was declining in either Zambia or control group countries during the late 1980s, a fact that is inconsistent with a broad literature on contraception in sub-Saharan Africa (e.g. Bertrand et al. (1993), Caldwell and Caldwell (1987)).
— urban Zambian women use modern contraceptives at similar rates as control country women despite limited access to injectables during the 1990s.

The broad nature of contraceptive take-up following legalization of injectables in Zambia makes injectable legalization an excellent candidate to study the impact of improved access to contraceptives on fertility behavior. High take-up across women of all ages, in both urban and rural areas of the country, and across education levels suggests it is appropriate to search for aggregate fertility responses to injectable legalization.

6.2 Contraceptive Access & Traditional Methods

Strong take-up of modern contraceptives post-legalization in Zambia is accompanied by women reducing reliance on traditional pre-pregnancy and post-pregnancy methods of fertility control. Rural women have the strongest substitutions away from traditional methods, increasing coital frequency (12.7%), and decreasing reliance on abortions (-35%) and postpartum methods of fertility control. In contrast, urban women only decrease use of postpartum methods. Reductions in abortion use are driven by women older than 30 and by women with more than four live births. These results confirm Predictions 2 & 6 of our model.

6.2.1 Methods

We use two different data sets and two different regression specifications to study three classes of traditional methods of fertility control: coital frequency, abortions, and postpartum behaviors and outcomes. Below, we discuss the data and regression specifications we use for each method of traditional fertility control.

Coital Frequency: We study how coital frequency changes in response to improved contraceptive access by estimating specification (1) on our repeated cross-section dataset. We measure coital frequency using an indicator variable that takes value one if a woman reports having had sexual intercourse during the week prior to survey date. As this information is only collected for sexually active women, we restrict our sample to women who report
ever having had sexual intercourse. As robustness, we also examine alternate measures of coital frequency including sexual intercourse during the month prior to survey date and initiation into sexual activity.

**Abortions:** We study how abortion use changes in response to improved contraceptive access by estimating specification (1) on our *repeated cross-section* dataset. We measure abortion use with an indicator variable that takes value one if a woman reports ever having had a terminated pregnancy at survey date. As asked, terminated pregnancies include miscarriages, stillbirths, and abortions. By bundling responses for all types of terminated pregnancies, the survey question minimizes underreporting of abortions due to stigma but makes it difficult to isolate changes in abortions independent of changes in miscarriages and stillbirths. In particular, if women idiosyncratically vary in their ability to carry pregnancies to term and the composition of women choosing to have pregnancies changes in response to contraceptive legalization, then reductions in reports of ever having had a terminated pregnancy can be driven by both reductions in abortions and reductions in the fraction of pregnant women who experience miscarriages. Given that miscarriage rates are highest in the first seven weeks, and that first trimester miscarriages are the least likely to be self-reported by women, it is unlikely that any changes we find in reports of ever having had a terminated pregnancy are driven solely by changes in reported miscarriages.

**Postpartum Variables:** We study postpartum breastfeeding, abstinence, amenorrhea, and protection from pregnancy risk using our *postpartum panel*, which addresses the censoring of postpartum duration variables by creating a panel for each live birth and weighting each month after a live birth where the child is alive equally. On this dataset, we estimate specification (1) with additional controls for different hazard rates for women in different age-groups and sectors — we include fixed effects for months since birth interacted with fixed effects for age-group and sector. We assess the validity of the parallel trends as-

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47Specifically, DHS survey questionnaires ask: “Have you ever had a pregnancy that miscarried, was aborted, or ended in a stillbirth?”

48Most of these miscarriages present as a late period with heavier menstrual flow.

49For a formal presentation of the regression specification, refer to Appendix E.2.
sumption by providing event studies for postpartum variables using a similarly modified version of specification (2). For each of the postpartum outcomes we study, the dependent variable is an indicator variable taking value one in a given month since birth if a woman is still experiencing that postpartum outcome.

We estimate this specification on two samples — 1–12 months after a live birth, and 13–24 months after a live birth — to better capture substitution patterns between postpartum behaviors and modern contraception. We expect to see larger substitutions in the second year since birth relative to the first if: (a) postpartum behaviors have positive impacts on the health of both mother and child that are largest immediately following birth, decline in magnitude over time, and are unaffected by improvements in contraceptive access; and (b) the cost of persisting with a postpartum behavior is increasing in its duration. Hence, pooling across both years since birth may mask reductions in the duration of postpartum behavior.

6.2.2 Results

Below, we present results for each class of traditional fertility control we study and confirm Prediction 2.

**Coital Frequency**: Sexually active Zambian women are 5.4 percentage points more likely to report having sexual intercourse within one week of survey date post-legalization (see Table 4), consistent with Prediction 2. Consistent with Prediction 6, the change in sexual behavior may be driven by increases in coital frequency following the legalization of contraception.

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50 In contrast to our hypothesis, Jayachandran (2014) provides evidence from Indonesia that breastfeeding and modern contraceptives are substitutes immediately post-birth, but are complements 13–24 months post-birth. She argues that this occurs because during the second year post-birth, contraception delays the onset of pregnancy and allows for longer breastfeeding durations (as many women wean when they become pregnant). In the Zambian context, this argument is less likely to be true because birth-spacing intervals were long prior to legalization: the mean birth-spacing interval among Zambian women 15–44 prior to legalization was 34.7 months, implying that on average women began a pregnancy resulting in a live birth 25 months after giving birth.

51 Results are robust to the inclusion of fixed effects for marital status and educational attainment, through our preferred specification excludes these controls as they may be endogenous. Results are also robust to dropping each control group country one at a time and to using a paired region regression specification (Table C3). Event studies for coital frequency (see Figure D7) suggest that the parallel trends assumption holds (time trends for rural women in Zambia and control group countries are parallel and overlapping from 1990-2004) and confirm that our estimated treatment effects are driven by increases.
behavior is driven by rural women, who are 6.2 percentage points (12.7%) more likely
to report increased coital frequency post-legalization. Urban women show no substantial
changes in coital frequency — point estimates are positive but smaller (1.8–3 percentage
points). Point estimates are qualitatively consistent but smaller in magnitude when we
examine coital frequency during the month prior to survey date (Table C.2), suggesting
that women are substituting away from both abstinence durations longer than a month
and abstinence durations longer than a week but shorter than a month. There is no change
in women’s initiation into sexual activity in either rural or urban areas (Table C.2).

Abortion: Zambian women are 5.3 percentage points less likely to report ever having
a terminated pregnancy at survey date post-legalization of injectables (see Table 4).\textsuperscript{52}
Consistent with Prediction 6, the reduction in reports of ever experiencing a terminated
pregnancy is driven by rural women, who are 6.1 percentage points (35%) less likely to
report ever having had a terminated pregnancy post-legalization. Urban women show no
substantial changes in ever experiencing a terminated pregnancy — point estimates are
negative but only half as large as in rural areas (-3.1 percentage points). Consistent with
Prediction 2, substitutions away from abortions are larger amongst rural women older
than 30 (Figure B.7), and amongst rural women with more than four children (Figure
B.9). Declines in abortion use are similar across levels of educational attainment (Figure
B.8).

Our results are robust to studying an alternate measure of abortion use — the fraction
of pregnancies borne by a woman during the 5-6 years prior to interview that result in
termination (Table E.1). Specifically, by combining information on birth histories with
information collected on the timing of each terminated pregnancy during the 5-6 years
in coital frequency among rural Zambian women post-2004.

\textsuperscript{52}Results are also robust to dropping one country at a time and to using a paired-region regression
specification (Table C.4), and to the inclusion of dummy variables for marital status and education in our
specification. Event studies for ever reporting a terminated pregnancy (see Figure D.8) confirm that our
estimated treatment effects are driven by decreases in reports of terminated pregnancies in Zambia post-
legalization rather than any changes in control group countries. As questions on terminated pregnancies are
only asked of women interviewed post-2000 and countries only have a single survey round during 2000-2004,
it is not possible to assess time trends pre-legalization.
prior to survey date, we construct a *pregnancy panel* consisting of all pregnancies borne by a woman during the 5-6 years prior to interview. We use this dataset to estimate specification \(^1\) while flexibly controlling for recall error, finding that rural women are 32.2% less likely to report a pregnancy as terminated post-legalization. See Appendix E.4 for details.

**Postpartum variables**: Both rural and urban Zambian women show substantial reductions in the probability they are amenorrheic or protected from pregnancy risk in any given month during the second year post-birth (see Table 5).\(^3\) Specifically, rural Zambian women are 7.4 percentage points (21%) and 8.9 percentage points (21%) less likely to be amenorrheic or protected from pregnancy risk in a given month during the second year post-birth, respectively. Urban women are 9.3 percentage points (36%) less likely to be amenorrheic and 9.8 percentage points (28%) less likely to be protected from pregnancy risk during the second year post-birth. These reductions in postpartum outcomes are driven by different behavioral changes in urban and rural areas — rural women are 3.8 percentage points (25%) less likely to be abstaining, while urban women are 8.7 percentage points (12%) less likely to be breastfeeding, in a given month during the second year post-birth. Women in both areas are likely reducing the intensity with which they breastfeed children, as evidenced by the reduction in duration of postpartum amenorrhea.

Reductions in the use of traditional methods are smaller in the first year post-birth, consistent with our expectations. Both rural and urban women experience declines in protection of pregnancy risk of 2.3 and 3.7 percentage points, respectively, reflecting only 27% and 38% of the reduction in use during the second year post-birth. While the sign of point estimates are similar, women in rural areas no longer significantly reduce reliance on postpartum abstinence and no longer experience significantly reduced periods of postpartum

\(^{3}\)Our results are robust to the inclusion of dummy variables for marital status and educational attainment (Table C5), to excluding one control group country at a time (Table C6), and to using a paired-region regression specification. Event studies (Figures D9–D14) confirm that estimated treatment effects are driven by reductions in the durations of postpartum outcomes in Zambia post-legalization and that Zambia and surrounding countries are on similar trends during 1996–2004. Assessing time trends prior to 1992 is not feasible as there are insufficient months with data from Zambia and four control group countries.
amenorrhea. Similarly urban women do not significantly reduce breastfeeding duration.

6.3 Contraceptive Access & Realized Fertility

Using both across-women and within-woman difference-in-difference techniques on our birth-history panel and birth-spacing panel datasets, we find that rural women post-2004 increase fertility and decrease birth-spacing, while urban women do not. Fertility increases post-legalization are confined to rural women younger than 45, with childless rural women older than 20 exhibiting particularly large increases in fertility. Importantly, neither short-term fertility for women 45–49, nor completed fertility (i.e., women’s stock of live births when 45–49) increase, consistent with contraceptive access inducing women to have births earlier. Taken together, these results are consistent with Predictions 3–5 and Prediction 7 of our model.

6.3.1 Methods

We first estimate fertility responses to injectable legalization on our yearly-frequency birth history dataset using specification (1) with flow fertility as the dependent variable. Specifically, \( y \) is an indicator variable taking value one for woman \( i \) in year \( t \) if she reports a live birth during that year. We present results both with and without controls for marital status, years of schooling, and parity. We restrict our regression sample to all women in our sample observed during the years 1996–2010 to ensure a consistent group of control group countries in all years.

We then estimate treatment effects unbiased by any confounding factors that are woman-specific and time-invariant (e.g., a target fertility) using an individual fixed effects estimation strategy:

\[
y_{isbt} = \alpha + \beta T_{isbt} + \gamma_{st} + \lambda_b + \xi X_{isbt} + \phi_i + \epsilon_{isbt}
\]

(3)

where \( i \) indexes individuals, \( s \) indexes urban or rural place of residence, \( b \) indexes age in years, and \( t \) indexes years. The dependent variable and treatment variable in specification (3) are the same as in specification (1). We present results with and without controls for
time-varying individual determinants of fertility such as martial status and parity. We identify $\beta$ only using comparisons of women in the same sector by interacting time fixed effects with urbanity, and we flexibly control for a woman’s age-profile of flow fertility using fixed effects for age in years, $\lambda_b$. We restrict our regression sample to only include women interviewed post-2005 — for whom we have information from before and after injectable legalization in Zambia — and use information from these women corresponding to the years 1996-2010.

Identification of $\beta$ in specification (3) comes from examining a rural (urban) Zambian woman at two points in time, one after injectable legalization and one before, and comparing her to a rural (urban) woman from outside of Zambia with the same birth-year at the same two points in time. This identification strategy is valid provided that women in Zambia and control group countries would have had parallel time trends in flow fertility in the absence of treatment. We provide evidence for this by constructing subsamples $zs$ of our data disaggregated by Zambia $z$ and sector $s$ and estimating:

$$y_{ibt}^{zs} = \alpha^{zs} + \gamma^{zs}_t + \lambda^{zs}_b + \phi^{zs}_i + \varepsilon^{zs}_{ibt}$$  \hspace{1cm} (4)

where $i$ indexes individuals, $b$ indexes age in years, and $t$ indexes year. We estimate specification (4) on all women in our sample observed during 1985-2010; our event studies plot the coefficients $\gamma^{zs}_t$.

We assess the impact of injectable legalization on birth-spacing using estimation strategies analogous to specifications (1) and (3) on our birth-spacing panel that additionally control for differential hazard rates by sector and age — we include fixed effects for months since last birth interacted with fixed effects for sector and age. The dependent variable in both specifications is again an indicator taking value one if a woman reports a live birth in a given month. We estimate how the probability of giving birth changes post-legalization in separately for each of the seven years following a live birth to determine how birth-

---

54 Measure of education in our sample are time-invariant, and captured by individual fixed effects $\phi_i$. 

34
spacing changes. Hence, *increases* in probability of giving birth post-legalization in a given year post-birth correspond to *decreases* in birth-spacing. For a formal presentation of the regression equations, refer to Appendix E.3.

### 6.3.2 Results

Estimates from across-woman and within-woman specifications (Table 6) both show *increases in flow fertility* post-legalization of 2.1–2.5 percentage points (9.6–11.2%), consistent with Prediction 3. Fertility increases are driven solely by rural women, who increase fertility by 2.8–3.1 percentage points (11.2–12.1%). In contrast, urban women show no change in fertility: point estimates are slightly positive and statistically indistinguishable from zero. These heterogeneous responses by sector are consistent with Prediction 7. Fertility increases in rural areas are consistent among women older than 20 (Figure B.10), among women with more than one child (Figure B.12), and among women with fewer than 8 years of completed schooling (Figure B.11). As women 15-19 are the most likely to be childless and to have more than 9 years of completed schooling, these results suggest that improved modern contraceptive access eliminated precautionary motives to delay births for women during their prime childbearing years. Adolescent women have additional incentives to delay births (i.e., human capital formation) that are not eroded by improved access to

---

55 We assume that women cannot have a subsequent birth during the nine months immediately following a live birth: the first “year” after a live birth corresponds to 9–20 months post-birth, etc.

56 Fertility responses are robust to excluding one control group country at a time (Table C.7), to the inclusion of controls for education, parity, and marital status, and to estimating treatment effects using paired region specifications (Table C.8). Event studies using both specification (2) and specification (4) confirm that: (a) women in Zambia and surrounding countries have parallel time trends in flow fertility prior to 1992; and (b) positive fertility responses in rural areas are driven by increases in flow fertility in Zambia post-2004 (see Figures D.15–D.18). Identification appears particularly strong in rural areas, where time trends of flow fertility overlap and move synchronously in response to minor shocks prior to 1992.

57 Assessing heterogeneous fertility responses among women in subgroups based on ever-use of modern contraceptives is highly endogenous, leading us to cut our data along age, parity, and educational dimensions. One concern with our method is that the subgroup of women who are unwilling to use contraceptives — a group that constitutes a larger share of never-users post-legalization — increase fertility in the years following injectable legalization, resulting in our aggregated estimates masking fertility declines among women who are willing to use modern contraceptives. Time trends for subsamples of Zambian women defined by ever-use of modern contraceptives within five years of survey date reveals this to be false as contraceptive users display fertility increases post-legalization.
contraceptives.

Similarly, both across-woman and within-woman specifications for birth-spacing (Tables 7 & 8) confirm that rural, but not urban, women are reducing birth-spacing durations, consistent with Predictions 3 & 7. For example, rural women are 0.76–0.81 percentage points (17.9–18.5%) more likely to have a subsequent birth in any given month during their second year (21–32 months) post-birth; increases for urban women during their second year post-birth are insignificant and one-tenth in magnitude. These reductions in birth-spacing provide direct evidence that women are less likely to delay childbirth. Moreover, increases in the likelihood of having a subsequent birth during the first four years post-birth suggest that fertility increases are not being driven by either childless women entering childbearing or women who had been avoiding childbirth for lengthy periods of time (and, hence, may be selected on some unobservable dimension) choosing to have an additional child.

Childless women eschew modern contraceptives and increase fertility (Table 9), consistent with Prediction 4. In particular, rural childless women aged 20 and older show no take-up of injectable contraceptives (point estimates are negative and insignificant) and increase flow fertility by 4.5 percentage points, nearly double the increase for rural women as a whole. Results are qualitatively similar, but slightly attenuated when we include childless women aged 15-19, consistent with adolescent girls having additional incentives to delay childbearing due to tradeoffs between entering childbearing and human capital formation.

Consistent with Predictions 3 & 5, fertility increases are confined to rural women younger than 45 (Figure B.10), and do not increase among women aged 45-49 (Table 10). Specifically, rural women over 45 increase use of injectables by 2.7 percentage points (329%) post-legalization, have no changes in flow fertility, and have negative (insignificant) point estimates for completed fertility (i.e., their stock of live births). That completed fertility has negative point estimates suggests, as in our model, that fertility increases in response to modern contraceptives reflect changes in the timing of births across the life-cycle (i.e., tempo effects) rather than changes in the total number of births (i.e., quantum effects). More speculatively, these results suggest that by eliminating the risk of exceeding
target fertilities, improved contraceptive access reduces fertility in the long-run.

Taken together, these results confirm that improved modern contraceptive access can cause positive short-run fertility responses by relaxing precautionary motives to delay children.

7 Conclusion

In this paper, we theoretically and empirically investigate the impact of a broad expansion of contraceptive type and availability in Zambia. By building a lifecycle model of fertility control choice, we highlight that improved contraceptive access can change women’s intertemporal fertility incentives, leading them to shift births earlier in the lifecycle. Expanded contraceptive access improves women’s ability to restrict unwanted births, resulting in: (a) increases in flow, but not completed, fertility as women with intermediate target fertilities substitute away from traditional fertility control methods and no longer delay wanted births to avoid exceeding target fertilities; and (b) decreases in flow and completed fertility as women who were already at their target fertilities can better restrict unwanted births. When sufficiently many women have precautionary motives to delay childbearing, modern contraceptive access leads to increases in flow, but not completed, fertility. We use our model to generate different predictions for substitution and fertility responses for women in urban and rural sectors, for women at different ages, and for women at different parities.

We empirically confirm that women in Zambia responded to improved contraceptive access by adopting modern contraceptives, substituting away from traditional methods of fertility control, and increasing short-run fertility. Consistent with the predictions of our model, we find that: (a) adoption of modern contraceptives is higher for women at higher parities; (b) substitution away from traditional methods is stronger in rural areas; (c) reductions in abortion use are stronger among older women and women with higher parities; (d) increases in fertility (and decreases in birth-spacing) occur only for rural women younger than 45; (e) women older than 45 do not increase fertility; (f) childless women
eschew modern contraceptives in favor of increasing fertility; and (g) completed fertility
does not increase.

Our results highlight the importance of evaluating contraceptive interventions using
lifecycle models of fertility choice, and can be used to reconcile the differential impacts of
improved contraceptive access on completed and short-run fertility found in the literature.
In particular, our results suggest that the ambiguous short-run relationship may be driven
by intertemporal incentives to increase births dominating immediate gains in women’s
ability to limit unwanted births. Finally, the substitution patterns we observe — both
intertemporally and across methods of fertility control — suggest that contraceptive access
is welfare improving for women, despite having counterintuitive implications for fertility.
### 8 Tables

#### Table 2: Contraceptive Adoption

<table>
<thead>
<tr>
<th>Modern Contraceptives</th>
<th>Injectables</th>
<th>Condoms</th>
<th>Pills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.064***</td>
<td>0.066***</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.020)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Obs.</td>
<td>76,126</td>
<td>76,126</td>
<td>76,126</td>
</tr>
<tr>
<td>Mean</td>
<td>0.255</td>
<td>0.109</td>
<td>0.0355</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Changes in Contraceptive Choice Among Contraceptive Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Obs.</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Clusters</td>
</tr>
<tr>
<td>Controls</td>
</tr>
</tbody>
</table>

**Notes:** The dependent variable in these regressions is an indicator variable that takes value 1 if a woman is using (a type of) contraception at survey date. The reported coefficient and standard errors are for the term $\beta$ in regression (1). All regression samples are restricted to women 15–44 interviewed during 1996–2014. The regression sample in Panel A consists of this full sample; Panel B is restricted to women using contraceptives at survey date. The category modern contraceptives include injectables, norplant, pills, condoms, male & female sterilization, IUDs, & diaphragms. Controls include dummy variables for marital status and years of schooling. All regressions are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
Table 3: Heterogeneous Contraceptive Adoption Across Sectors

<table>
<thead>
<tr>
<th></th>
<th>Rural Women</th>
<th></th>
<th></th>
<th>Urban Women</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Modern</td>
<td></td>
<td></td>
<td>Modern</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Injectables</td>
<td></td>
<td></td>
<td>Contraceptives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post Inj</td>
<td>0.066***</td>
<td>0.066***</td>
<td>0.065***</td>
<td>0.066***</td>
<td>-0.006</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.015)</td>
<td>(0.021)</td>
<td>(0.020)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Obs.</td>
<td>52,660</td>
<td>52,162</td>
<td>52,660</td>
<td>52,162</td>
<td>52,660</td>
<td>52,162</td>
</tr>
<tr>
<td>Mean</td>
<td>0.109</td>
<td>0.109</td>
<td>0.235</td>
<td>0.235</td>
<td>0.0282</td>
<td>0.0282</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in these regressions is an indicator variable that takes value 1 if a woman is using (a type of) contraception at survey date. The reported coefficient and standard errors are for the term \( \beta \) in regression (1). All regression samples are restricted to women 15–44 interviewed during 1996–2014. The category modern contraceptives include injectables, norplant, pills, condoms, male & female sterilization, IUDs, & diaphragms. Controls include dummy variables for marital status and years of schooling. All regressions are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
<table>
<thead>
<tr>
<th>Panel A: Changes in Coital Frequency</th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.0537**</td>
<td>0.0617**</td>
<td>0.0309</td>
</tr>
<tr>
<td></td>
<td>(0.0222)</td>
<td>(0.0268)</td>
<td>(0.0184)</td>
</tr>
<tr>
<td>Obs.</td>
<td>66,757</td>
<td>46,996</td>
<td>19,761</td>
</tr>
<tr>
<td>Mean</td>
<td>0.542</td>
<td>0.557</td>
<td>0.507</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Changes in Ever-Use of Abortions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Obs.</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Clusters</td>
</tr>
<tr>
<td>Controls</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in the regressions in Panel A is an indicator variable that takes value 1 if a woman reports having had sexual intercourse during the week prior to the interview date. The dependent variable in the regressions in Panel B is an indicator variable that takes value 1 if a woman reports ever having had a terminated pregnancy (miscarriage, stillbirths, and abortions) at survey date. The reported coefficient and standard errors are for the term $\beta$ in regression (1). All regression samples are restricted to women 15–44 interviewed during 1996–2014. Controls include dummy variables for marital status and educational attainment. All standard errors are clustered at the region level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Table 5: Changes in Postpartum Behaviors

Panel B: 1-12 Months Post-Birth

<table>
<thead>
<tr>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breastfeeding</td>
<td>Postpartum</td>
</tr>
<tr>
<td>Postpartum Abstinence</td>
<td>Amenorrhea</td>
</tr>
<tr>
<td>Post Inj</td>
<td>-0.007</td>
</tr>
<tr>
<td>(0.0099)</td>
<td>(0.0188)</td>
</tr>
<tr>
<td>Obs.</td>
<td>259,855</td>
</tr>
<tr>
<td>Mean</td>
<td>0.968</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
</tr>
</tbody>
</table>

Panel B: 13-24 Months Post-Birth

| Post Inj             | 0.0182               | -0.0380***            | -0.0735***           | -0.0886***      | -0.0869**   | -0.0111    | -0.0925*** | -0.0978*** |
| (0.0179)             | (0.0125)             | (0.0138)              | (0.0148)             | (0.0306)        | (0.0299)    | (0.0227)   | (0.0312)   |
| Obs.                 | 80,956               | 109,717               | 109,717              | 109,717         | 21,100      | 30,503     | 30,503     | 30,503     |
| Mean                 | 0.765                | 0.132                 | 0.298                | 0.370           | 0.715       | 0.134      | 0.228      | 0.316      |
| Clusters             | 18                   | 18                    | 18                   | 18              | 18          | 18         | 18         | 18         |

Notes: The dependent variable in these regressions is an indicator variable that takes value 1 if a woman is breastfeeding, abstaining, amenorrheic, or experiencing the postpartum protection period at a given month following a live birth. The reported coefficient and standard errors are for the term $\beta$ in regression (E.2). All regression samples are restricted to information from women 15–44 during 1996–2010. No regressions include individual level controls. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
Table 6: Fertility Responses For Women 15 - 44

Panel A: Across-Women Fertility Responses

<table>
<thead>
<tr>
<th>Post Inj</th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0213***</td>
<td>0.0250***</td>
<td>0.0281***</td>
</tr>
<tr>
<td></td>
<td>(0.0061)</td>
<td>(0.0061)</td>
<td>(0.0055)</td>
</tr>
<tr>
<td>Obs.</td>
<td>525,528</td>
<td>525,221</td>
<td>372,202</td>
</tr>
<tr>
<td>Mean</td>
<td>0.211</td>
<td>0.211</td>
<td>0.229</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

Panel B: Within-Woman Fertility Responses

| Post Inj                  | 0.0250***      | 0.0439***      | 0.0311***      | 0.0509***      | 0.0090          | 0.0247**        |
|                          | (0.0063)       | (0.0099)       | (0.0064)       | (0.0103)       | (0.0069)        | (0.0090)        |
| Obs.                     | 417,976        | 417,976        | 288,419        | 288,419        | 129,557         | 129,557         |
| Number of Women          | 44,227         | 44,227         | 30,242         | 30,242         | 13,985          | 13,985          |
| Mean                     | 0.211          | 0.211          | 0.231          | 0.231          | 0.168           | 0.168           |
| Clusters                 | 18             | 18             | 18             | 18             | 18              | 18              |
| Controls                 | N              | Y              | N              | Y              | N               | Y               |

Notes: The dependent variable in all regressions is an indicator variable that takes value 1 if a woman reports having a live birth in a given month. Panel A reports coefficients and standard errors for $\beta$ in regression (1). Controls include dummy variables for educational attainment, for ever having been married in a given year, and for parity in a given year. Regression samples are restricted to women 15–44 observed during 1996–2010. Panel B reports coefficients and standard errors for $\beta$ in regression (3). Controls include dummy variables for whether or not a woman has ever been married in a given year and for parity in a given year. Regression samples are restricted to women 15–44 interviewed post-2005 observed during 1996–2010. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
Table 7: Across-Women Birth-Spacing Responses For Women 15 - 44

Panel A: Rural Women

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>.0033***</td>
<td>.0076***</td>
<td>.0077***</td>
<td>.0061***</td>
<td>.0009</td>
<td>.0063***</td>
</tr>
<tr>
<td></td>
<td>(.0006)</td>
<td>(.0020)</td>
<td>(.0020)</td>
<td>(.0017)</td>
<td>(.0019)</td>
<td>(.0015)</td>
</tr>
<tr>
<td>Obs.</td>
<td>978,223</td>
<td>735,720</td>
<td>397,532</td>
<td>215,287</td>
<td>132,831</td>
<td>89,874</td>
</tr>
<tr>
<td>Mean</td>
<td>.0086</td>
<td>.0356</td>
<td>.0488</td>
<td>.0376</td>
<td>.0276</td>
<td>.0202</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Panel B: Urban Women

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>-.0012</td>
<td>.0024</td>
<td>.0057**</td>
<td>.0030</td>
<td>.0039</td>
<td>-.0009</td>
</tr>
<tr>
<td></td>
<td>(.0011)</td>
<td>(.0027)</td>
<td>(.0024)</td>
<td>(.0022)</td>
<td>(.0023)</td>
<td>(.0029)</td>
</tr>
<tr>
<td>Obs.</td>
<td>295,396</td>
<td>236,086</td>
<td>150,640</td>
<td>96,028</td>
<td>65,545</td>
<td>47,182</td>
</tr>
<tr>
<td>Mean</td>
<td>.0068</td>
<td>.0260</td>
<td>.0332</td>
<td>.0262</td>
<td>.0195</td>
<td>.0160</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in all regressions is an indicator variable that takes value 1 if a woman reports having a live birth in a given month. “Year 1” corresponds to 9-20 months post-birth; “Year 2” corresponds to 21-32 months post-birth, etc. All reported coefficients and standard errors for $\beta$ in regression (E.3). Controls include dummy variables for educational attainment, for ever having been married in a given year, and for parity in a given year. Regression samples are restricted to women 15–44 observed during 1996–2010. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
Table 8: Within-Woman Birth-Spacing Responses For Women 15 - 44

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: Rural Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post Inj</td>
<td>.0030***</td>
<td>.0081**</td>
<td>.0087*</td>
<td>.0192***</td>
<td>.0098</td>
<td>.0208**</td>
<td>.0003</td>
</tr>
<tr>
<td></td>
<td>(.0007)</td>
<td>(.0029)</td>
<td>(.0042)</td>
<td>(.0045)</td>
<td>(.0079)</td>
<td>(.0078)</td>
<td>(.0088)</td>
</tr>
<tr>
<td>Obs</td>
<td>742,457</td>
<td>556,371</td>
<td>301,976</td>
<td>163,019</td>
<td>99,421</td>
<td>66,008</td>
<td>46,084</td>
</tr>
<tr>
<td>Number of Women</td>
<td>22836</td>
<td>21566</td>
<td>18650</td>
<td>13283</td>
<td>8864</td>
<td>6149</td>
<td>4360</td>
</tr>
<tr>
<td>Mean</td>
<td>.0088</td>
<td>.0357</td>
<td>.0481</td>
<td>.0379</td>
<td>.0281</td>
<td>.0213</td>
<td>.0155</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Panel B: Urban Women

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>-.0004</td>
<td>.0008</td>
<td>.0064</td>
<td>.0027</td>
<td>-.0023</td>
<td>-.0101</td>
<td>-.0037</td>
</tr>
<tr>
<td></td>
<td>(.0010)</td>
<td>(.0040)</td>
<td>(.0062)</td>
<td>(.0067)</td>
<td>(.0078)</td>
<td>(.0156)</td>
<td>(.0181)</td>
</tr>
<tr>
<td>Obs</td>
<td>242,655</td>
<td>192,902</td>
<td>123,616</td>
<td>78,737</td>
<td>53,544</td>
<td>38,128</td>
<td>27,937</td>
</tr>
<tr>
<td>Number of Women</td>
<td>9094</td>
<td>8564</td>
<td>7581</td>
<td>6050</td>
<td>4550</td>
<td>3461</td>
<td>2581</td>
</tr>
<tr>
<td>Mean</td>
<td>.0070</td>
<td>.0259</td>
<td>.0328</td>
<td>.0268</td>
<td>.0202</td>
<td>.0169</td>
<td>.0129</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in all regressions is an indicator variable that takes value 1 if a woman reports having a live birth in a given month. “Year 1” corresponds to 9-20 months post-birth; “Year 2” corresponds to 21-32 months post-birth, etc. The reported coefficients and standard errors for $\beta$ in specification (E.4). Regression samples are restricted to women 15–44 interviewed post-2005 observed during 1996–2014. Controls include dummy variables for whether or not a woman has ever been married in a given year and fixed effects for parity in a given year. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
<table>
<thead>
<tr>
<th></th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injectables</td>
<td>Flow Fertility</td>
</tr>
<tr>
<td>Post Inj</td>
<td>-0.0055</td>
<td>0.0453***</td>
</tr>
<tr>
<td></td>
<td>(0.0111)</td>
<td>(0.0145)</td>
</tr>
<tr>
<td>Obs.</td>
<td>2,339</td>
<td>22,483</td>
</tr>
<tr>
<td>Mean</td>
<td>0.0180</td>
<td>0.272</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

Panel B: All Childless Women

<table>
<thead>
<tr>
<th></th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injectables</td>
<td>Flow Fertility</td>
</tr>
<tr>
<td>Post Inj</td>
<td>0.0050</td>
<td>0.0129*</td>
</tr>
<tr>
<td></td>
<td>(0.0030)</td>
<td>(0.0066)</td>
</tr>
<tr>
<td>Obs.</td>
<td>11,701</td>
<td>99,841</td>
</tr>
<tr>
<td>Mean</td>
<td>0.0109</td>
<td>0.180</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in regressions for injectable use is an indicator variable that takes value 1 if a woman reports using injectables at survey date. Regressions are estimated using our repeated cross-section dataset on samples consisting of childless women aged 15–44 interviewed during 1996–2014. Controls include dummy variables for marital status and educational attainment. The dependent variables in regressions for flow fertility is an indicator variable that takes value 1 if a woman reports having a live birth in a given year. Regressions are estimated using our birth-history panel on samples consisting of childless women aged 15-44 observed during 1996–2010. Controls include dummy variables for ever having been married in a given year, educational attainment at survey date, and parity in a given year. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
Table 10: Contraceptive Adoption & Fertility Responses for Women 45-49

<table>
<thead>
<tr>
<th>Panel A: Rural Women</th>
<th>Injectable Adoption</th>
<th>Completed Fertility</th>
<th>Flow Fertility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post Inj</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.027*** (0.008)</td>
<td>-0.242 (0.206)</td>
<td>0.0035 (0.0115)</td>
</tr>
<tr>
<td></td>
<td>0.026*** (0.008)</td>
<td>-0.259 (0.195)</td>
<td>0.0020 (0.0110)</td>
</tr>
<tr>
<td>Obs.</td>
<td>4,082</td>
<td>4,185</td>
<td>6,115</td>
</tr>
<tr>
<td>Mean</td>
<td>0.0394</td>
<td>7.188</td>
<td>0.0366</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Urban Women</th>
<th>Injectable Adoption</th>
<th>Completed Fertility</th>
<th>Flow Fertility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post Inj</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.032 (0.024)</td>
<td>-0.424 (0.326)</td>
<td>-0.0064 (0.0145)</td>
</tr>
<tr>
<td></td>
<td>0.024 (0.021)</td>
<td>-0.247 (0.267)</td>
<td>-0.0096 (0.0153)</td>
</tr>
<tr>
<td>Obs.</td>
<td>1,314</td>
<td>1,333</td>
<td>1,576</td>
</tr>
<tr>
<td>Mean</td>
<td>0.0419</td>
<td>6.385</td>
<td>0.0133</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in regressions for injectable use is an indicator variable that takes value 1 if a woman reports using injectables at survey date. The dependent variable in regressions for completed fertility is the stock of live births a woman reports at survey date. Regressions are estimated using our repeated cross-section dataset on samples consisting of women aged 45–49 interviewed during 1996–2014. Controls include dummy variables for marital status and educational attainment. The dependent variables in regressions for flow fertility is an indicator variable that takes value 1 if a woman reports having a live birth in a given year. Regressions are estimated using our birth-history panel on samples consisting of women aged 45-49 observed during 1996–2010. Controls include dummy variables for ever having been married in a given year, educational attainment at survey date, and parity in a given year. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
The graph plots estimated Total Fertility Rates (TFR) for Zambia and several regions of the developing world from the World Development Indicators Database maintained by the World Bank. Aggregates for regions are constructed excluding high income countries. All series include TFR rates that are imputed.
The graphs plot coefficients for $\gamma_{zsa}^{t}$ from regression specification (2). The dependent variable in specification (2) is an indicator variable that takes value 1 if a woman is using injectables at survey date. All coefficients are shifted upward by the fraction of women using injectables in sample $zsa$ in the first time period 1990–95 to capture differences in baseline usage by sample. Regression samples include all women 15–44 interviewed during 1990–2014. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{t|zsa}$ from regression specification (2). The dependent variable in specification (2) is an indicator variable that takes value 1 if a woman is using modern contraceptives at survey date. All coefficients are shifted upward by the fraction of women using modern contraceptives in sample $zsa$ in the first time period 1990-95 to capture differences in baseline usage by sample. Regression samples include all women 15–44 interviewed during 1990–2014. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
References


A Mathematical Appendix

A.1 Formal Presentation of Main Model

A.1.1 World Without Modern Contraceptives

Recall the maximization problems in periods $t = 1, 2, 3$ in a world without modern contraceptives:

$$V_t(\gamma_{t-1}) = \max_{b \in [0,1]} \{ \bar{u} - \phi(b) + p(b) \max \{ V_{t+1}(\gamma_{t-1}^i + 1), V_{t+1}(\gamma_{t-1}^i) - c_i \} + (1 - p(b))V_{t+1}(\gamma_{t-1}^i) \}$$

where $V_4(\gamma_2^i) \equiv U(\gamma_2^i)$. The above maximization problem can be rewritten as:

$$V_t(\gamma_{t-1}^i) = \bar{u} + V_t(\gamma_{t-1}^i, c_i) - \min_{b \in [0,1]} \{ \phi(b) + p(b) \min \{ V_t(\gamma_{t}^i, c_i) - V_t(\gamma_{t-1}^i + 1, c_i), c_i \} \}$$

We define

$$\bar{b}(\alpha) = \arg \min_{b \in [0,1]} \{ \phi(b) + \alpha p(b) \} \quad \forall \alpha \in \mathbb{R}$$

$$B(\alpha) = \min_{b \in [0,1]} \{ \phi(b) + \alpha p(b) \} \quad \forall \alpha \in \mathbb{R}$$

and place the following restrictions on cost functions and probabilities.

Assumption 1. We assume the following properties about payoffs and probabilities:

1. The functions $\phi(\cdot)$, $r(\cdot)$ and $p(\cdot)$ are all twice continuously differentiable.

2. The cost functions $\phi(\cdot)$ and $r(\cdot)$ are strictly increasing and strictly convex. The probability $p(\cdot)$ is strictly decreasing and strictly convex.

With this notation, we characterize women’s optimal behavior when they do not have access to modern contraceptives.

Lemma 1. Let Assumption 1 hold. Then,
1. Both $\tilde{b}(\alpha)$ and $\tilde{B}(\alpha)$ are well-defined and increasing in $\alpha$.

2. Women’s optimal choice of abortions and traditional methods of fertility control satisfy:

$$a_t^*(\gamma_{t-1}^i, c_i) = \mathbf{1}_{\{c_i < r(\gamma_{t+1}^i) - r(\gamma_{t}^i)\}} \quad \forall \ t \in \{1, 2, 3\}$$

$$b_t^*(\gamma_{1}^i, c_i) = \tilde{b} (c_i \wedge [V_t(\gamma_{t+1}^i) - V_{t+1}(\gamma_{t+1}^i + 1)]) \quad \forall \ t \in \{1, 2, 3\}$$

Define $q_1$, $q_2$, and $q_3$ the real numbers satisfying:

$$(1 - q_1)^2 r(1) = B(r(1))$$
$$(1 - q_2) r(1) = B(r(1))$$
$$(1 - q_3)^2 [r(2) - r(1)] + 2 q_3 (1 - q_3) r(1) = B(r(1))$$

Similarly define $c_2^*$, $c_1^*$ and $c_1^+$ as the threshold values of abortion costs satisfying

$$(1 - \bar{p})^2 r(1) = B(c_1^*)$$
$$(1 - \bar{p}) r(1) = B(c_2^*)$$
$$(1 - \bar{p})^2 [r(2) - r(1)] + 2 \bar{p} (1 - \bar{p}) r(1) = B(c_1^+)$$

**Lemma 2.** Let Assumption 1 hold. Then, the scalars $q_1$, $q_2$, and $q_3$ satisfy $q_1 < q_2 < q_3$ and reflect the degree of asymmetry that women have in fertility control. Specifically,

1. When $q_1 > \bar{p}$, no women have a precautionary motive to delay having children and women’s fertility behavior is identical to behavior in a model of repeated static fertility choice.

2. When $q_2 > \bar{p} > q_1$, women with target fertility $n_i = 1$ and abortion costs $c_i > c_1^*$ have a precautionary motive to delay having children during $t = 1$.

3. When $q_3 > \bar{p} > q_2$, women with target fertility $n_i = 1$ and abortion costs $c_i > c_1^*$ have
a precautionary motive to delay having children during \( t = 1 \); and women with target fertility \( n_i = 1 \) and abortion costs \( c_i > c_1^* \) have a precautionary motive to delay having children during \( t = 2 \).

4. When \( \bar{p} > q_3 \), women with target fertility \( n_i = 1 \) and abortion costs \( c_i > c_1^* \) have a precautionary motive to delay having children during \( t = 1 \); women with target fertility \( n_i = 1 \) and abortion costs \( c_i > c_2^* \) have a precautionary motive to delay having children during \( t = 2 \); and women with target fertility \( n_i = 2 \) and abortion costs \( c_i > c_1^+ \) have a precautionary motive to delay having children during \( t = 3 \).

Denote by \( N(t, \gamma) \) the fraction of women at time \( t \) with for whom \( \gamma_{t-1} = \gamma \) and observe that \( N(1, -x) = N_x \) for \( x \in \{0, 1, 2, 3\} \). Below, we analyze women’s fertility behavior in the two extreme cases (i.e. when \( \bar{p} > q_3 \) and when \( q_1 > \bar{p} \)).

**Corollary 1.** Let Assumption 1 hold and let \( \bar{p} > q_3 \). Define

\[
g(c_i, \gamma, t) \equiv p \left( \tilde{b}(c_i) \land \left[ V_{t+1}(\gamma) - V_{t+1}(\gamma + 1) \right] \right)
\]

Then at times \( t \), the fraction of women having abortions, \( A_t \), is:

\[
A_1 = N_0 \int_0^{r(1)} p(\tilde{b}(c_i))dF
\]

\[
A_2 = N(2, 0) \int_0^{r(1)} p(\tilde{b}(c_i))dF + N(2, 1) \int_0^{r(2) - r(1)} p(\tilde{b}(c_i))dF
\]

The fraction of women using traditional methods, \( T_t \), is:

\[
T_1 = N_0 + N_1(1 - F(c_1^*)) + N_2(1 - F(c_1^+))
\]

\[
T_2 = N(2, 1) + N(2, 0) + N(2, -1)(1 - F(c_2^*))
\]
and the fraction of women giving birth, $F_t$, is:

$$F_1 = \int_{r(1)}^{\infty} g(c, 0, 1) dF + \int_{c_i}^{c_i+1} g(c, -1, 1) dF + \int_{c_i+2}^{\infty} g(c, -2, 1) dF$$

$$F_2 = \text{\(N_1\int_{r(2) - r(1)}^{\infty} g(c, 1, 2) dF + N_2\int_{r(1)}^{\infty} g(c, 0, 2) dF + N_3\int_{c_i+2}^{\infty} g(c, -1, 2) dF$$

$$\text{\(N_1F(c^*_1) + N_2F(c^*_1) + N_3\bar{p}$$

We derive similar formulas when fertility control is at its most symmetric:

**Corollary 2.** Let Assumption 1 hold and let $q_1 > \bar{p}$. Denote by $\tilde{N}(t, \gamma)$ the fraction of women at time $t$ with for whom $\gamma_{t-1} = \gamma$ and observe that $\tilde{N}(1-x) = N_x$ for $x \in \{0, 1, 2, 3\}$. Define

$$g(c, \gamma, t) \equiv p(\tilde{b}(c_i \land [V_{t+1}(\gamma) - V_{t+1}(\gamma + 1)])$$

Then at times $t$, the fraction of women having abortions, $\tilde{A}_t$, is:

$$\tilde{A}_1 = \int_{0}^{r(1)} p(\tilde{b}(c_i)) dF$$

$$\tilde{A}_2 = \tilde{N}(2, 1) \int_{0}^{r(2) - r(1)} p(\tilde{b}(c_i)) dF + \tilde{N}(2, 0) \int_{0}^{r(1)} p(\tilde{b}(c_i)) dF$$

the fraction of women using traditional methods, $T_t$, is:

$$\tilde{T}_1 = N_0$$

$$\tilde{T}_2 = \tilde{N}(2, 0) + \tilde{N}(2, 1)$$
and the fraction of women giving birth, \( F_t \), is:

\[
\begin{align*}
\tilde{F}_1 &= N_0 \int_{r(1)}^{\infty} g(c_i, 0, 1) dF + (N_1 + N_2 + N_3) \bar{p} \\
\tilde{F}_2 &= \tilde{N}(2, 1) \int_{r(2)-r(1)}^{\infty} g(c_i, 1, 2) dF + \tilde{N}(2, 0) \int_{r(1)}^{\infty} g(c_i, 0, 2) dF \\
&\quad + [\tilde{N}(2, -1) + \tilde{N}(2, -2) + \tilde{N}(2, -3)] \bar{p}
\end{align*}
\]

A.1.2 World With Modern Contraceptives

When women have access to modern contraceptives, their maximization problems change:

\[
V^I_t(\gamma^i_{t-1}, c_i) = \bar{u} + V^I_{t+1}(\gamma^i_{t-1}, c_i) - \min\{\tilde{\phi}, B (c_i \land [V^I_{t+1}(\gamma^i_{t-1}, c_i) - V^I_{t+1}(\gamma^i_{t-1} + 1, c_i)])\}
\]

We solve for women’s optimal decisions when they have access to modern contraceptives. The size of the disutility of modern contraceptives, \( \tilde{\phi} \), will be an important determinant of women’s behaviors. We first consider the case when the cost of contraceptives is low; then we consider a case where the cost of contraceptives is high.

**Assumption 2.** Assume that \( \tilde{\phi} < (1 - \bar{p})^2 r(1) \).

Here, the per-period disutility of using abortions is less than the expected undershooting loss for a woman desiring one child who has two fertile periods to achieve her target fertility. A useful way of thinking of this condition is that penalties for failing to achieve target fertilities are orders of magnitude larger than per-period disutilities from using contraceptives.

Denote by \( c^I \) the threshold value of abortions costs satisfying \( \bar{\phi} = B(c^I) \).

**Lemma 3.** Let Assumption 1 \& 2 hold. Then, \( c^I < c^*_1 \), and women’s optimal choice of
abortions and traditional methods of fertility control satisfy:

\[
\begin{align*}
  a_{t}^{I_{*}}(\gamma_{t-1}, c_{i}) & = \mathbb{1}_{\{c_i \leq r(|\gamma_{t+1}| - r(|\gamma_{t}|))\}} \quad \forall \ t \in \{1, 2, 3\} \\
  m_{t}^{I_{*}}(\gamma_{t-1}, c_{i}) & = \mathbb{1}_{\{\gamma_{t-1} \geq 0\}} \mathbb{1}_{\{c_i \geq c_{I}\}} \quad \forall \ t \in \{1, 2, 3\} \\
  b_{t}^{I_{*}}(\gamma_{t-1}, c_{i}) & = \mathbb{1}_{\{\gamma_{t-1} \geq 0\}} \mathbb{1}_{\{c_i < c_{I}\}} \tilde{b}(c_i) \quad \forall \ t \in \{1, 2, 3\}
\end{align*}
\]

Moreover, if \( \bar{p} > q_3 \), modern contraceptive access eliminates any precautionary motives for delaying children. If \( q_1 > \bar{p} \), women’s fertility behavior is unchanged by modern contraceptive access.

Women’s optimal behavior with modern contraceptives allows us to derive expressions for the fraction of women having abortions, the fraction of women using traditional methods, and the fraction of women giving birth in any given period.

**Corollary 3.** Let Assumptions 1 & 2 hold. Denote by \( N^{I}(t, \gamma) \) the fraction of women at time \( t \) with for whom \( \gamma_{t-1} = \gamma \) and observe that \( N^{I}(1, -x) = N_{x} \) for \( x \in \{0, 1, 2, 3\} \). Then at time \( t \), the fraction of women having abortions, \( A_{t} \), is:

\[
\begin{align*}
  A_{1}^{I} & = N_{0} \int_{0}^{c_{I}} p(b(c_{i}))dF \\
  A_{2}^{I} & = N^{I}(2, 0) \int_{0}^{c_{I}} p(b(c_{i}))dF
\end{align*}
\]

the fraction of women using traditional methods, \( T_{t} \), is:

\[
\begin{align*}
  T_{1}^{I} & = N_{0} * F(c_{I}) \\
  T_{2}^{I} & = N^{I}(2, 0) * F(c_{I})
\end{align*}
\]

and the fraction of women giving birth, \( F_{t} \), is:

\[
\begin{align*}
  F_{1}^{I} & = (N_{1} + N_{2} + N_{3})\bar{p} \\
  F_{2}^{I} & = [N^{I}(2, -1) + N^{I}(2, -2) + N^{I}(2, -3)]\bar{p}
\end{align*}
\]
In contrast, when the cost of modern contraceptives is sufficiently high, women’s optimal behavior remains unchanged from the world without modern contraceptives.

**Corollary 4.** Let Assumption 1 hold. Suppose $\bar{\phi} > B(r(1))$. Then, no one adopts modern contraceptives and women’s fertility behavior is unchanged.

For intermediate disutility of modern contraceptive use, modern contraceptives can eliminate precautionary motives for some women, and weaken women’s precautionary motives for others.

**Corollary 5.** Let Assumption 1 hold. Suppose $c_1^* < c^t < c_1^+ < r(1)$. Then, women’s precautionary motives to delay childbearing remain in place for women with target fertilities $n_i = 1$ but are eliminated for women with target fertilities $n_i = 2$. Women never use modern contraceptives to delay births, and women with target fertility $n_i = 1$ who have abortions disutility $c_i > c^t$ use traditional methods with less intensity than they would have in the absence of modern contraceptives.

### A.1.3 Injectable Legalization

To derive testable empirical predictions from our model, we consider an extension of our model where cohorts of women age through the lifecycle to more accurately capture the reality of injectable legalization in Zambia. Prior to modern contraceptive access, $\bar{N}$ women are alive in each of the three fertile periods in our model, corresponding to different cohorts. When we move to the next time period, the $\bar{N}$ women at the end of their fertile lives exit the model, and a new cohort of $\bar{N}$ women enter their childbearing year ($t = 1$) with new draws of $n_i$ and $c_i$, ensuring that there exists a complete age-profile of women during each period.

We consider how women’s fertility behavior changes when injectables are legalized by assuming that injectable legalization occurs between two periods. Thus, women at $t = 3$ prior to legalization will see no benefits, while women at $t = 1$ prior to legalization will be able to adjust their behavior and women newly entering their fertile life will have access to modern contraceptives during all periods.
Proposition 1. Let Assumptions 1 & 2 hold. Recall the notation $N(t, \gamma)$ and the expressions for these quantities derived in the proof of Corollary 1. Define

$$g(c_i, \gamma, t) \equiv p\left(\tilde{b}(c_i \land [V_{t+1}(\gamma + 1) - V_{t+1}(\gamma)])\right)$$

Legalizing injectables increases use of modern contraceptives, decreases use of abortions,

$$0 > A_1^I - A_1 = -N_0 \int_{c_I}^{r(1)} p(\tilde{b}(c_i))dF$$

$$0 > A_2^I - A_2 = -[N(2, 0) + N(2, 1)] \int_{c_I}^{r(1)} p(\tilde{b}(c_i))dF - N(2, 1) \int_{r(1)}^{r(2)-r(1)} p(\tilde{b}(c_i))dF$$

$$0 > A_3^I - A_3 = -[N(3, 0) + N(3, 1) + N(3, 2)] \int_{c_I}^{r(1)} p(\tilde{b}(c_i))dF$$

$$- [N(3, 1) + N(3, 2)] \int_{r(1)}^{r(2)-r(1)} p(\tilde{b}(c_i))dF - N(3, 2) \int_{r(2)-r(1)}^{r(3)-r(2)} p(\tilde{b}(c_i))dF$$

decreases use of traditional methods of fertility control:

$$0 > T_1^I - T_1 = -N_0(1 - F(c_I)) - N_1(1 - F(c_1^*)) - N_2(1 - F(c_1^*))$$

$$0 > T_2^I - T_2 = -[N(2, 0) + N(2, 1)](1 - F(c_I)) - N(2, -1)(1 - F(c_2^*))$$

$$0 > T_3^I - T_3 = -[N(3, 0) + N(3, 1) + N(3, 2)](1 - F(c_I))$$
and has ambiguous effects on fertility during the first two periods:

\[
F^I_1 - F_1 = N_1 \left[ \bar{p}(1 - F(c_1^*)) + \int_{c_1^*}^{\infty} (\bar{p} - g(c_i, -1, 1))dF \right] \\
+ N_2 \left[ \bar{p}(1 - F(c_1^*)) + \int_{c_1^*}^{\infty} (\bar{p} - g(c_i, -2, 1))dF \right] - N_0 \int_{r(1)}^{\infty} g(c_i, 0, 1)dF
\]

\[
F^I_2 - F_2 = N(2, -1) \left[ \bar{p}(1 - F(c_2^*)) + \int_{c_2^*}^{\infty} (\bar{p} - g(c_i, -1, 2))dF \right] - N(2, 0) \int_{r(1)}^{\infty} g(c_i, 0, 2)dF \\
- N(2, 1) \int_{r(2)-r(1)}^{\infty} g(c_i, 1, 2)dF
\]

\[
F^I_3 - F_3 = -N(3, 0) \int_{r(1)}^{\infty} g(c_i, 0, 3)dF - N(3, 1) \int_{r(2)-r(1)}^{\infty} g(c_i, 1, 3)dF - N(3, 2) \int_{r(3)-r(2)}^{\infty} g(c_i, 2, 3)dF
\]

Proposition 1 characterizes how the fraction of women using abortions and traditional methods, and the fraction of women having births, changes over the lifecycle in response to modern contraceptive legalization. It allows us to generate empirical predictions for how these quantities change over the lifecycle:

**Corollary 6.** Reductions in abortion use are larger at older ages:

\[
A^I_3 - A_3 < A^I_2 - A_2 < A^I_1 - A_1 < 0
\]

**Corollary 7.** For \( N_0 \) small, fertility increases for younger ages \((t = 1)\) in response to injectable legalization. When, additionally, \( N_1 \) is small relative to \( N_2 \), fertility also increases for older ages \((t = 2)\) in response to injectable legalization.

**Corollary 8.** Fertility decreases for women in their terminal fertile period \((t = 3)\).

**Corollary 9.** Women’s expected completed fertility declines.
A.2 Model Extensions

A.2.1 Extension 1: Preferences for spacing of births

We extend our model to allow women to have preferences over the spacing of births. In particular, for all women with target fertilities $n_i < 3$, women experience personal disutility $\lambda_i$ if they give birth in two subsequent periods.

[More to come!]

A.2.2 Extension 2: Heterogeneous initial access to modern contraceptives

We extend our model to allow some women to have access to (different types) of modern contraceptives prior to injectable legalization. Consider a second type of modern contraceptive, $l$, with associated disutility $\bar{\phi}_l$. Contraceptive $l$ also eliminates pregnancy risk perfectly, but may entail higher disutility to use. Women are randomly assigned type $\theta_i \in \{\theta_R, \theta_U\}$ at time $t = 0$ independently of draws of $c_i$ and $n_i$. Women with type $\theta_U$ have access to contraceptive type $l$ prior to legalization; women with type $\theta_R$ do not.

[More to come!]

A.2.3 Extension 3: Infant mortality

We extend our model to include the possibility of infant mortality. Let $s^i_t$ denote the stock of living children at the end of period $t$. Denote by $\hat{s}^i_t$ the stock of children at the beginning of period $t + 1$, where

$$\hat{s}^i_t = \begin{cases} s^i_t & \text{with probability } q \\ s^i_t - 1 & \text{with probability } 1 - q \end{cases}$$

[More to come!]

A.3 Proofs

Proof of Lemma \[\boxed{1}\]: Weierstrass’ Extreme Value Theorem guarantees existence of $\bar{b}(\alpha)$ and $B(\alpha)$. That $\bar{b}(\alpha)$ is weakly increasing in $\alpha$ follows from the increasing convexity of $\phi$ and
the decreasing convexity of $p$. In particular, $\tilde{b}(\alpha) = 0$ for all $\alpha \leq 0$, and satisfies
\[
-\frac{\phi'(\tilde{b}(\alpha))}{p'(b(\alpha))} = \alpha
\]
for all $\alpha > 0$. The expression $-\phi'(b)/p'(b)$ is increasing in $b$; as $\alpha$ increases, the optimal choice of $b$ must also increase to ensure the first-order condition is satisfied.

$B(\alpha)$ is increasing in $\alpha$ by the Envelope Theorem, applicable because both $\phi$ and $p$ are twice continuously differentiable.

Deriving expressions for a woman’s optimal decisions requires backward induction, algebra and use of the Envelope Theorem. □.

**Proof of Lemma 2** This follows from women’s optimal decisions, and manipulation of value functions. □.

**Proof of Corollary 1** This immediately follows from Lemmas 1 & 2. Simply take expectations. Expressions for the $N(t, \gamma)$ are given by:

\[
N(2, -3) = N_3 (1 - \bar{p})
\]
\[
N(2, -2) = N_3 \bar{p} + N_2 \left[ F(c_1^+) (1 - \bar{p}) + \int_{c_1^+}^{\infty} (1 - g(c_i, -2, 1)) dF \right]
\]
\[
N(2, -1) = N_1 \left[ F(c_1^+) (1 - \bar{p}) + \int_{c_1^+}^{\infty} (1 - g(c_i, -1, 1)) dF \right] + N_2 \left[ F(c_1^+) \bar{p} + \int_{c_1^+}^{\infty} g(c_i, -2, 1) dF \right]
\]
\[
N(2, 0) = N_0 \left[ F(r(1)) + \int_{r(1)}^{\infty} (1 - g(c_i, 0, 1)) dF \right] + N_1 \left[ F(c_1^+) \bar{p} + \int_{c_1^+}^{\infty} g(c_i, -1, 1) dF \right]
\]
\[
N(2, 1) = N_0 \int_{r(1)}^{\infty} g(c_i, 0, 1) dF
\]

□.

**Proof of Corollary 2** This immediately follows from Lemmas 1 & 2. Simply take expecta-
tions. Expressions for $\tilde{N}(t, \gamma)$ are given by:

\[
\begin{align*}
\tilde{N}(2, -3) &= N_3(1 - \bar{p}) \\
\tilde{N}(2, -2) &= N_3\bar{p} + \tilde{N}_2(1 - \bar{p}) \\
\tilde{N}(2, -1) &= N_2\bar{p} + N_1(1 - \bar{p}) \\
\tilde{N}(2, 0) &= N_0 \left( F(r(1)) + \int_{r(1)}^{\infty} (1 - g(c_i, 0, 1))dF \right) + N_1\bar{p} \\
\tilde{N}(2, 1) &= N_0 \int_{r(1)}^{\infty} g(c_i, 0, 1)dF
\end{align*}
\]

□.

Proof of Lemma 3: Backwards induct and apply the Envelope Theorem to derive women’s optimal policies. □.

Proof of Corollary 3: Immediate from Lemma 3. Take expectations. Expressions for $N^I(t, \gamma)$ are given by:

\[
\begin{align*}
N^I(2, -3) &= N_3(1 - \bar{p}) \\
N^I(2, -2) &= N_3\bar{p} + N_2(1 - \bar{p}) \\
N^I(2, -1) &= N_2\bar{p} + N_1(1 - \bar{p}) \\
N^I(2, 0) &= N_0 + N_1\bar{p}
\end{align*}
\]

□.

Proof of Corollary 4: Immediate from women’s maximization problems. □.

Proof of Corollary 5: Use the same methods discussed above to re-solve for women’s optimal decisions. □.

Proof of Proposition 1: Use the expressions derived in Lemmas 1 & lemma3. Note that because injectable legalization is happening during women’s lives, the composition of women
at $t = 2, 3$ is determined by fertility behavior in a pre-legalization world. □.

*Proof of Corollary 6:* Immediate from Proposition 1. □.

*Proof of Corollary 7:* Immediate from Proposition 1 and manipulation of the formulas for $N(t, \gamma)$ found in Corollary 1. □.

*Proof of Corollary 8:* Immediate from Proposition 1. □.

*Proof of Corollary 9:* Immediate from Proposition 1. □.
B  Analysis of Heterogeneous Treatment Effects

B.1  Contraceptive Adoption

Figure B.1: Heterogeneous Contraceptive Take-up Across Age Group

The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect \( \beta \) from the regression specification (1) estimated separately on subsamples defined by age. The dependent variable is an indicator variable that takes value one if a woman is using a type of contraceptive at survey date. All standard errors are clustered at the region level.

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Figure B.2: Heterogeneous Contraceptive Take-up Across Education Level

The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by years of schooling. The dependent variable is an indicator variable that takes value one if a woman is using a type of contraceptive at survey date. All standard errors are clustered at the region level.
The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by parity. The dependent variable is an indicator variable that takes value one if a woman is using a type of contraceptive at survey date. All standard errors are clustered at the region level.
B.2 Coital Frequency

Figure B.4: Heterogeneous Coital Frequency Response Across Age Groups

The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by age. The dependent variable is an indicator variable that takes value one if a woman reports having had sex during the week prior to survey date. All standard errors are clustered at the region level.
The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by years of schooling. The dependent variable is an indicator variable that takes value one if a woman reports having had sex during the week prior to survey date. All standard errors are clustered at the region level.
The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by parity. The dependent variable is an indicator variable that takes value one if a woman reports having had sex during the week prior to survey date. All standard errors are clustered at the region level.
### B.3 Abortions

Figure B.7: Heterogeneous Abortion Response Across Age Groups

<table>
<thead>
<tr>
<th>Age</th>
<th>Coefficient</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-19</td>
<td>-0.3</td>
<td>-0.15 to 0.3</td>
</tr>
<tr>
<td>20-24</td>
<td>-0.15</td>
<td>0 to 0.15</td>
</tr>
<tr>
<td>25-29</td>
<td>0</td>
<td>-0.15 to 0.15</td>
</tr>
<tr>
<td>30-34</td>
<td>0.15</td>
<td>0.0 to 0.3</td>
</tr>
<tr>
<td>35-39</td>
<td>0.3</td>
<td>0.15 to 0.45</td>
</tr>
<tr>
<td>40-44</td>
<td>0.3</td>
<td>0.15 to 0.45</td>
</tr>
</tbody>
</table>

The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by age. The dependent variable is an indicator variable that takes value one if a woman reports ever having had a terminated pregnancy at survey date. All standard errors are clustered at the region level.
The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by years of schooling. The dependent variable is an indicator variable that takes value one if a woman reports ever having had a terminated pregnancy at survey date. All standard errors are clustered at the region level.
The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by parity. The dependent variable is an indicator variable that takes value one if a woman reports ever having had a terminated pregnancy at survey date. All standard errors are clustered at the region level.
B.4 Fertility

Figure B.10: Heterogeneous Fertility Response Across Age Groups

The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by age. The dependent variable is an indicator variable taking value one in a year in which a woman gives birth. All standard errors are clustered at the region level.
The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by years of schooling. The dependent variable is an indicator variable taking value one in a year in which a woman gives birth. All standard errors are clustered at the region level.
The graphs plot coefficient estimates and 95% confidence intervals for the treatment effect $\beta$ from the regression specification (1) estimated separately on subsamples defined by parity. The dependent variable is an indicator variable taking value one in a year in which a woman gives birth. All standard errors are clustered at the region level.
C Robustness Tables

Table C.1: Contraceptive Adoption Robustness

Panel A: Contraceptive Adoption Excluding Malawi

<table>
<thead>
<tr>
<th></th>
<th>Modern Contraceptives</th>
<th>Condoms</th>
<th>Pills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.090*** (0.017)</td>
<td>0.116*** (0.021)</td>
<td>-0.007 (0.009)</td>
</tr>
<tr>
<td></td>
<td>0.091*** (0.017)</td>
<td>0.123*** (0.024)</td>
<td>-0.007 (0.008)</td>
</tr>
<tr>
<td>Obs.</td>
<td>51,731 51,101</td>
<td>51,731 51,101</td>
<td>51,731 51,101</td>
</tr>
<tr>
<td>Mean</td>
<td>0.0939 0.0939</td>
<td>0.254 0.254</td>
<td>0.0376 0.0376</td>
</tr>
<tr>
<td>Clusters</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y</td>
<td>N Y</td>
<td>N Y</td>
</tr>
</tbody>
</table>

Panel B: Contraceptive Adoption Using A Paired-Region Regression Specification

<table>
<thead>
<tr>
<th></th>
<th>Modern Contraceptives</th>
<th>Condoms</th>
<th>Pills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.062** (0.022)</td>
<td>0.085** (0.030)</td>
<td>-0.000 (0.003)</td>
</tr>
<tr>
<td></td>
<td>0.063** (0.021)</td>
<td>0.088** (0.029)</td>
<td>0.001 (0.002)</td>
</tr>
<tr>
<td>Obs.</td>
<td>61,280 60,655</td>
<td>61,280 60,655</td>
<td>61,280 60,655</td>
</tr>
<tr>
<td>Mean</td>
<td>0.117 0.117</td>
<td>0.266 0.266</td>
<td>0.0367 0.0367</td>
</tr>
<tr>
<td>Clusters</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Controls</td>
<td>N Y</td>
<td>N Y</td>
<td>N Y</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in these regressions is a dummy variable that takes value 1 if a woman reports using the specific type (or types) of contraception at survey date and takes value zero otherwise. The category modern contraceptives include injectables, norplant, pills, condoms, male & female sterilization, IUDs, & diaphragms. Panel A reports coefficients and standard errors are for the term $\beta$ in regression (1) excluding Malawi. Panel B reports coefficients and standard errors are for the term $\beta$ in regression (E.1) excluding Malawi. Controls include fixed effects for marital status and educational attainment. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, *p<0.1
Table C.2: Alternate Measures of Coital Frequency

## Panel A: Ever Had Sexual Intercourse

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.0017</td>
<td>0.0099</td>
<td>-0.0202</td>
</tr>
<tr>
<td></td>
<td>(0.0068)</td>
<td>(0.0066)</td>
<td>(0.0129)</td>
</tr>
<tr>
<td>Obs.</td>
<td>77,569</td>
<td>53,787</td>
<td>23,782</td>
</tr>
<tr>
<td>Mean</td>
<td>0.865</td>
<td>0.877</td>
<td>0.837</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

## Panel B: Sex Within Last Month

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.0440**</td>
<td>0.0470*</td>
<td>0.0355*</td>
</tr>
<tr>
<td></td>
<td>(0.0192)</td>
<td>(0.0225)</td>
<td>(0.0201)</td>
</tr>
<tr>
<td>Obs.</td>
<td>66,757</td>
<td>46,996</td>
<td>19,761</td>
</tr>
<tr>
<td>Mean</td>
<td>0.684</td>
<td>0.696</td>
<td>0.658</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

**Notes:** All coefficients and standard errors are for the term $\beta$ in regression (1). The dependent variable in Panel A is an indicator variable that takes value one if a woman reports ever having had sexual intercourse at survey date. The dependent variable in Panel B is an indicator variable taking value one if a woman reports having had sex during the past month at survey date. Controls include fixed effects for marital status and educational attainment. All standard errors are clustered at the region level. *** $p<0.01$, ** $p<0.05$, *$p<0.1$
Table C.3: Coital Frequency Robustness

Panel A: Coital Frequency Responses Excluding Malawi

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.0576**</td>
<td>0.0713**</td>
<td>0.0105</td>
</tr>
<tr>
<td></td>
<td>(0.0226)</td>
<td>(0.0281)</td>
<td>(0.0221)</td>
</tr>
<tr>
<td>Obs.</td>
<td>45,990</td>
<td>29,788</td>
<td>16,202</td>
</tr>
<tr>
<td>Mean</td>
<td>0.519</td>
<td>0.535</td>
<td>0.489</td>
</tr>
<tr>
<td>Clusters</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

Panel B: Coital Frequency Responses Using a Paired-Region Regression Specification

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.0930***</td>
<td>0.1000***</td>
<td>0.0628**</td>
</tr>
<tr>
<td></td>
<td>(0.0161)</td>
<td>(0.0191)</td>
<td>(0.0236)</td>
</tr>
<tr>
<td>Obs.</td>
<td>54,041</td>
<td>39,932</td>
<td>14,109</td>
</tr>
<tr>
<td>Mean</td>
<td>0.549</td>
<td>0.561</td>
<td>0.514</td>
</tr>
<tr>
<td>Clusters</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in these regressions is a dummy variable that takes value 1 if a woman reports having had sexual intercourse during the week prior to survey date. Panel A reports coefficients and standard errors are for the term $\beta$ in regression (1) excluding Malawi. Panel B reports coefficients and standard errors are for the term $\beta$ in regression (E.1). Controls include fixed effects for marital status and educational attainment. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, *p<0.1
Table C.4: Abortion Use Robustness

Panel A: Abortion Responses Excluding Malawi

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>-0.0265</td>
<td>-0.0433</td>
<td>0.0176</td>
</tr>
<tr>
<td></td>
<td>(0.0397)</td>
<td>(0.0399)</td>
<td>(0.0448)</td>
</tr>
<tr>
<td>Obs.</td>
<td>40,780</td>
<td>25,038</td>
<td>15,742</td>
</tr>
<tr>
<td>Mean</td>
<td>0.110</td>
<td>0.117</td>
<td>0.0969</td>
</tr>
<tr>
<td>Clusters</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

Panel B: Abortion Responses Using a Paired-Region Specification

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>-0.0464</td>
<td>-0.0570*</td>
<td>0.0041</td>
</tr>
<tr>
<td></td>
<td>(0.0264)</td>
<td>(0.0281)</td>
<td>(0.0204)</td>
</tr>
<tr>
<td>Obs.</td>
<td>51,914</td>
<td>38,172</td>
<td>13,742</td>
</tr>
<tr>
<td>Mean</td>
<td>0.108</td>
<td>0.115</td>
<td>0.0893</td>
</tr>
<tr>
<td>Clusters</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in these regressions is a dummy variable that takes value 1 if a woman reports ever having had a terminated pregnancy prior to survey date. Panel A reports coefficients and standard errors are for the term $\beta$ in regression (1) excluding Malawi. Panel B reports coefficients and standard errors are for the term $\beta$ in regression (E.1). Controls include fixed effects for marital status and educational attainment. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, *p<0.1
Table C.5: Changes in Postpartum Outcomes With Controls

Panel A: 1-12 Months Post-Birth

<table>
<thead>
<tr>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breastfeeding</td>
<td>Postpartum Abstinence</td>
</tr>
<tr>
<td>Post Inj</td>
<td>-0.0003</td>
</tr>
<tr>
<td>(0.0099)</td>
<td>(0.0183)</td>
</tr>
<tr>
<td>Obs.</td>
<td>259,657</td>
</tr>
<tr>
<td>Mean</td>
<td>0.968</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
</tr>
</tbody>
</table>

Panel B: 13-24 Months Post-Birth

<table>
<thead>
<tr>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breastfeeding</td>
<td>Postpartum Abstinence</td>
</tr>
<tr>
<td>Post Inj</td>
<td>0.0188</td>
</tr>
<tr>
<td>(0.0177)</td>
<td>(0.0127)</td>
</tr>
<tr>
<td>Obs.</td>
<td>80,915</td>
</tr>
<tr>
<td>Mean</td>
<td>0.765</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in these regressions is a dummy variable that takes value 1 if a woman reports that she is breastfeeding, abstaining, or experiencing amenorrhea or the postpartum protection period in a given month post-birth. All coefficients and standard errors are for the term $\beta$ in regression (E.2). Panel A reports treatment effects for the first 12 months post-birth. Panel B reports treatment effects for the second 12 months post-birth. All regressions include as controls fixed effects for marital status and educational attainment. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, *p<0.1
Table C.6: Changes in Postpartum Outcomes Excluding Malawi

Panel A: 1-12 Months Post-Birth

<table>
<thead>
<tr>
<th>Post Inj</th>
<th>Breastfeeding</th>
<th>Postpartum Abstinence</th>
<th>Postpartum Amenorrhea</th>
<th>Postpartum Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Areas</td>
<td>-0.0080</td>
<td>-0.0381</td>
<td>-0.0419**</td>
<td>-0.0392**</td>
</tr>
<tr>
<td></td>
<td>(0.0171)</td>
<td>(0.0264)</td>
<td>(0.0194)</td>
<td>(0.0157)</td>
</tr>
<tr>
<td>Urban Areas</td>
<td>-0.0345</td>
<td>-0.0299</td>
<td>-0.0621**</td>
<td>-0.0485*</td>
</tr>
<tr>
<td></td>
<td>(0.0234)</td>
<td>(0.0296)</td>
<td>(0.0241)</td>
<td>(0.0244)</td>
</tr>
<tr>
<td>Obs.</td>
<td>142,619</td>
<td>192,765</td>
<td>192,765</td>
<td>192,765</td>
</tr>
<tr>
<td>Mean</td>
<td>0.968</td>
<td>0.588</td>
<td>0.786</td>
<td>0.860</td>
</tr>
<tr>
<td>Clusters</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

Panel B: 13-24 Months Post-Birth

<table>
<thead>
<tr>
<th>Post Inj</th>
<th>Breastfeeding</th>
<th>Postpartum Abstinence</th>
<th>Postpartum Amenorrhea</th>
<th>Postpartum Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Areas</td>
<td>0.0211</td>
<td>-0.0608**</td>
<td>-0.0928***</td>
<td>-0.1141***</td>
</tr>
<tr>
<td></td>
<td>(0.0233)</td>
<td>(0.0234)</td>
<td>(0.0280)</td>
<td>(0.0317)</td>
</tr>
<tr>
<td>Urban Areas</td>
<td>-0.0705</td>
<td>0.0155</td>
<td>-0.0614**</td>
<td>-0.0457</td>
</tr>
<tr>
<td></td>
<td>(0.0420)</td>
<td>(0.0434)</td>
<td>(0.0257)</td>
<td>(0.0357)</td>
</tr>
<tr>
<td>Obs.</td>
<td>43,863</td>
<td>59,843</td>
<td>59,843</td>
<td>59,843</td>
</tr>
<tr>
<td>Mean</td>
<td>0.753</td>
<td>0.138</td>
<td>0.316</td>
<td>0.387</td>
</tr>
<tr>
<td>Clusters</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

Notes: The dependent variable in these regressions is a dummy variable that takes value 1 if a woman reports that she is breastfeeding, abstaining, or experiencing amenorrhea or the postpartum protection period in a given month post-birth. All coefficients and standard errors are for the term $\beta$ in regression (E.2) excluding Malawi. Panel A reports treatment effects for the first 12 months post-birth. Panel B reports treatment effects for the second 12 months post-birth. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, *p<0.1
<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.0131*</td>
<td>0.0202***</td>
<td>-0.0040</td>
</tr>
<tr>
<td></td>
<td>(0.0069)</td>
<td>(0.0059)</td>
<td>(0.0083)</td>
</tr>
<tr>
<td>Obs.</td>
<td>350,957</td>
<td>221,332</td>
<td>129,625</td>
</tr>
<tr>
<td>Mean</td>
<td>0.206</td>
<td>0.228</td>
<td>0.167</td>
</tr>
<tr>
<td>Clusters</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>0.0168*</td>
<td>0.0230**</td>
<td>0.0023</td>
</tr>
<tr>
<td></td>
<td>(0.0080)</td>
<td>(0.0082)</td>
<td>(0.0074)</td>
</tr>
<tr>
<td>Obs.</td>
<td>294,177</td>
<td>181,212</td>
<td>112,965</td>
</tr>
<tr>
<td>Number of Women</td>
<td>31,356</td>
<td>19,185</td>
<td>12,171</td>
</tr>
<tr>
<td>Mean</td>
<td>0.206</td>
<td>0.230</td>
<td>0.168</td>
</tr>
<tr>
<td>Clusters</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

**Notes:** The dependent variable in all regressions is an indicator variable that takes value 1 if a woman reports having a live birth in a given month. **Panel A** reports coefficients and standard errors for $\beta$ in regression (1) excluding Malawi. Controls include fixed effects for educational attainment, for ever having been married in a given year, and for parity in a given year. **Panel B** reports coefficients and standard errors for $\beta$ in regression (3) excluding Malawi. Controls include fixed effects for whether or not a woman has ever been married in a given year and fixed effects for parity in a given year. All standard errors are clustered at the region level. *** p<0.01, ** p<0.05, * p<0.1
Table C.8: Fertility Responses Using A Paired Regression Specification

### Panel A: Across-Women Fertility Responses

<table>
<thead>
<tr>
<th>Post Inj</th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0193** (0.0071)</td>
<td>0.0217*** (0.0059)</td>
<td>0.0264*** (0.0064)</td>
</tr>
<tr>
<td>Obs.</td>
<td>430,963</td>
<td>430,705</td>
<td>320,662</td>
</tr>
<tr>
<td>Mean</td>
<td>0.208</td>
<td>0.208</td>
<td>0.224</td>
</tr>
<tr>
<td>Clusters</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

### Panel B: Within-Woman Fertility Responses

<table>
<thead>
<tr>
<th>Post Inj</th>
<th>0.0202** (0.0076)</th>
<th>0.0373*** (0.0099)</th>
<th>0.0290*** (0.0080)</th>
<th>0.0596*** (0.0116)</th>
<th>0.0085 (0.0094)</th>
<th>0.0294** (0.0132)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obs.</td>
<td>339,888</td>
<td>339,888</td>
<td>247,188</td>
<td>247,188</td>
<td>92,700</td>
<td>92,700</td>
</tr>
<tr>
<td>Number of Women</td>
<td>36,127</td>
<td>36,127</td>
<td>26,073</td>
<td>26,073</td>
<td>10,054</td>
<td>10,054</td>
</tr>
<tr>
<td>Mean</td>
<td>0.208</td>
<td>0.208</td>
<td>0.226</td>
<td>0.226</td>
<td>0.162</td>
<td>0.162</td>
</tr>
<tr>
<td>Clusters</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

**Notes:** The dependent variable in all regressions is an indicator variable that takes value 1 if a woman reports having a live birth in a given month. Panel A reports coefficients and standard errors for $\beta$ in regression (E.1). Controls include fixed effects for educational attainment, for ever having been married in a given year, and for parity in a given year. Panel B reports coefficients and standard errors for $\beta$ in regression (3) adapted so that the time fixed effects are interacted with effects for the three region zones (Western, Eastern, and Southern). Controls include fixed effects for whether or not a woman has ever been married in a given year and fixed effects for parity in a given year. All standard errors are clustered at the region level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$
The graphs plot coefficients for $\gamma_{it}^{zsa}$ from regression specification (2). The dependent variable is an indicator variable that takes value 1 if a woman reports wanting another child at survey date. All coefficients are shifted upward by the fraction of women who report wanting another child at survey date in sample $zsa$ during the first time period 1990-95 to capture differences in baseline desire by sample. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{zsa}^{\text{co}}$ from regression specification (2). The dependent variable is an indicator variable that takes value 1 if a woman reports wanting no more children at survey date. All coefficients are shifted upward by the fraction of women who report wanting no more children at survey date in sample $zsa$ during the first time period 1990-95 to capture differences in baseline desire by sample. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{zsa}^{t}$ from regression specification (2). The dependent variable is a variable measuring women’s self-reported completed years of schooling. All coefficients are shifted upward by the mean years of schooling completed by survey date by women in sample $zsa$ during the first time period 1990-95 to capture differences in baseline education by sample. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
D.2 Event Studies for Method Mix Results

Figure D.4: Event Studies for Injectable Use Across Age Groups Among Modern Contraceptive Users

The graphs plot coefficients for \( \gamma_{zs}^{\text{sa}} \) from regression specification (2) restricted to the sample of women using modern contraceptives at interview date. All coefficients are shifted upward by the average injectable use among modern contraceptive users in sample \( zs \) during the first time period 1990-95 to capture differences in baseline usage by sample. The dependent variable in specification (2) is an indicator variable that takes value 1 if a woman is using injectables at survey date. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{i}^{zsa}$ from regression specification (2) restricted to the sample of women using modern contraceptives at interview date. All coefficients are shifted upward by the average condom use among modern contraceptive users in sample $zsa$ during the first time period 1990-95 to capture differences in baseline usage by sample. The dependent variable in specification (2) is an indicator variable that takes value 1 if a woman is using condoms at survey date. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{zsa}^{\text{pill}}$ from regression specification (2) restricted to the sample of women using modern contraceptives at interview date. All coefficients are shifted upward by the average pill use among modern contraceptive users in sample $zsa$ during the first time period 1990-95 to capture differences in baseline usage by sample. The dependent variable in specification (2) is an indicator variable that takes value 1 if a woman is using birth control pills at survey date. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
D.3 Event Studies for Traditional Methods of Fertility Control

Figure D.7: Event Studies for Coital Frequency for Women 15-44

The graphs plot coefficients for $\gamma_{t \cdot \cdot s \cdot a}$ from regression specification (2). The dependent variable in specification (2) is an indicator variable that takes value 1 if a woman reports having had sexual intercourse during the week prior to survey. All coefficients are shifted upward by the fraction of women reporting sexual intercourse during the past week in sample $zsa$ in the first time period 1990-95 to capture differences in baseline coital frequency by sample. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{zt}^{zsa}$ from regression specification (2). The dependent variable in specification (2) is an indicator variable that takes value 1 if a woman reports ever having had a terminated pregnancy at survey date. All coefficients are shifted upward by the fraction of women reporting a terminated pregnancy in sample $zsa$ in the first time fixed effect 2000-2004 to capture differences in baseline usage by sample. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{zsa}^{t}$ from an event-study version of regression specification (E.2) that omits our treatment variable. The dependent variable is an indicator variable that takes value 1 if a woman reports postpartum abstaining in a given month post-birth. All coefficients are shifted upward by the fraction of women reporting that they are abstaining in sample $zsa$ in 1996 to capture differences in baseline usage by sample. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma^{zsa}_t$ from an event-study version of regression specification (E.2) that omits our treatment variable. The dependent variable is an indicator variable that takes value 1 if a woman reports postpartum abstaining in a given month post-birth. All coefficients are shifted upward by the fraction of women reporting that they are abstaining in sample $zsa$ in 1996 to capture differences in baseline usage by sample. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{za}$ from an event-study version of regression specification (E.2) that omits our treatment variable. The dependent variable is an indicator variable that takes value 1 if a woman reports experiencing amenorrhea in a given month post-birth. All coefficients are shifted upward by the fraction of women reporting that they are amenorrheic in sample $za$ in 1996 to capture differences in baseline usage by sample. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{zsa}^{t}$ from an event-study version of regression specification (E.2) that omits our treatment variable. The dependent variable is an indicator variable that takes value 1 if a woman reports experiencing amenorrhea in a given month post-birth. All coefficients are shifted upward by the fraction of women reporting that they are amenorrheic in sample $zsa$ in 1996 to capture differences in baseline usage by sample. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{zsa}$ from an event-study version of regression specification (E.2) that omits our treatment variable. The dependent variable is an indicator variable that takes value 1 if a woman reports that she is either abstaining or amenorrheic in a given month post-birth. All coefficients are shifted upward by the fraction of women reporting that they are either abstaining or amenorrheic in sample $zsa$ in 1996 to capture differences in baseline usage by sample. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
Figure D.14: Event Studies for Postpartum Protection Period During 13-24 Months Post-Birth

The graphs plot coefficients for $\gamma_{zt}^{zsa}$ from an event-study version of regression specification (E.2) that omits our treatment variable. The dependent variable is an indicator variable that takes value 1 if a woman reports that she is either abstaining or amenorrheic in a given month post-birth. All coefficients are shifted upward by the fraction of women reporting that they are either abstaining or amenorrheic in sample $zsa$ in 1996 to capture differences in baseline usage by sample. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
D.4 Event Studies for Fertility Results

Figure D.15: Event Studies for Flow Fertility For Women 15-24

The graphs plot coefficients for $\gamma_{izsa}^{t}$ from regression specification (2). All coefficients are shifted upward by the mean probability of giving birth in sample $zsa$ in the first year 1985 to capture differences in baseline usage by sample. The dependent variable in specification (2) is an indicator variable that takes value 1 has a live birth in a given year. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_{i,zsa}^t$ from regression specification (2). All coefficients are shifted upward by the mean probability of giving birth in sample $zsa$ in the first year 1985 to capture differences in baseline usage by sample. The dependent variable in specification (2) is an indicator variable that takes value 1 has a live birth in a given year. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_i^{za}$ from regression specification (2). All coefficients are shifted upward by the mean probability of giving birth in sample $zsa$ in the first year 1985 to capture differences in baseline usage by sample. The dependent variable in specification (2) is an indicator variable that takes value 1 has a live birth in a given year. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
The graphs plot coefficients for $\gamma_s^z$ from regression specification (3). All coefficients are shifted upward by the mean probability of giving birth in sample $zs$ in the first year 1985 to capture differences in baseline usage by sample. The dependent variable in specification (4) is an indicator variable that takes value 1 has a live birth in a given year. The left-most vertical red line corresponds to the 1992 legalization of injectable contraceptives in countries surrounding Zambia. The right-most vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
E Supplementary Analysis

E.1 Paired region regression specification

We estimate paired region regression specification by excluding Zambian regions bordering only the Congo, matching the remaining regions on either side of the Zambian border into three zones, and interacting the time fixed effects in specification (I) with indicator variables for our zones. Formally, the paired region regression specification is:

\[ y_{irsapt} = \alpha + \beta T_{ir} + \delta_{sar} + \gamma_{sapt} + \xi X_{irsapt} + \varepsilon_{irsapt} \]  

(E.1)

where \( i \) indexes individuals, \( r \) indexes regions, \( s \) indexes urbanity, \( a \) indexes age group, \( p \) indexes zone, and \( t \) indexes time. Identification for \( \beta \) is now additionally constrained to come from comparisons between pairs of women in the same zone, unlike in specification (I). The three paired region zones correspond to a Western zone, a Southern zone, and an Eastern zone. All other categories and controls are the same as in (I).

E.2 Postpartum variables regression specification

On our postpartum panel, we estimate:

\[ y_{irsamt} = \alpha + \beta T_{rt} + \delta_{sar} + \gamma_{sat} + \lambda_{sam} + \xi X_{irsamt} + \varepsilon_{irsamt} \]  

(E.2)

where \( i \) indexes individuals, \( r \) indexes region, \( s \) indexes sector, \( a \) indexes age-group, \( m \) indexes months since birth, and \( t \) indexes time (year-month). For each of the postpartum outcomes we study, the dependent variable is an indicator variable taking value one in a given month since birth if a woman is still experiencing that postpartum outcome. The treatment variable, time and space fixed effects, and individual controls are the same as in specification (I). We interact fixed effects for months since birth with fixed effects for sector and age-group to flexibly control for different hazard rates for women in different age groups and sector. We assess the validity of the parallel trends assumption by providing
event studies for postpartum variables using a modified version of specification (2) that similarly controls for months since live birth.

As questions on the durations of postpartum variables are only asked of live births during a 5-6 year window prior to survey date, when examining postpartum behaviors during the first year (two years) post-birth, we must omit the first year (two years) of the survey window to ensure that every time fixed effect includes observations for women in each month since last birth. Our regression samples consist of all information from 1996–2010, excluding the relevant portions of the survey window and excluding times for which information from at least four control group countries is missing due to non-synchronous survey rounds.

E.3 Birthspacing regression specification

We assess the impact of injectable legalization on birth-spacing using the following specifications on our birth-spacing panel:

\[ y_{irsamt} = \alpha + \beta T_{rt} + \delta_{sar} + \gamma_{sat} + \tau_{sam} + \xi X_{irsamt} + \varepsilon_{irsamt} \]  
\[ y_{isbmt} = \alpha + \beta T_{rt} + \gamma_{st} + \lambda_{b} + \tau_{m} + \xi X_{isbmt} + \phi_{i} + \varepsilon_{isbmt} \]  

where \( i \) indexes individuals, \( r \) indexes region, \( s \) indexes sector, \( a \) indexes age-group, \( b \) indexes age in years, \( m \) indexes month since last birth, and \( t \) indexes time (year-month). We estimate our birth-spacing specifications separately for each of the seven years following a live birth.\(^{58}\) The dependent variable in both specifications is an indicator taking value one if a woman reports a live birth in a given month. As birth-spacing is a duration outcome, we flexibly control for months since last birth (interacted with fixed effects for sector and age group in specification \((E.3)\)) to control for hazard rates. The treatment variable, fixed effects, and controls are all identical to specifications \((1)\) and \((3)\). Identification of \( \beta \) in both specifications is analogous to our identification when studying flow fertility, with

\(^{58}\text{We assume that women cannot have a subsequent birth during the nine months immediately following a live birth. Hence, the first “year” after a live birth corresponds to 9–20 months post-birth, etc.}\)
specification (E.3) using both across-women and within-woman variation to identify $\beta$, and specification (E.4) using only within-woman variation.

### E.4 Changes in the Intensive Margin of Abortion Use

We utilize information from contraceptive calendars and birth histories to construct a pregnancy panel that records pregnancies borne by a woman during the 5-6 years prior to survey date. This dataset includes information on whether each pregnancy resulted in a live birth or was terminated.\footnote{Terminated pregnancies include abortions, miscarriages, and stillbirths.} Terminated pregnancies are underreported\footnote{For example, miscarriages that occur during the first trimester are often under-reported as respondents may not realize they are pregnant at the time of miscarriage and the miscarriage presents as a delayed, severe menstrual cycle. Similarly, abortions may be under-reported due to stigma.} and the pregnancy panel includes only a subset of all pregnancies experienced by interviewed women during the 5-6 years prior to survey.

We use our pregnancy panel to study whether the fraction of pregnancies reported as terminated changes in response to improved contraceptive access. The contraceptive calendar information used to construct our pregnancy panel contains substantial recall error: plotting the time trend for the fraction of pregnancies reported as terminated while controlling flexibly for region and age yields a distinct sawtooth pattern (see Figure E.1). To address this, we estimate a specification similar to (1) that flexibly accounts for recall error:

\[
y'_{irsadt} = \alpha + \beta T_{rt} + \delta_{sar} + \gamma_{sat} + \lambda_{sad} + \xi X_{irsadt} + \varepsilon_{irsadt}
\]  
(E.5)

where $i$ indexes individuals, $r$ indexes region, $s$ indexes sector, $a$ indexes age group, $d$ indexes recall year, and $t$ indexes year. The dependent variable is an indicator variable taking value one if a women reports a given pregnancy as resulting in a termination. The treatment variable, time and space fixed effects, and individual-level controls are the same as in specification (1). We measure recall year as years to date of survey, and exploit staggered months of survey within each survey round to include fixed effects for both recall year and year.\footnote{For example, a woman interviewed in June of 2007 will be in her first recall year from July 2006 - June}
group to flexibly control for different recall patterns by sector and age-group. We restrict our regression sample to pregnancies during 2002-2007, years corresponding to the recall period for the 2007 Zambian DHS round, to examine changes in the intensive margin of terminated pregnancies in a window with three years of information prior to injectable legalization and three years of information after injectable legalization.

Figure 1: Recall Effects in Contraceptive Calendar

The graphs plot coefficients on year fixed effects from regression specification (2) for the urban and rural sectors in Zambia, pooling across age groups. All coefficients are shifted upward by the mean probability of reporting a terminated pregnancy in a given sector in 1996. The dependent variable is an indicator variable taking value one if a pregnancy was reported as terminated. The three vertical red lines correspond to the three survey years in Zambia for which we have information on terminated pregnancies.

2007, in her second recall year from July 2005 - June 2006, etc.
### Table E.1: Changes in Flow Abortion Use During 2002-2007

<table>
<thead>
<tr>
<th></th>
<th>All Areas</th>
<th>Rural Areas</th>
<th>Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Inj</td>
<td>-0.0568</td>
<td>-0.0961**</td>
<td>0.1888</td>
</tr>
<tr>
<td></td>
<td>(0.0330)</td>
<td>(0.0351)</td>
<td>(0.2128)</td>
</tr>
<tr>
<td></td>
<td>-0.0632+</td>
<td>-0.1003***</td>
<td>0.1616</td>
</tr>
<tr>
<td></td>
<td>(0.0307)</td>
<td>(0.0340)</td>
<td>(0.1750)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,962</td>
<td>3,230</td>
<td>732</td>
</tr>
<tr>
<td>Mean</td>
<td>0.318</td>
<td>0.298</td>
<td>0.407</td>
</tr>
<tr>
<td>Clusters</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Controls</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

**Notes:** The dependent variable in these regressions is an indicator variable that takes value 1 if a woman reports ever having had a terminated pregnancy (miscarriage, stillbirths, and abortions) at survey date. The reported coefficient and standard errors are for the term $\beta$ in regression (1). All standard errors are clustered at the region level. *** $p<0.01$, ** $p<0.05$, + $p<0.1$
Figure E.2: Event Studies for Terminated Pregnancies Using Contraceptive Calendar Information

The graphs plot coefficients for $\gamma_z^{s_a}$ from regression specification (2) adapted to include controls for recall year. All coefficients are shifted upward by the mean probability of reporting a terminated pregnancy in sample $zsa$ in the first time fixed effect 2000-2004 to capture differences in baseline usage by sample. The dependent variable is an indicator variable that takes value 1 if a woman reports ever having had a terminated pregnancy at survey date. The vertical red line corresponds to the 2004 legalization of injectable contraception in Zambia.
## Data Appendix

[More to come!]

Table F.1: Criterion for Legal Abortions

<table>
<thead>
<tr>
<th>Abortions Legal for:</th>
<th>Zambia</th>
<th>Tanzania</th>
<th>Malawi</th>
<th>Mozambique</th>
<th>Zimbabwe</th>
<th>Namibia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk to life</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Physical Health</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Mental Health</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Rape/Incest</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Fetal Impairment</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Socioeconomic Grounds</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>By choice</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

Criterion taken from the UN.