The Power to Protect: Household Bargaining and Female Condom Use[*]

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Abstract: Women may face systematically greater benefits than men from adopting certain technologies, as a result of gender differences in preferences or costs of non-adoption. Yet women commonly hold lower bargaining power, implying that men's preferences may constrain household adoption when decisions are joint. If neither female bargaining power nor male preferences can be easily changed, introducing a version of the technology that is second-best in terms of cost or effectiveness, but more acceptable to men, may increase adoption and welfare. We conduct a field experiment introducing female condoms – which are less effective and more expensive than male condoms, but often preferred by men – in a setting with high HIV prevalence. We find strongest adoption of female condoms among women with lower bargaining power, who were previously having unprotected sex, and observe an increase in the likelihood that women have sex.

JEL classification: C78, O33, C93, J16, I12

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1 Introduction

The costs and benefits of adopting household technologies may differ systematically across genders. There is evidence that women have a stronger preference for risk reduction (Agnew et al., 2008; Eckel and Grossman, 2008), investment in children's education (Duflo, 2003), and investment in health via nutritious food (Duflo and Udry, 2004; Attanasio and Lechene, 2014). Women may also bear more of the costs of technology non-adoption, through responsibility for domestic chores, caring duties, and greater exposure to certain health and safety risks. If a technology can be adopted unilaterally, for example the pill or concealable contraceptives, then even women with lower bargaining power may be able to adopt (Goldin and Katz, 2002; Ashraf et al., 2014b). When adoption of a technology requires agreement between partners, intra-household bargaining matters, and men's preferences may constrain household adoption. Examples include improved cookstoves (Miller and Mobarak, 2013), private latrines, anti-malarial bednets, and condoms. One way to increase adoption may be to target men's preferences (Stopnitzky, 2017; Miller et al., 2020), although this can prove difficult (Creese et al., 2002). Another option is to increase women's bargaining power directly (Bandiera et al., 2015; Ashraf et al., 2017), or via giving women control of income from government safety nets (Field et al., 2019). A substantial proportion of women, however, will continue to have lower bargaining power than their male partner in the absence of broader changes in labour and marriage markets. In contexts where lower female bargaining power and male preferences continue to constrain adoption, a second-best solution may be to introduce a variant of the technology that is more acceptable to men, even if less effective or more costly.

We propose and test this idea, using a field experiment in Maputo Province, Mozambique. We study adoption of condoms: a technology which is observable to both parties and hence requires joint adoption;[1] but where women face higher costs from non-adoption, via higher risk of contracting HIV (in this context) and unwanted pregnancy.[2]

[1] Female condoms can be inserted by women prior to intercourse, but remain observable.

[2] In 2015, women accounted for 59% of all individuals aged 15 and over living with HIV in Sub-Saharan Africa, and the rate of new infections among young women aged 15-24 was double that among young men (UNAIDS, 2016a). Reasons for this gender disparity include that women tend to have older partners, lower access to sexual and reproductive health services, and a higher biological risk than men of becoming infected from heterosexual intercourse (UNAIDS, 2016b).

We examine how intra-household bargaining affects adoption of female condoms when they are introduced, in a setting where only male condoms are available. Female condoms are second-best insofar as they have lower effectiveness than male condoms[3] and higher unit cost.[4]However, female condoms are viewed by men in particular as more comfortable and less stigmatising than male condoms (Philpott et al., 2006; Wanyenze et al., 2011; Koster et al., 2015). We show that women with lower bargaining power — many of whom are unable to convince their partners to use male condoms at baseline — convince their partners to adopt female condoms when they are made freely available. An illustrative cost-benefit analysis shows that this could lead to free provision of female condoms being cost-effective; but that this result is sensitive to a behavioural response that we observe: namely, an increase in the number of sex acts.

Condoms are an important technology from a public health perspective, as they are the only well-established protection against HIV/AIDS and other sexually transmitted infections (STIs) if one is sexually active. Condoms exemplify technologies where adoption is partially or fully observable within the household, agreement of both partners is needed to ensure sustained and proper use, and hence bargaining may constrain adoption. Indeed there is evidence that women struggle to convince their partners to use male condoms (Anderson, 2018), helping to explain their persistent under-adoption.[5] An estimated 3.3 billion risky sex acts took place without condoms in Sub-Saharan Africa in 2015, leading to 910,000 new HIV infections (UNAIDS, 2016a). Condoms are also a particularly good technology for studying the implications of introducing a second-best version of a technology. This is because existing epidemiological models of HIV transmission allow us to quantify the potential trade-offs between improving condom coverage and decreasing average effectiveness — as well as behavioural responses

[3]In ordinary use, female condoms have 79% effectiveness at preventing pregnancy in the first year, while male condoms are 85% effective (Farr et al., 1994; Trussell, 2011; Beksinska et al., 2012).

[4]The unit production cost for female condoms at current volumes is \$0.57, compared to \$0.03 for male condoms (Mantell et al., 2015). There is currently a monopoly on the production of WHO-approved female condoms, and consequent low production volumes (Peters et al., 2010). Lower-cost female condoms have been developed in India and approved by the EU, but are still awaiting WHO approval (*ibid.*). Costs would likely substantially decrease at a larger scale of production (Dowdy et al., 2006); although female condoms will likely remain more expensive, because of higher input costs due to their larger size compared to male condoms.

[5]We refer here to under-adoption from the perspective of a social planner who cares about costs and effectiveness of protection against HIV/AIDS.

such as increases in the frequency of sex acts — while taking into account the negative externalities from HIV transmission.

We evaluate a condom programme in the slums of Maputo, Mozambique. The programme seeks to increase condom use by offering female condoms alongside male condoms. Women attend a series of group sessions that provide information about contraceptives, including female condoms. Female condoms are also added to the set of products carried by local health workers — which already includes male condoms — that participants can access freely and discreetly at the end of each session. The intervention thus allows us to study which women, if any, adopt female condoms when informational, access, and price constraints are alleviated. Importantly, free provision allows us to study couples' willingness to adopt unconfounded by their ability to pay, which may be correlated with female bargaining power. Free provision is also arguably the most relevant policy option in countries with high HIV/AIDS prevalence, where male condoms are typically already provided for free by the government.

We conduct a randomised control trial to assess the short-run impacts of the programme on women who were assigned to receive it at the end of 2014, compared to those who were assigned to receive it six months later. In addition to baseline and endline data, we collect weekly sexual diary data for a subsample of the women. This allows us to investigate impacts at the sex-act level, including effects on the frequency of sex acts. To measure bargaining power, we use two different survey modules covering decision-making and power dynamics in the relationship (Donald et al., 2017).

To formalise our predictions, we introduce a collective model of the household, where partners jointly decide whether to adopt STI protection technologies. Both men and women value the levels of pleasure and of health protection associated with different technologies. However, for the reasons outlined above, we argue that the marginal rate of substitution between pleasure and health is greater for men than for women. When the only STI protection technologies available are male condoms or unprotected sex,[6] the model predicts that women may prefer to use male condoms, but that those with lower bargaining power may be unable to convince their partners to do so. When female condoms — an intermediate technology with lower health but higher pleasure than male condoms — are introduced, the model predicts two effects. First, while women with the

[6] This includes sex protected by pure contraceptives such as the pill, but not by an STI protection method; see Section 2 for details.

lowest bargaining power may still not be able to use condoms, women with intermediate bargaining power may adopt female condoms. While women with the lowest bargaining power will still not be able to convince their partner to use condoms, some women with intermediate bargaining power, who were previously having unprotected sex, may now be able to convince their partners to adopt female condoms (but not male condoms), increasing condom coverage. At the same time, some women with intermediate bargaining power who were previously using male condoms may also substitute into using female condoms, decreasing average condom effectiveness. The relative magnitudes of the margin of switching from male condoms to female condoms and the margin of switching from unprotected sex to female condoms depend on how "close" the technologies are, as well as the distribution of preferences and bargaining power. These magnitudes are important to determine empirically, in order to establish total effects on transmission of HIV/AIDS and other STIs. Second, on the margin of whether couples have sex or not, some couples who were previously not having sex now have sex with female condoms.

The results show a large impact of treatment on female condom use: an increase of 18.4 percentage points in the proportion of women who have ever used female condoms, and of 7.7 percentage points in the proportion of those currently using female condoms, compared to baseline means of 8.8% and 2.0% respectively. Reassuringly for our intervention, and for interventions providing female condoms in similar contexts, we see no significant evidence of substitution away from male condoms. As predicted by the model, adoption of female condoms is driven by women with intermediate baseline bargaining power, who are having unprotected sex at baseline. On the extensive margin, the diary data show that treatment leads to an increase of 9.1 percentage points in the probability that a woman has sex each week. We rule out various alternative explanations for the heterogeneous treatment effect by bargaining power, including experimenter demand effects, or that baseline bargaining power may be proxying physical access to male condoms, baseline use of other contraceptives, HIV status, or beliefs about partner fidelity.

Given that this is a second-best technology, a social planner whose primary concern is the cost and effectiveness of these technologies should weigh the observed increase in condom coverage against the increase in production and distribution costs, and the reduction in average condom effectiveness; as well as the observed increase in the likelihood of sex acts, which may also increase disease transmission.[7] To demonstrate the potential magnitude of these trade-offs, we conduct an illustrative exercise in which we estimate the costs and benefits of scaling up access to female condoms to all of Southern Mozambique, focusing solely on the benefits in terms of reduced HIV transmissions and the costs in terms of providing anti-retrovirals, drugs for prevention of mother-to-child transmission, and productivity losses. In our naïve scenario, before accounting for the behavioural response (i.e. the observed increase in sex acts), both our full programme and adding female condoms to existing sex education programmes are cost-effective. Intuitively, this is because low female bargaining power implies that the main margin of female condom adoption is from women previously having unprotected sex, rather than substitution away from male condoms. However, once we account for the increase in sex acts, only adding female condoms to existing sex education programmes has the potential to be cost-effective. These illustrative simulations thus show how behavioural responses may partially offset direct benefits of a programme (Greenwood et al., 2017).

Regarding our contribution to the literature on contraceptive technologies, to our knowledge this is the first experimental study explicitly to consider how intra-household bargaining may constrain adoption of condoms. The existing literature on bargaining within couples focuses on fertility (Eswaran, 2002), and emphasises limited commitment or imperfect information (Rasul, 2008; Ashraf et al., 2014b). In contrast, we emphasise bargaining over STI protection, where use of the technology is fully observable and potentially negotiated each time. Gertler et al. (2005) model bargaining over male condom use, between female sex workers and male clients in Mexico, as a finite-horizon, non-cooperative interaction mediated by price. Our contribution is to model bargaining over condoms within the collective household model, capturing the efficiency arising from the repeated household bargaining process that takes place within couples.

Our study also highlights female condoms as a way to reduce HIV transmission in the presence of male resistance to male condoms and low female bargaining power. Numerous studies have examined the effects of information interventions which attempt to change preferences or beliefs, or incentive interventions which attempt to change risky

[7]Given that the negative health effects and externalities of unprotected sex are large in the context of our study, it is reasonable to assume that these are the social planner's first-order concern. We hence abstract from quantifying individuals' pleasure from using different types of condoms and from the increase in sex acts.

sexual behaviour directly (see, for example, Thornton (2008); Dupas (2011); De Walque et al. (2012); Baird et al. (2012); Bjorkman Nyqvist et al. (2015); Duflo et al. (2015)). Many of these studies focus on young women. In contrast, we highlight the importance of considering male preferences in contexts where men typically hold high bargaining power within couples. Medical studies have shown that introducing female condoms alongside male condoms improves protection rates (Fontanet et al., 1998; Vijayakumar et al., 2006; Coman et al., 2013; Mantell et al., 2015), but have largely overlooked the role of intra-household bargaining. Meanwhile Ashraf et al. (2014a) examine the effect of incentives on agents selling female condoms, but do not study impacts on end users.

More broadly, we contribute to a literature examining the relationship between intra-household bargaining and technology adoption, such as in the form of cookstoves (Miller and Mobarak, 2013; Mohapatra and Simon, 2017), savings accounts (Schaner, 2015), saving through ROSCAs (Anderson and Baland, 2002) and microfinance (Van Tassel, 2004). To our knowledge, we are the first explicitly to model and estimate the trade-offs inherent in introducing a second-best technology, when low female bargaining power constrains adoption of the first-best technology.

2 Theoretical framework

In this section we introduce a simple model of intra-household bargaining over STI protection technologies. We abstract from pure contraceptive technologies such as the pill, since these are not close substitutes for STI protection methods in contexts with high HIV prevalence and/or where concurrency is high even in stable partnerships. Our study setting is one such context, as are many settings targeted by programs promoting (male or female) condom use. We use the model to formalise three main predictions about what will happen when female condoms are made freely available, in a context where male condoms are already readily and freely available. First, while women with the lowest bargaining power will still not be able to adopt any type of condoms, some women with intermediate bargaining power who were previously having unprotected sex may adopt female condoms. Second, while women with the highest bargaining power will continue to use male condoms, some women with intermediate bargaining power who were previously using male condoms may switch to using female condoms. Third, the availability of female condoms will increase the probability that couples have sex.[8]

Preferences: Consider a population of heterosexual couples each consisting of a male m and a female f. When considering the choice of STI protection technology, individual i has preferences over the levels of pleasure (P) and health (H) that the technology yields on average to the population, $u_i(P,H)$, which is quasi-concave and increasing in each argument. For example, P may include the average level of discomfort associated with the material used to produce the technology, and H may include the average level of HIV transmission risk provided by the technology. We allow for idiosyncratic and gender-specific heterogeneity in preferences over P and H through the utility functions. For example, an individual may place a larger weight on health if she is particularly risk-averse, or believes that she has a particularly high risk of HIV infection due to her beliefs about her partner's sexual behaviour. However, we assume that on average, couples' preferences satisfy the following single-crossing property:

Assumption 1.

$$\frac{\partial u_m(P,H)/\partial P}{\partial u_m(P,H)/\partial H} > \frac{\partial u_f(P,H)/\partial P}{\partial u_f(P,H)/\partial H} \tag{1}$$

That is, we argue that the marginal rate of substitution between pleasure and health is greater for men than for women. This assumption is motivated by the facts discussed above, that women on average face greater risk of contracting HIV and greater costs from pregnancy than men do, and that men have stronger reported displeasure and stigma from condom use.

Technologies: In general, let the STI protection technology frontier be represented by a continuously-differentiable function $P(H)$ for $H \in \left[\underline{H}, \overline{H}\right]$. By definition of being on the frontier, $P'(H) < 0$, and let $P''(H) \leq 0$ such that the frontier is weakly concave. This is illustrated in Figure 1. In reality, only certain points on the frontier are easily

[8] For ease of representation, we present the model here without the possibility of intra-household transfers – for example, if one partner offers to do more household chores in order to compensate the other partner for a given choice of contraceptive technology. Online Appendix B.1 shows that all of the predictions are robust to generalising the model to allow for transfers, as long as those transfers are not perfectly frictionless: a reasonable assumption if there are utility costs to negotiating transfers, or productivity losses from overriding the usual division of chores within the household.

accessible to couples, depending on the technologies that are readily available.[9] For simplicity, we assume that prior to our intervention, the set of readily-available technologies, unprotected sex (US) and male condoms (MC), is just the binary set of points on the frontier $\{US, MC\}$. This is presented in Panel 1a in Figure 1. We model no sex (abstinence) as an outside option, rather than a technology on the frontier $P(H)$, see below. Male condoms offer greater health than unprotected sex because of their protection against HIV/AIDS and other STIs, but offer lower pleasure.

By introducing female condoms (FC), our treatment expands the set of readily-available technologies to the ternary set of points on the frontier $\{US, FC, MC\}$. As discussed in Section 1, female condoms provide lower effectiveness and thus lower health than male condoms, but are considered more pleasurable especially by men. For both men and women, female condoms hence represent an intermediate option between male condoms and unprotected sex, as shown in Panel 1b in Figure 1. Of course, couples may have initial uncertainty about the pleasure and health associated with female condoms. In what follows we abstract from such uncertainty and consider the permanent adoption decision, once learning has taken place.

Co-operative decision-making: We model decision-making in stable couples, and assume that sex within such couples is voluntary; thus the woman's (as well as the man's) participation constraint is binding.[10] It is reasonable to assume that decision-making over condom use occurs under full information – since use of both male and female condoms is observable by both parties. We can also assume commitment, since in stable couples the decision to use condoms can be thought of as a repeated game with an infinite horizon. It is therefore natural to make the following modelling assumption:

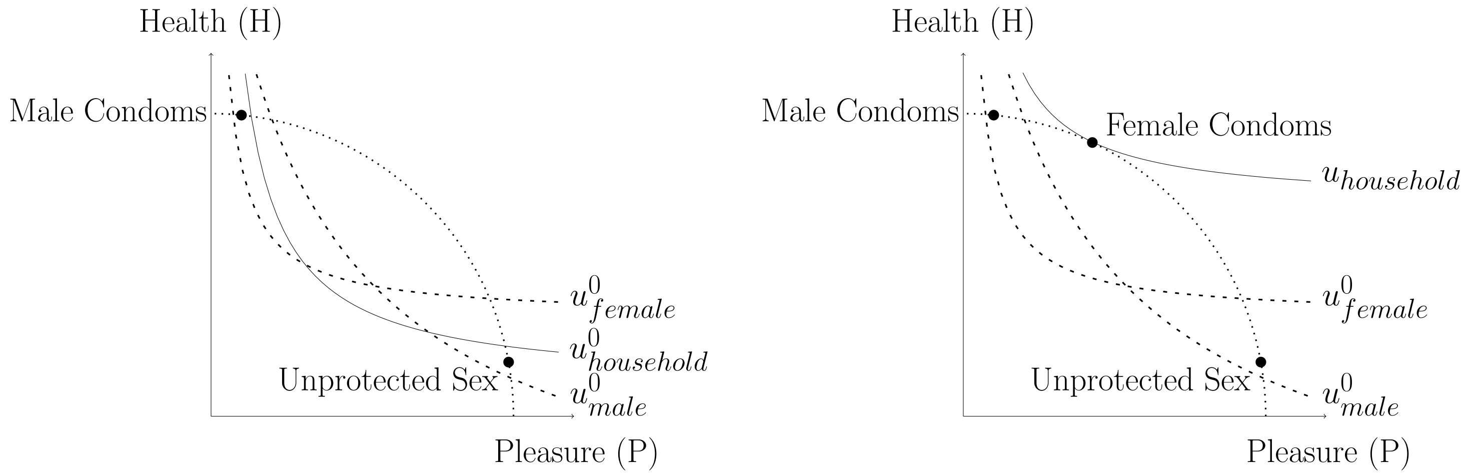
Assumption 2. Decisions over STI protection technologies are taken co-operatively, resulting in choices that are Pareto efficient.

Chiappori (1992) shows that any bargaining process which satisfies these properties can be represented by the collective model, in which the household maximises the

[9] Couples could mix their use of two or more technologies so as to obtain a wider range of points on the frontier. However, as long as there are transaction costs from mixing, couples will prefer to adopt a new technology that yields a given point rather than mixing two other technologies to obtain that point.

[10] Almost all women in our sample (91%) report in the survey that they can refuse sex with their partner.

Figure 1: Intra-household bargaining over STI protection technologies



(a) Before the introduction of female condoms

(b) After the introduction of female condoms

Notes: "STI" stands for sexually transmitted infections. The dotted line is the STI protection technology frontier. The dashed line labelled u^0_{female} represents the reservation utility of the female. The dashed line labelled u^0_{male} represents the reservation utility of the male. The solid line labelled $u^0_{household}$ in panel (a) represents the reservation utility of the household. The solid line labelled $u_{household}$ in panel (b) is the indifference curve of the household that maximizes utility in case female condoms are available.

following utility function

$$V = \alpha u_f \left(P(H), H\right) + (1-\alpha)\, u_m \left(P(H), H\right), \tag{2}$$

where $\alpha \in [0,1]$ is the woman's Pareto weight in the couple's sharing rule (Browning and Chiappori, 1998).[11] The weight α may depend on factors such as the woman's relative contribution to the couple's income and housework, and her options outside of the relationship.

As a simplification, we also assume that the financial and opportunity costs of acquiring any of the technologies is zero, and hence that there is no budget constraint. This is true in our experimental setting, and in most public health programmes, where male and female condoms are made available for free if they are provided.

Intensive margin: It is straightforward to show that as long as Assumption 1 holds, the optimal choice of health is increasing in α. The full proof can be found in Online Appendix B.1. The intuition is simple: if the woman places relatively greater weight on health than the man does, then the more bargaining power she holds, the more the household's choice of STI protection technology will be tilted towards health, and consequently away from pleasure. Given this result, our first prediction follows (again, full proof in Online Appendix B.1):

Proposition 1. Female condoms will be adopted by:

i) women with intermediate bargaining who are previously having unprotected sex;

ii) women with intermediate bargaining power who are previously using male condoms.

Women with low bargaining power will continue to have unprotected sex, and women with high bargaining power will continue to have sex with male condoms.

In terms of the margins of adoption, both couples who were previously having unprotected sex and couples who were previously using male condoms may adopt female

[11] Such a model can accommodate altruistic or "caring" preferences, where each individual's utility function also has the other partner's consumption as an argument. We abstract from this here by making P and H public goods. However, intuitively the predictions below about the relationship between female bargaining power and choice of STI protection technology would hold if pleasure and health were private, as long as both partners' degree of altruism was not perfect.

condoms if this interior option allows them to get closer to their optimal point on the technology frontier. Among the women who are engaging in unprotected sex at baseline, women with relatively higher bargaining power — i.e. intermediate bargaining power compared to the whole population — may take up female condoms. Among women using male condoms at baseline, women with relatively low bargaining power — i.e. intermediate bargaining power compared to the whole distribution — may switch from male to female condoms. The quantitative importance of these margins of adoption will depend on the distribution of preferences and bargaining power in the population, and also on the position of the new and old technologies on the frontier.

Which effect dominates empirically is an important question. If take-up of female condoms mainly comes from women who were engaging in unprotected sex at baseline, then introducing female condoms unambiguously increases rates of protection against HIV/AIDS and other STIs. On the other hand, if female condoms are mainly used as substitutes for male condoms, then offering female condoms will not lead to an increase in condom coverage. In that case, whilst couples who switch to female condoms must be better off in terms of their private utility, the marginal loss of effectiveness is likely to reduce welfare from the perspective of a social planner, given the negative externalities inherent in transmission of HIV and other STIs.

Extensive margin: Let $s \in \{0, 1\}$ indicate the choice of whether to have sex or not. The no-sex option $s = 0$ can be enforced by either partner, and gives reservation utility u_i^0 to each partner. This can be thought of as the utility from partners' best immediate alternative, for example in terms of time use. Along with $s = 1$, partners make a choice of contraception from the available sets as described above.

It is straightforward to see that the introduction of female condoms increases the probability that both couples' reservation utilities are satisifed, and hence that $s = 1$; see Online Appendix B.1 for formal proof. This leads to our second prediction:

Proposition 2. Making female condoms freely available increases the probability that couples have sex.

To illustrate, Figure 1 depicts a couple whose reservation utilities are only both satisfied following the introduction of female condoms.

Note that bargaining power α does not enter a couple's decision as to whether to have sex or not: this extensive-margin decision depends only on individual reservation utilities and preferences over pleasure and health, and the set of readily-available points on the technology frontier.

3 Context and experimental design

3.1 HIV and condom use in Maputo

Our study took place in Matola, which is the capital of Maputo Province and lies approximately 10km west of Maputo City. HIV prevalence in Maputo Province is high and disproportionately so among women, at an estimated 29.6% for women and 15.8% for men (Ministério da Saúde, 2015). Concurrency among men has been identified as a contributing factor, even among men in stable relationships (Macia et al., 2011). Indeed, 85% of the women in our sample are in stable relationships, but of these 36% report believing their partner is "involved" with other people. In such a climate, technologies which protect against transmission of HIV and other STIs are not close substitutes for pure contraceptive technologies such as the pill, and may be used in addition to pure contraceptive technologies. In our baseline sample, 39% of respondents are currently using pure contraceptive methods (mainly the pill or injectables), and of these 40% are also currently using male condoms.

Both male and female condoms are available in Matola, but male condoms are far more accessible. Female condoms are typically only available at health facilities, which women report would take on average 60 minutes to reach, and even there are subject to frequent stock-outs (Pilz, 2014). In contrast, male condoms are readily available, both for free at health facilities and from local health workers, as well as cheaply on the private market. Yet despite the widespread availability of male condoms, there is evidence that men's preferences constrain adoption. Of the women in our study who are currently sexually active but not using any form of protection at baseline, by far the most common reason given is that their partner does not like to or refuses to use male condoms (45% of responses).

3.2 Female condom intervention

Evidence suggests that small-group information and education interventions may be particularly important for promoting female condom use (Terris-Prestholt and Windmeijer, 2016). The intervention we study is run by Pathfinder International, and is aimed at women in populations with high HIV transmission risk. The programme consists of six group sessions lasting ninety minutes each, held fortnightly over a three month period. Pathfinder trains female health workers from the local area to facilitate the programme, and thus facilitators are socially proximal to the participants. The sessions cover: information on male and female condoms and demonstration of their use on pelvic models; information about other contraceptive methods; information on HIV/AIDS and other STIs; discussing consent and contraceptive use, and intimate partner violence and women's rights.[12] Group sizes range from a minimum of five to a maximum of twelve women per facilitator, which are thresholds set by the NGO for creating an environment conducive to discussion. Female condoms are also added to the set of products carried by local health workers — which already include male condoms — that participants can access freely and discreetly at the end of each session.

The intervention thus allows us to study which women — if any — in terms of their bargaining power adopt female condoms when informational, access and price constraints are alleviated. The estimated treatment effect may also include the effect of simply coming together in a group with other women to discuss personal issues. We do not attempt to disentangle these mechanisms, since our primary objective is to study how bargaining power affects adoption of female condoms once all constraints to adoption apart from intra-household bargaining are alleviated. Moreover, since any standard sex education programme would likely involve all of these components, their combined impact is arguably of most interest to policymakers.

[12] Qualitative evidence from the medical literature suggests that information about use and about negotiation help introduction of female condoms (Schuyler et al., 2016). The discussions are also included for ethical reasons, to mitigate any risk of these women facing increased violence when introducing new contraceptives into the home.

3.3 Study design

Pathfinder International began its female condom programme in Matola in 2011. We expanded the progamme to four additional neighbourhoods in 2014, using a phased-in experimental design with participant-level randomisation across all four neighbourhoods. Seventeen programme facilitators — healthcare workers from the local community — were recruited and trained by Pathfinder to deliver the programme. These facilitators then conducted door-to-door recruitment to identify women willing to participate. The eligibility criteria were that women needed to be between 18 and 49 years of age, sexually active, and not pregnant.

The baseline survey was conducted by enumerators from an independent survey firm in August 2014, after the sign-up period but before randomisation and the start of the programme. At the end of the baseline interview, each participant was told that two phases of training sessions would be organized to accommodate the large number of interested participants, and that assignment to the first or second round would be determined randomly by a computer for fairness. Once the entire sample had responded to the baseline survey, the research team randomly allocated half of the respondents recruited by each facilitator to the treatment group (i.e. the first round of training sessions) and half to the control group (i.e. the second round of training sessions).[13] The reason for stratifying on facilitator was to improve power, and to ensure that there would be enough space for treatment and control participants to attend sessions close to their home.

To limit spillovers between participants in the treatment and the control arm, we organized a third and separate set of training sessions for women who registered together and who knew one another. This separate group received the intervention at a later stage, but was not included in the study. The women assigned to the first or second round of training sessions were not connected to each other; we expect spillovers between them to be negligible, given the small number of participants compared to the total population of these neighbourhoods (which each had 20,000 inhabitants on average). Indeed, Section 5.1 presents evidence that there do not appear to be spillovers from our

[13] The randomisation was done in private, given the sensitive nature of participating in our intervention. A member of the research team took the list of respondents for each facilitator, sorted them by a randomly-generated number, and assigned the first half to treatment and the second half to control.

treatment.

The treatment group then received the intervention from September-December 2014. The endline survey was conducted in February-March 2015, five to six months after the intervention had started for treated individuals, and two to three months after treated individuals had received their last group session. Following the endline survey, the control group then received the intervention from March-May 2015.

Our baseline sample consists of 298 women, of whom 232 were re-interviewed at endline and so constitute our balanced panel.[14] The retention rate was thus 78%, which is similar to that in other studies tracking female populations in urban or peri-urban areas (Banerjee et al., 2015; Cohen et al., 2017). Online Appendix Table B.1 shows that the observable predictors of attrition are not differential across treatment and control groups, and that treatment itself does not significantly predict attrition.[15] Due to an administrative error, the control group for one facilitator received the endline survey only after having been treated in the second phase of implementation. These five observations are dropped from all estimations of treatment effects, leaving a final estimating sample of 227 respondents. The sample remains balanced across treatment and control when excluding these five individuals (see Table B.3 in the Online Appendix).

4 Data

4.1 Survey data

Table 1 shows measures of key covariates and contraceptive use for the full baseline sample, and demonstrates that all are balanced across treatment and control. These variables are also balanced when attritters are excluded, see Online Appendix Tables B.2 and B.3. 85% of respondents report being in a stable relationship with an average duration of 8.7 years, comprising 63% who are married and 22% who are unmarried

[14]317 women were initially recruited into the study. However, one facilitator fell severely ill at the start of the study, and there was nobody sufficiently trained to replace her. She had recruited a total of 19 participants, whom we drop from the sample.

[15]Since attrition is high, despite it not being differential on observables across treatment and control, we conduct a Heckman selection correction to account for potential differential attrition by unobservables. Our results are robust to this correction, as discussed in Section 5.4

but still in relationships of on average 4.8 years.[16] The rest of the sample (15%) are sexually active but not in a stable relationship. The vast majority of respondents report having had just one sexual partner in the last twelve months, with 10% reporting zero partners and 3% reporting two partners. A third of respondents report being HIV-positive, which is close to the official statistics reported above. Slightly more than 10% of respondents report having had an STI in the last three months; although this may be under-reported.[17] Fewer than half, 41%, mention the female condom when asked to list contraceptive methods that they know about.

Our primary outcome variables are the use of contraceptive methods, disaggregated by female condoms, male condoms and other modern contraceptive methods — mainly the pill and injectables. For each method, we ask respondents whether they have ever used that method, and whether they are currently using it, i.e. consider it to be part of their current portfolio. For male and female condoms, we also ask whether they have used that method in the last thirty days. Table 1 describes the baseline values of each of these measures. Baseline use of female condoms is low: 9% of the respondents have ever used a female condom, 3% have used one in the last 30 days, and 2% are currently using female condoms. Male condom use is substantially higher: around three quarters of women have ever used a male condom, 32% have used one in the last 30 days, and 39% percent say they are currently using male condoms. Altogether, 39% of our sample are currently using pure contraception methods at baseline, comprising 20% using the pill and 14% using injectables, and a small number using intrauterine devices (IUDs), the diaphragm, and sterilisation. As mentioned above, even if these women plan to continue using their pure contraception method, they may have signed up to the female condom programme because they are seeking an additional method that protects against HIV/AIDS and other STIs; although they may also be open to substituting away from their existing method.

Finally, Table 2 compares our sample to a representative urban sample of women

[16]The former includes traditional marriages and respondents who describe themselves as "living as married" but not legally married. The latter is common in this region due to the high bride price and costs of obtaining a marriage certificate.

[17]We do not test for HIV, since the accuracy of testing is sensitive to the timing of infection, especially shortly after infection, and our endline survey is only a few months after the end of the intervention. We also opted not to test for STIs such as chlamydia, given the already sensitive nature of participation in the study and the budgetary implications of providing treatment to those who test positive (as required by medical research ethics guidelines).

Table 1: Baseline balance of covariates and contraceptive use – full sample

	Mean	Control Mean	Treatment Mean	t-test	Total N	Control N	Treatment N
Demographics							
Age in years	30.32	30.12	30.52	-0.42	298	146	152
Years of education	6.22	6.26	6.18	0.24	298	146	152
Literate	0.84	0.84	0.85	-0.17	298	146	152
Household head	0.22	0.21	0.24	-0.51	298	146	152
Income							
Has job	0.38	0.42	0.33	1.64	298	146	152
Personal income last 30 days (MZN)	880.74	942.19	821.72	0.51	298	146	152
Relationships							
In a stable relationship (incl. married)	0.85	0.85	0.84	0.17	298	146	152
Married (officially or unofficially)	0.63	0.64	0.62	0.37	298	146	152
Years relation	8.50	8.47	8.54	-0.09	298	146	152
# Partners last 12 months	0.92	0.92	0.93	-0.23	298	146	152
Sexual knowledge & behaviour							
Pregnant	0.05	0.05	0.06	-0.41	298	146	152
HIV positive (self-report)	0.33	0.35	0.31	0.75	260	129	131
STI last 3 months (self-report)	0.13	0.13	0.13	-0.10	259	124	135
Wants another child now	0.11	0.12	0.09	0.87	298	146	152
Wants another child	0.56	0.59	0.54	0.82	298	146	152
Beliefs high risk of HIV – general	0.66	0.67	0.65	0.33	298	146	152
Beliefs high risk of HIV – for self	0.69	0.68	0.70	-0.23	298	146	152
Walking distance to health centre (in min.)	54.97	53.06	56.80	-0.90	298	146	152
Mentions female condom as contraceptive	0.41	0.44	0.39	0.90	298	146	152
Baseline use							
Ever use female condoms	0.09	0.09	0.09	0.11	298	146	152
Ever use male condoms	0.74	0.76	0.73	0.59	298	146	152
Ever use other	0.72	0.72	0.72	0.04	298	146	152
Use female condoms last 30 days	0.03	0.01	0.04	-1.39	298	146	152
Use male condoms last 30 days	0.32	0.28	0.35	-1.26	298	146	152
Current use female condoms	0.02	0.02	0.03	-0.33	298	146	152
Current use male condoms	0.39	0.37	0.41	-0.79	298	146	152
Current use other	0.39	0.41	0.37	0.75	298	146	152
Attrition							
Attrited	0.21	0.25	0.18	1.59	298	146	152

Notes: N=298 in the baseline sample. Lower sample sizes reflect observations that are missing or not applicable. "Treatment" contains all individuals assigned to the treatment group (i.e. to the first round of the family planning training sessions), whether or not they attended the sessions. "Control" contains all individuals assigned to the control group (i.e. to the second round of training sessions). Column 4 presents the test statistic for the null hypothesis that the mean in the treatment group is equal to the mean in the control group. Unless otherwise indicated, all are binary variables. MZN stands for Mozambican meticais. HIV stands for Human Immunedeficiency Virus. STI stands for Sexually Transmitted Infections. "Beliefs high risk of HIV – general ' and "... – for self" are binary variables which are coded 1 (and 0 otherwise) if the respondent scored a value above the median for the questions "What is the risk of being infected with HIV when having unprotected sex for a woman in general? And for you specifically?" measured on a 1-5 scale ranging from No risk to Very risky. "Ever used other" and "Current use other" refer to use of any other modern contraceptive method apart from condoms, e.g. the pill, injectables, or an IUD.

from Maputo Province, from the 2011 Demographic Health Survey (DHS, 2011). It is important to stress that we did not seek to recruit a representative sample of women into our intervention; not least because it may have been unethical and difficult to convince the least empowered women to attend, given our prediction that such women would never be able to convince their partners to use male or female condoms. Nonetheless, Table 2 shows two important features of our sample. First, our sample happens to be close to the overall adult female population of Maputo Province, in terms of demographic characteristics such as age, years of education, marital status, pregnancy, and desired fertility.[18] Second, in contrast, the women in our study appear to have greater bargaining power than the representative sample: they began to have sex at a later age, are more likely to have used a condom the last time they had sex, and report greater decision-making power.

4.2 Bargaining power

To test the model's predictions, we require proxies of women's bargaining power within their relationship. We include a standard survey module on how decision-making on key domains is distributed across a woman and her partner, and a survey module on power dynamics within the relationship, which we adapted through extensive local piloting.[19] By their nature, this latter set of questions is only asked to the 85% of our sample who have a stable partner. Table 3 provides summary statistics for each of the questions at baseline.

Since each of these modules contains multiple questions whose responses are highly correlated, we perform a tetrachoric factor analysis to construct a baseline bargaining power index. This bargaining power index explains 30.1% of the variance in all the decision-making and power dynamics questions. Online Appendix Figure B.2 presents the distribution of the index. The index is balanced across treatment and control, in

[18] One exception is that the women in our sample are much less likely to have a job, which makes sense if women with a lower opportunity cost of time are more willing to participate in a time-intensive programme.

[19] We also collected data on assets brought to the relationship. However, only a very small percentage of our respondents report that they brought assets to the relationship, of which 7.58% brought jewelry, 1.14% brought land and 0.34% brought animals. Given such little variation is observed, we exclude assets from our analysis.

Table 2: Comparison of Study Sample to DHS Representative Sample

	Study Mean	DHS Mean	t-test	Study N	DHS N
Demographics					
Age in years	30.32	29.47	1.55	298	1007
Years of education	6.22	6.72	-2.55	298	1007
Literate	0.84	0.76	3.51	298	1007
Income					
Has job	0.38	0.58	-6.50	298	1007
Relationships					
Married (officially or unofficially)	0.63	0.61	0.52	298	871
Pregnant	0.05	0.07	-0.82	298	1007
Wants another child in future	0.56	0.57	-0.17	298	961
Decision-making visiting family	0.64	0.39	7.27	294	580
Decision-making spending earnings	0.60	0.21	11.63	297	569
Decision-making her health	0.55	0.39	4.65	297	580
Sexual Behaviour					
Age of sexual debut in years	16.56	16.16	2.97	298	955
Used condom during last time sex	0.55	0.31	7.67	298	871

Notes: Column 1 displays the mean from our study sample at baseline (N=298). Column 2 shows the 2011 Demographic and Health Survey (DHS) mean for women in urban areas of Maputo Province (N=1007). Lower sample sizes in Columns 4 and 5 reflect observations that are missing or not applicable. Unless otherwise indicated, all are binary variables. Column 3 presents the test statistic for the null hypothesis that the mean in the study sample is equal to the mean in the DHS sample. Variables selected for comparison are those that appear in both our study and the DHS, with similar or identical wording. The three "Decision-making" variables are indicators for whether the respondent is involved in making decisions on the respective activities.

both the baseline sample and the balanced panel sample.[20]

Table 3: Bargaining power – summary statistics

	Mean	sd	Min	Max	Total
Who decides about...					
...buying clothes for you?	0.80	0.40	0.00	1.00	297
...buying phone credit?	0.76	0.43	0.00	1.00	297
...education for the children?	0.49	0.50	0.00	1.00	288
...health expenses for you?	0.55	0.50	0.00	1.00	297
...health expenses for the children?	0.41	0.49	0.00	1.00	291
...if you are allowed to work?	0.59	0.49	0.00	1.00	296
...how earnings are used?	0.60	0.49	0.00	1.00	297
...visits to friends?	0.64	0.48	0.00	1.00	296
...visits to family?	0.64	0.48	0.00	1.00	294
Who usually has more say when you talk about serious things	0.47	0.50	0.00	1.00	250
In general, who do you think has more power in your relationship	0.39	0.49	0.00	1.00	249
Power dynamics					
Most of the time, we do what my partner wants to do	2.33	1.08	1.00	4.00	250
My partner won't let me wear certain things	2.61	1.11	1.00	4.00	250
When my partner and I are together, I'm pretty quiet	3.07	0.96	1.00	4.00	250
My partner has more say about important decisions that affect us	2.39	1.09	1.00	4.00	250
My partner tells me who I can spend time with	2.79	1.09	1.00	4.00	249
I feel trapped or stuck in our relationship	3.20	0.86	1.00	4.00	250
My partner does what he wants, even if I do not want him to	2.86	1.00	1.00	4.00	249
I am more committed to our relationship than my partner is	2.74	1.08	1.00	4.00	250
My partner is involved with other people apart from me	2.77	1.02	1.00	4.00	249
My partner always wants to know where I am	2.16	1.10	1.00	4.00	250
When my partner and I disagree, he gets his way most of the time	2.73	1.06	1.00	4.00	248

Notes: All values taken from the baseline survey. The "Decision-making" module was enumerated to all respondents (N=298), except the questions "who has more say" and "who has more power" which were asked only of women in a stable relationship at baseline (N=250). Decision-making variables are indicators for whether respondent was involved in making decisions on each of the activities or if respondent had more say/more power than her partner. "Power dynamics" questions were only asked from women who were in a stable relationship at baseline (N=250), based on a Likert-scale coded from 1 (completely disagree) to 4 (completely agree), and recoded such that a greater value represents higher bargaining power for the respondent. Lower observation numbers in the final column reflect missing values or unwillingness to answer.

The bargaining power index is correlated with baseline characteristics in the way we might expect. Specifically, bargaining power is positively correlated with a woman's income (correlation 0.21, p-value < 0.01), having a job (0.20, p-value < 0.01), being the household head (0.30, p-value < 0.01), and age (0.13, p-value 0.04). One anomaly is that bargaining power is negatively correlated with a woman's education (-0.12, p-value

[20] A regression of treatment on the bargaining power score, while controlling for facilitator dummies, gives a coefficient of -0.031 (p-value 0.524, t-statistic -0.64) in the baseline sample, and of -0.045 (p-value 0.430, t-statistic -0.79) in the balanced panel sample.

0.06), but this disappears when we control for age. Meanwhile, bargaining power is negatively and significantly correlated with a woman believing she faces a high risk of HIV infection if she has unprotected sex with her partner (correlation -0.12, p-value 0.05), with wanting another child now (-0.11, p-value 0.09), wanting another child in general (-0.11, p-value 0.08), and with being married (-0.37, p-value < 0.01). To avoid the bargaining power index spuriously proxying the effects of any of these variables, we include these variables as controls when estimating the effects of bargaining power on condom adoption; see Section 5.3.

As predicted by the model, we also observe a positive correlation between the bargaining power index and the use of male condoms at baseline. This correlation is significant for the "last 30 days" measure of male condom use at baseline (correlation 0.12, p-value 0.06), and marginally insignificant for the "current use" measure (0.09, p-value 0.15).

4.3 Diary data

At the end of the baseline interview, all respondents were also invited to participate in a weekly sexual diary exercise. Altogether 56 respondents volunteered to participate, comprising 27 who were subsequently randomised into the treatment group and 29 who were subsequently randomised into the control group.[21] The diaries recorded detailed information on all of the respondents' sexual encounters in the seven days prior to each interview, with the high-frequency nature of the data collection designed to reduce recall bias (Das et al., 2012). Diary interviews took place over a period of 17 weeks, beginning four weeks prior to the first group receiving its first session and ending one week after the last group received its last session. The baseline period for each respondent is taken to run from the start of the diary data collection until the week that the facilitator to which the respondent was assigned began her first meeting for

[21] We did not stratify the randomisation on diary participation, but there is balance on treatment status, covariates and baseline contraceptive use within this diary subsample; tables available on request. Online Appendix Table B.4 shows that the diary participants are representative of the balanced panel of all survey participants, except that the diary participants have been in a relationship for longer than the average study participant, no diary respondents are pregnant, and diary respondents are more likely to have ever used other contraceptives. The results from the diary subsample presented below are robust to re-weighting to make the diary subsample representative of the full sample (available on request).

her treatment-group participants (5.6 weeks on average). The endline period is taken to run from the week after a respondent's facilitator started her first session until the end of the diary data collection, comprising 8.9 weeks on average. On average 75% of the diary sample participated each week.[22]

The diary data allow us to analyse the impact of the intervention at the level of the sex act. Altogether respondents report a total of 349 sex acts during the endline period: an average of 6.1 sex acts per respondent, with a minimum of zero and a maximum of 30. The diary data also lend support to our bargaining model, as we see that a large proportion of sex acts involve discussions or disagreements over the use of condoms: 31% of sex acts in the last fourteen days in the control group at endline, see Online Appendix Table B.15. This in turn implies that even if sorting on contraceptive preferences occurs in the dating or marriage market, a substantial gap in preferences still persists.

5 Results

5.1 Impacts on condom use

Our preferred estimations are derived from an analysis of covariance (ANCOVA) linear probability models of the following form:[23]

$$Pr\left[Y_{if1} = 1 | Y_{if0}, treat_{if}, \eta_f\right] = \alpha + \delta Y_{if0} + \beta treat_{if} + \eta_f, \tag{3}$$

where Y_{if1} is the outcome variable of interest at endline for individual i assigned to facilitator f, and Y_{if0} is its value at baseline. $treat_{if}$ is a dummy for being assigned to the treatment group, i.e. to receiving the programme in the first rather than the second phase. β represents the intent-to-treat effect, since not all individuals assigned to treatment attended the programme: the participation rate was around 65% for each individual session, with 20 women (17.7% of the treatment group) not attending any of the six sessions. η_f is a facilitator fixed effect, which is included for inference since

[22] Individual respondents took part in the diaries an average of 13 times, with a minimum of three weeks and a maximum of 17 weeks. There are no significant differences in participation between the treatment and control group.

[23] Results are robust to using OLS specifications without the lagged dependent variable (see Online Appendix Table B.5) and to using logit specifications (see Online Appendix Table B.6).

randomisation was blocked on the seventeen facilitators (Bruhn and McKenzie, 2009). Standard errors are robust to individual-level heteroskedasticity, as this was the level of randomisation (Abadie et al., 2017). We also report additional p-values for the treatment coefficients as calculated from randomisation inference tests (Young, 2016).

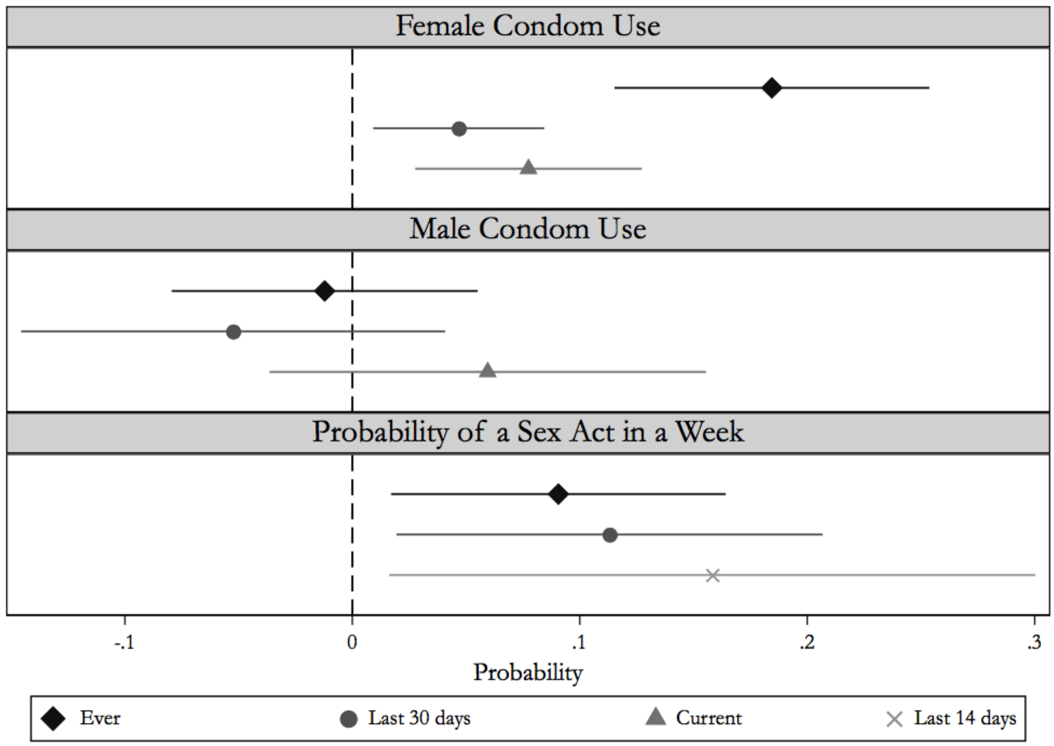
Figure 2 displays the treatment effects on condom use as estimated from Equation 3, while the full estimations are reported in Table A.1 in the Appendix. The programme has a substantial and highly significant effect on the use of female condoms: we observe an 18.4 percentage point increase in the proportion of women who have ever used female condoms (compared to an endline mean of 8.8% in the control group); a 4.7 percentage point increase in the proportion who have used a female condom in the last thirty days; and a 7.7 percentage point increase in the proportion who are currently using female condoms. The fact that the treatment effects on ever use is higher than the treatment effect on use in the last thirty days and current use suggests that many women in the treatment group try female condoms at the start of the intervention, then a smaller although sizeable fraction continues to use them. This is a natural adoption pattern if couples experiment with female condoms and thereby learn more about their costs and benefits, then some return to their original contraceptive method while others adopt female condoms more permanently.

We see no evidence of anticipation effects or spillovers — e.g., through the control group obtaining female condoms from the treatment group — as there are no significant differences between baseline use in the control group and endline use in the control group for any of our outcome indicators (see Online Appendix Table B.16). This is unsurprising, since female condoms are difficult to obtain in the study area through channels other than our intervention. Indeed, the number of free female condoms that a respondent in the treatment group took from the sessions is highly correlated with her report of ever use (correlation 0.38, p-value < 0.01), use last 30 days (0.21, p-value 0.02), and current use (0.29, p-value <0.01). This also weighs against concerns that reported use of female condoms might represent response bias.

We do not observe any significant evidence that respondents substitute away from or increase their use of male condoms.[24] Table A.2 in the Appendix shows that when

[24] We have 80% power to detect the following minimum detectable effect sizes at the 5% level in a two-tailed test: ever use – female condoms 7.6 pp, male condoms 9.6 pp, other 10.3 pp; use last 30 days – female condoms 3.5 pp, male condoms 14.0 pp; current use – female condoms 4.9

Figure 2: Treatment effects on condom use and sex acts



Notes: Predicted average marginal effect of treatment on outcome variables. Each marker (diamond, circle, triangle, x) represents the average marginal treatment effect. Each bar represents the 90% confidence interval. Treatment is an indicator for being assigned to the treatment group (i.e. to the first round of the family planning training sessions) as opposed to the control group (i.e. the second round of training sessions). Not all respondents assigned to treatment attended the sessions, thus the treatment coefficients represent the intent-to-treat effect. The panels titled "Female Condom Use" and "Male Condom Use" present regressions on the balanced survey sample, N=227. Dependent variables are binary indicators. The bars with a "diamond" marker refer to whether the respondent has ever used the method, the bars with a "circle" marker refer to whether she has used it in the last 30 days, and the bars with the "triangle" marker whether she is currently using it. Regressions in these panels are linear probability model ANCOVA specifications, including the baseline value of the dependent variable as a regressor. All regressions include facilitator dummies (N=16) since randomisation was stratified on facilitator. The panel titled "Probability of a Sex Act in a Week" presents regressions on the balanced diary sample, N=56. Dependent variables are binary indicators for whether a respondent had at least one sex act in a particular week. In this panel, the bars with a "diamond" marker refer to the treatment effect on the probability that the respondent had at least one sex act in a week, the bars with a "circle" marker refer to the treatment effect on the probability that the respondent had at least one sex act per week in the last 30 days, and the bars with the "x" marker the treatment effect on the probability that the respondent had at least one sex act per week in the last 14 days. All regressions in this panel are linear probability individual fixed effects models comparing the probability of a sex act in a week during the baseline period with the probability of a sex act in a week during the specified endline period, with the respondent-week as the unit of observation (N=863 for the full endline period, N=536 for the last 30 days, and N=367 for the last 14 days). All regressions include facilitator × endline fixed effects (N=16) since randomisation was stratified on facilitator. Standard errors in all regressions are robust to individual-level heteroskedasticity, since this was the level of randomisation.

we split the sample by women who are using or not using male condoms at baseline, both groups experiment with female condoms (Columns 1 and 2), but it is those women not using male condoms at baseline who appear to drive the more sustained adoption (Columns 3 and 5); although we note the reduced power in these subsamples.Importantly, the lack of substitution suggests that the intervention decreases the number of women having sex unprotected from HIV/AIDS and other STIs. Section 6 describes use of epidemiological modelling to estimate how our observed impacts on condom coverage translate into impacts on longer-term rates of HIV transmission.

Table A.1 shows that we also see no increase in or substitution away from other contraceptive methods such as the pill and injectables. This suggests that women who adopt female condoms were either previously using no contraceptives, or use female condoms in addition to other methods in order to protect against HIV/AIDS and other STIs. Indeed, of the women who are currently using female condoms at endline, 42% are also using other contraceptive methods (mainly the pill or injectables).

When we restrict the sample to just those women in a stable relationship, we still observe positive treatment effects on female condom use: a 16.4 percentage point increase in ever use of female condoms (p-value < 0.01), a 5.6 percentage point increase in use in the last 30 days (p-value 0.042), and a 7.9 percentage point increase in current use (p-value 0.019).[25] This may be rational if one partner is HIV-positive while the other is HIV-negative, or if one or both partners have relations with others or suspect that their partner does. Even individuals who are already HIV-positive have an incentive to avoid further infection, as getting infected with a different strain of HIV may increase the viral load, and getting infected with other STIs may lead to further complications and increase the risk of transmitting HIV/AIDS.

5.2 Extensive-margin impacts

We use the diaries to examine the effects on the extensive margin, i.e. the probability of having sex. Our preferred measure of this is the likelihood of at least one sex act per

pp, male condoms 13.9 pp, other 13.6 pp.

[25]We would expect women who are not in a stable relationship to place a larger weight on the health offered by STI protection technologies, and so to have a higher demand for condoms. Indeed, Online Appendix Table B.13 shows that the treatment effect on ever use of female condoms is stronger for women who are not in a stable relationship at baseline.

respondent per week, so that results are not unduly influenced by a very small number of respondents who report a large number of sex acts. Taking advantage of the weekly nature of the diaries, we estimate the following fixed effects panel specification:

$$\begin{aligned} &Pr\left[Y_{ift} = 1 | treat_{if}, \eta_f, \phi_{if}\right] \\ &= \alpha + \delta \times endline_t + \beta treat_{if} \times endline_t + \eta_f \times endline_t + \phi_{if}, \quad t = 1, 2, ..T \end{aligned} \tag{4}$$

where Y_{ift} is the outcome variable of interest for individual i assigned to facilitator f in week t. The unit of observation is thus the respondent-week. Standard errors are again clustered at the individual level.

Figure 2 shows that, in line with Proposition 2 of the model, the introduction of female condoms leads to a significant increase in the likelihood of sex acts. The full estimations of Equation 4 are presented in Table A.3 in the Appendix. In the full endline period, respondents in the treatment group were on average 9.1 percentage points (pp) more likely to report a sex act in a given week, compared to a control group mean of 46.9%. In the last 30 and 14 days, the treatment effect on the likelihood of sex acts per week was 11.3 pp and 15.8 pp respectively, compared to 47.1% and 49.1% in the control group. The fact that we observe this increase in the treatment group indicates that there are couples in which one or both partners' participation constraints are sometimes or always binding when the only options are male condoms or unprotected sex, but where both find sex with female condoms preferable to not having sex. The introduction of female condoms therefore increases utility for such couples. Moreover, Online Appendix Table A.4 shows that the increase in sex acts is driven by those respondents who are not using male condoms when they do have sex at baseline. Again, we do not see evidence of spillovers or anticipation effects in the control group, for example that control-group respondents withheld from regular sex in anticipation of treatment: the mean of sex acts per week in the control group is 0.91 (standard deviation 0.51) during the baseline phase and 0.86 (s.d. 0.54) during the endline phase, and a t-test that these are different is rejected (t=0.71). We also observe a large and highly significant reduction for the treatment group in the proportion of sex acts in which a discussion or disagreement about condoms takes place (Table B.15 in the Online Appendix). This supports the idea that the expansion from a binary to a ternary choice allows the couple to choose an STI protection technology that is closer to their preferred choice on the technological frontier. Reassuringly, in the survey data we see no negative impact of treatment on measures of women's self-reported well-being, nor do we see any impacts on emotional or physical violence (see Online Appendix Table B.12).

5.3 Heterogeneity by bargaining power

We now test our main predictions about which women, among those in stable relationships, adopt female condoms in terms of their bargaining power. If we first run a naïve, linear regression of endline current use of female condoms on the interaction of treatment with the bargaining power index, we observe a strong, negative effect of the bargaining power index on the treatment effect on female condom adoption. Specifically, a one standard-deviation increase in our bargaining power index decreases the likelihood that the respondent adopts female condoms as a result of receiving the treatment by -0.198 percentage points (p-value 0.056) on average (see Table B.8 in the Online Appendix for the results).

However, according to Proposition 1, we expect to observe an "inverse-U" relationship between bargaining power and female condom adoption over the full distribution of women with low, intermediate, and high bargaining power. To test flexibly for such a non-linear "inverse-U" relationship we next regress endline current use of female condoms on a cubic function of the bargaining power index, controlling for baseline current use of female condoms, a full set of baseline controls,[26] and facilitator dummies. This estimation indeed suggests that there exists an inverse-U relationship between female bargaining power and female condom adoption, and that the maximum of the inverse-U occurs at the lower tail of the distribution of bargaining power in our sample.[27] However, as was shown in Table 2, the women in our sample have a higher average level of bargaining power than women in the population, suggesting that women with the

[26]Controls are "Age in years," "Years of education," "Literacy," "Household head," "Has job," "Personal income last 30 days (MZN)," "In a stable relationship (incl. married)," "Married," "Years relation," "Number of partners in the last 12 months," "Pregnant," "Wants another child now," "Wants another child," "Beliefs high risk of HIV – general," "Beliefs high risk of HIV – for self," "Walking distance to the health centre," "Mentions female condoms as contraceptive," as described in Section 4.2.

[27]See Figure B.3 in the Online Appendix.

lowest bargaining power in the population, whom our model predicts would not be able to persuade their partners to use even female condoms, are likely underrepresented in our sample. This would explain why we find a significant negative coefficient on the interaction between bargaining power and treatment status in the naïve linear regression: the negative interaction effect at higher levels of bargaining power masks the positive interaction for those women with low bargaining power.

To investigate the inverse-U relationship, we create dummies for low, medium and high bargaining power taking thresholds at the 5^{th} centile and 20^{th} centile of the index – since the point of inflection occurs towards the lower end of our sample distribution of bargaining power.[28] We regress endline current use of female condoms on the interaction of these dummies with treatment, controlling as above for current use of female condoms at baseline, the full set of controls, and our facilitator dummies. This allows us to effectively pull apart the upward- and the downward-sloping segments of the interaction between bargaining power and the treatment effect. To create standard errors, we bootstrap over the tetrachoric factor analysis used to produce the bargaining power index and the creation of dummies on the 5^{th} and 20^{th} centiles, as well as over the regression, with 11,566 replications.[29] Figure 3 shows the predicted probabilities of female condom use at endline, and their 95% confidence intervals, for each level of bargaining power in the treatment and the control group (Online Appendix Table B.9 reports the results in full). We observe a strong inverse-U relationship between bargaining power and female condom adoption in the treatment group.[30]

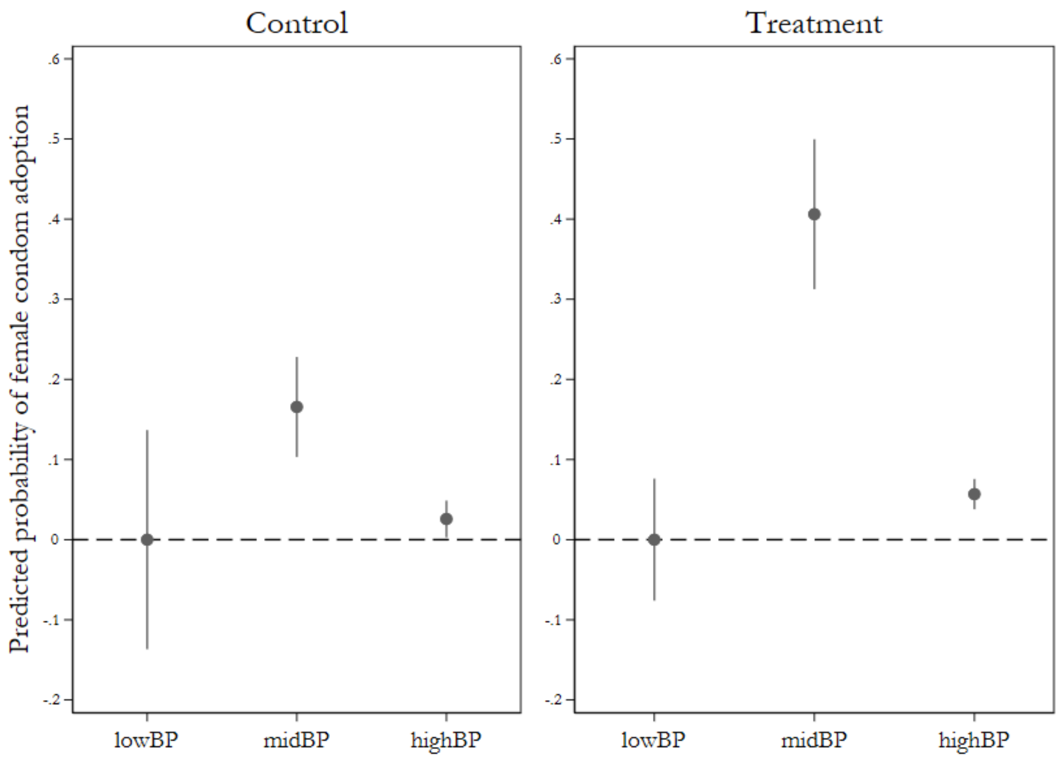
In terms of margins of adoption, as predicted by our model, our results show that the interaction between baseline bargaining power and treatment is especially strong for women who do not use male condoms at baseline (see Online Appendix Table B.9). Conversely, we do not see evidence of a large degree of substitution away from male

[28] Figure B.4 shows a sensitivity analysis of our results when we use alternative thresholds in our distribution.

[29] Because the usual estimation methods for factor analysis only predict a point estimate for each respondent without carrying standard errors, any use of factor analysis and estimations using factors requires bootstrapping the standard errors.

[30] The sensitivity analysis in Online Appendix Figure B.4 shows that if the thresholds for the low, medium and high bargaining power dummies are shifted towards the right tail of the bargaining power index distribution, we see a transition from the inverse-U shape to a negative, linear effect of the bargaining power index on female condom adoption, as observed in the naïve linear specification.

Figure 3: Impacts on Female Condom Use by Female Bargaining Power



Notes: Predicted marginal effect on current use of female condoms for respondents with low bargaining power (lowBP), intermediate bargaining power (midBP), and high bargaining power (highBP) for the control group in the left panel and the treatment group in the right panel. The thresholds for low versus intermediate bargaining power was set at the 5^{th} centile, and the threshold for intermediate versus high bargaining power was set at the 20^{th} centile. Each marker (circle) represents the predicted marginal effect. Each bar represents the 95% confidence interval. Treatment is an indicator for being assigned to the treatment group (i.e. to the first round of the family planning training sessions) as opposed to the control group (i.e. the second round of training sessions). Not all respondents assigned to treatment attended the sessions, thus the effect of treatment represents the intent-to-treat effect. The marginal effects are predicted based on a regression on the balanced survey sample (N=227) for those women in a stable relationship (N=194). The regression is a linear probability model ANCOVA specification where dummies for low bargaining power (versus intermediate bargaining power) and high bargaining power (versus intermediate bargaining power) are interacted with treatment. The regressions include the baseline value of the use of female condoms, controls, and facilitator dummies (N=16) since randomisation was stratified on facilitator. Controls are "Age in years," "Years of education," "Literacy," "Household head," "Has job," "Personal income last 30 days (MZN)," "In a stable relationship (incl. married)," "Married," "Years relation," "Number of partners in the last 12 months," "Pregnant," "Wants another child now," "Wants another child," "Beliefs high risk of HIV – general," "Beliefs high risk of HIV – for self," "Walking distance to the health centre," "Mentions female condoms as contraceptive." The factor analysis to create the bargaining power index, the creation of the binary bargaining power variables, and the regressions were bootstrapped with 11,566 replications.

condoms (see Online Appendix Table B.11). A possible explanation is that women with higher bargaining power who take up female condoms also intersperse their use with the use of male condoms. Indeed, 81% of women who are currently using female condoms at endline also report currently using male condoms. This "double protection" is a typical pattern of adoption observed in the medical literature, and is found to be associated with a large increase in the number of protected sex acts (Vijayakumar et al., 2006).

Finally, Online Appendix Table B.14 shows no systematic treatment impacts on the time-variant measures of bargaining power themselves, namely decision-making and power dynamics.

5.4 Robustness and alternative explanations

Additional controls: One possible concern is that the interaction effect of treatment with our bargaining power dummies might be proxying the interaction of treatment with any of our controls — especially since some of our controls are correlated with our bargaining power index as one might expect, as described in Section 4.2. To overcome this, we run a post-double LASSO specification in which we include the full set of control variables and their interactions with treatment, and then re-run our main specification with the LASSO-selected controls. Column 5 in Table B.9 in the Online Appendix shows that our results are robust to this procedure.

Selection on bargaining power: Our results suggest that women with low bargaining power may be underrepresented in our sample compared to the local population (see Table 2). This could reflect women with the lowest bargaining power in the population rationally not expressing interest in our intervention, and hence not making it into our sample, if they anticipate that they would not be able to convince their partner to use any type of condoms even after participating. To check whether our finding of an inverse-U relationship between bargaining power and adoption of female condoms would hold if our sample were more representative of the population in terms of bargaining power, we re-weight our results by the inverse probability of the likelihood that a woman with low bargaining power is in our sample, when controlling for all controls and baseline contraceptive use. Our finding of an inverse-U shape is robust and strengthened, as presented in Figure B.5 in the Online Appendix.

Attrition: Despite the fact that predictors of attrition are not different across treatment and control, and that treatment status does not predict attrition, we do observe sizeable attrition between the baseline and endline survey. To check if our results are robust to the possibility that *unobservables* differentially predict attrition across treatment and control, we conduct a Heckman sample selection correction. To select the predictors of attrition that we include in the sample selection correction specifications, we first run a linear LASSO specification of attrition on all our control variables, measures of baseline contraceptive use, treatment, and facilitator dummies. The LASSO-selected variables are then included in our sample selection equation that we use for the Heckman selection correction. Our main treatment effects (Online Appendix Table B.10) as well as the results on heterogeneity by bargaining power (Online Appendix Figure B.6) are robust to this correction.

Experimenter demand: A possible alternative explanation for the negative interaction terms could be that women with lower bargaining power are more susceptible to experimenter demand, and so over-report use of female condoms whilst more empowered women do not. While we acknowledge potential concerns about our self-reported measures of condom use, we find little evidence of misreporting. First, we observe high consistency in reported use across the survey and diary data. The diaries are a more complex and granular instrument than the baseline and endline surveys, and administered at different points in time, yet we observe only a handful of cases where an individual's reporting in the surveys and diaries diverges.[31] Second, when we re-run analyses using the diary data, the estimated treatment effects are similar to those estimated from the survey data (tables available on request). Third, we also observe a strong correlation between reported condom use and the number of condoms an individual took from the sessions for ever use of female condoms (0.318, p-value <0.01), use of female condoms in the last 30 days (0.240, p-value <0.01), and current use of female condoms (0.389, p-value <0.01).

[31] There is actually limited evidence of *under*-reporting of contraceptive use in the surveys: 5 out of 56 diary participants report never having used a female condom during the endline survey but report using them in the diaries; whilst for male condoms the figure is 4 out of 56 respondents. We cannot make the opposite comparison, given that the endline survey took place two months after the end of the diaries: if a respondent reports using condoms in the survey but not the diaries, it may be that she adopted them during those two months.

Access: Another possible alternative explanation could be that women with intermediate bargaining power are less able than women with high bargaining power to access male condoms (or other contraceptives) through the market or at health clinics. However, if this were the case then we would expect also to see stronger treatment effects for women with intermediate bargaining power on current use of *male* condoms, which the health workers also carry. Instead, we see that women with lower bargaining and higher bargaining power are equally likely as women with intermediate bargaining power to take up male condoms as a result of treatment (see Column 6 in Online Appendix Table B.11).

Use of other contraceptive methods: The interaction between bargaining power and treatment is also not proxying a differential effect of treatment depending on whether the respondent is using other methods of contraception (i.e. the pill or injectables) at baseline. When baseline use of other forms of contraception and its interaction with treatment are included into the regressions, the interactions between treatment and bargaining power remain negative and highly significant (see Column 2 in Online Appendix Table B.11).

HIV status: Finally, heterogeneity by bargaining power is also not proxying the observed heterogeneity by HIV status. This could have been the case since we observe that women with lower bargaining power are more likely to be HIV-positive. However, the interaction of the bargaining power measures with treatment remain negative and significant when controlling for HIV status and its interaction with treatment (see Column 4 in Online Appendix Table B.11). We also consider whether the respondent believes her partner is involved with other women. This variable is negatively correlated with our bargaining power index at baseline; but again, including it and its interaction with treatment does not remove the negative interaction between treatment and bargaining power (see Column 5 in Online Appendix Table B.11).

6 Cost-Benefit and Cost-Effectiveness Analysis

To understand how our results might combine to impact welfare and policy, it is important to weigh the increase in condom coverage — and associated reduction in negative externalities from HIV transmission — against the decrease in average condom effectiveness compared to pure use of male condoms, and the observed increase in the number of sex acts. As an illustrative exercise, we conduct a cost-benefit analysis of two possible scale-ups to the entire female population of South Mozambique: a scale-up of our full training intervention; and a scale-up of just the free distribution of female condoms, with the assumption that information about female condoms can be provided with zero marginal cost via existing sex education programmes. The purpose of this exercise is to highlight the potential magnitudes of the trade-offs involved in introducing a second-best technology, and the quantitative importance of the behavioural response. The purpose is not to provide an accurate cost-benefit estimation, given the inherent uncertainty in extrapolating from our observed treatment effects to what treatment effects would be in the whole population, over a longer time horizon, and from a different version of the intervention in the case of provision via existing sex education programmes.

Online Appendix Section B.4 details the methodology of our cost-benefit analysis in full. We adjust the epidemiological model used by UNAIDS in order to estimate the number of HIV infections and disability-adjusted life years (DALYs) that free access to female condoms would help avert, based on our observed treatment effects. We also factor in productivity gains from a reduction in the burden of HIV, as is standard in the literature. On the cost side, we consider programme costs of introducing female condoms, but also cost savings from reduced provision of anti-retroviral therapies and prevention of mother-to-child transmission treatments.

The results show that accounting for the behavioural response, i.e. the observed increase in the number of sex acts, is crucial. Before accounting for this, both our full programme and adding female condoms to existing sex education programmes actually imply a cost saving. Intuitively, this is because low female bargaining power implies that the main margin of female condom adoption is from women previously having unprotected sex, rather than substitution away from male condoms. However, once we incorporate the behavioural response, only adding female condoms to existing sex education programmes has the potential to be cost-effective in our illustrative simulations.

7 Conclusion

Our results suggest that women with lower female bargaining power indeed struggle to adopt male condoms, in a context typical of many areas of Sub-Saharan Africa with high prevalence of HIV/AIDS. When female condoms are introduced with adequate information and support, they are taken up by women with lower bargaining power, who are otherwise having unprotected sex.

In terms of policy, this means that the correct cost comparison for free provision of female condoms is not the free provision of male condoms, but rather the costs of anti-retroviral therapies and other costs associated with unprotected sex. However, more evidence from a similar intervention with a representative sample of the population and a longer time horizon after adoption is needed to refine the cost-benefit calculations and inform funding decisions.

More broadly, we have highlighted how low female bargaining power may constrain adoption of potentially welfare-improving household technologies, in cases where women have a stronger preference for adoption or face higher costs of non-adoption compared to men. There are many other examples of technologies where women may have a stronger willingness than men to adopt. For instance, women may have a higher demand for insurance, given evidence that they are more risk-averse. In such cases, enhancing women's bargaining power or targeting information and social norm campaigns specifically at men may be the first-best approaches to increasing investments and adoption. Otherwise, providing alternative versions of the technology that are more acceptable to men, or bundling technologies with goods for which men have strong demand, may offer a second-best solution. These remain important topics for future research.

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A Appendix

Table A.1: Treatment effects – primary outcome variables

	(1) **Ever use female condoms**	(2) **Ever use male condoms**	(3) **Ever use other**	(4) **Use last 30 days female condoms**	(5) **Use last 30 days male condoms**	(6) **Current use female condoms**	(7) **Current use male condoms**	(8) **Current use other**
Treatment	0.184***	-0.012	0.020	0.047**	-0.052	0.077**	0.060	0.030
(Standard errors)	(0.042)	(0.041)	(0.042)	(0.023)	(0.057)	(0.030)	(0.058)	(0.053)
[Randomization inference p-value]	[0.000]	[0.777]	[0.649]	[0.080]	[0.359]	[0.025]	[0.348]	[0.583]
Observations	227	227	227	227	227	227	227	227
Control mean endline	0.088	0.824	0.735	0.010	0.363	0.020	0.353	0.412

Notes: Regressions on the balanced sample, N=227. Dependent variables are binary indicators for the use of female condoms, male condoms and other modern contraceptive methods (other), such as the pill, injectables or IUD. Columns 1-3 refer to whether the respondent has ever used the method, columns 4 and 5 to whether she has used it in the last 30 days (this was only asked for condoms, not for other contraceptive methods), and columns 6-8 whether she is currently using it. "Treatment" is an indicator for being assigned to the treatment group (i.e. to the first round of the family planning training sessions) as opposed to the control group (i.e. the second round of training sessions). Not all respondents assigned to treatment attended the sessions, thus the coefficient on "Treatment" is the intent-to-treat effect. All regressions are linear probability model ANCOVA specifications, including the baseline value of the dependent variable as a regressor. All regressions include facilitator dummies (N=16) since randomisation was stratified on facilitator. Standard errors are robust to individual-level heteroskedasticity, since this was the level of randomisation. Randomisation inference p-values are estimated from Monte Carlo simulations re-assigning treatment within facilitator strata, with 1000 repetitions. Significance levels $p < 0.10^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$.

Table A.2: Treatment effects on female condom use, by baseline male condom use

	(1) **Ever use female condom** **No use male condom at baseline**	(2) **Ever use female condom** **Current use male condom at baseline**	(3) **Last 30 days female condom** **No use male condom at baseline**	(4) **Last 30 days female condom** **Current use male condom at baseline**	(5) **Current use female condom** **No use male condom at baseline**	(6) **Current use female condom** **Current use male condom at baseline**
Treatment	0.169***	0.232***	0.073**	0.030	0.085***	0.049
(Standard errors)	(0.047)	(0.074)	(0.030)	(0.034)	(0.031)	(0.057)
[Randomization inference p-value]	[0.004]	[0.006]	[0.023]	[0.532]	[0.035]	[0.490]
Observations	141	86	141	86	141	86
Control mean endline	0.092	0.081	0.000	0.027	0.000	0.054

Notes: Regressions on the balanced sample, N=227. Dependent variables are binary indicators for the use of female condoms: ever used in columns 1-2, used in last 30 days in columns 3-4, and currently using in columns 5-6. Odd-numbered columns present results for the subsample of individuals who were not currently using male condoms (No use) at baseline; even-numbered columns present results for the subsample of individuals who were currently using male condoms (Current use) at baseline. "Treatment" is an indicator for being assigned to the treatment group (i.e. to the first round of the family planning training sessions) as opposed to the control group (i.e. the second round of training sessions). Not all respondents assigned to treatment attended the sessions, thus the coefficient on "Treatment" is the intent-to-treat effect. All regressions are linear probability model ANCOVA specifications, including the baseline value of the dependent variable as a regressor. All regressions include facilitator dummies (N=16) since randomisation was stratified on facilitator. Standard errors are robust to individual-level heteroskedasticity, since this was the level of randomisation. Randomisation inference p-values are estimated from Monte Carlo simulations re-assigning treatment within facilitator strata, with 1000 repetitions. Significance levels $p < 0.10^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$.

Table A.3: Impacts on likelihood of sex acts per respondent week – diary subsample

	(1) **Sex act per week full endline period**	(2) **Sex act per week last 30 days**	(3) **Sex act per week last 14 days**
Treat × endline	0.091**	0.113**	0.158*
	(0.045)	(0.057)	(0.086)
Facilitator × endline f.e.'s	✓	✓	✓
Observations	863	536	367
Control mean	0.469	0.471	0.491

Notes: Regressions on the balanced diary sample, N=56. Dependent variables are binary indicators for whether a respondent had at least one sex act in a particular week. Column 1 refers to whether the respondent had at least one sex act per week in the full endline period, Column 2 whether she had at least one sex act per week in the last 30 days, and Column 3 whether she had at least one sex act per week in the last 14 days. All regressions in this panel are linear probability individual fixed effects models comparing the probability of a sex act in a week during the baseline period with the probability of a sex act in a week during the specified endline period, with the respondent-week as the unit of observation (N=863 for the full endline period, N=536 for the last 30 days, and N=367 for the last 14 days). "Treat × endline" is an indicator for observations in the treatment group (i.e. assigned to the first round) during the relevant endline period ("full endline", "last 30 days", or "last 14 days") as opposed to the control group (i.e. assigned to the second round). Not all respondents assigned to treatment attended the sessions, thus the coefficient on "Treat × endline" is the intent-to-treat effect. All regressions include facilitator × endline fixed effects (N=16) since randomisation was stratified on facilitator. Standard errors (in parentheses) are robust to individual-level heteroskedasticity, since this was the level of randomisation. Significance levels $p < 0.10^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$

Table A.4: Likelihood of sex acts: Interaction of treatment and baseline male condom use – diary subsample

	(1) **Sex act per week full endline period**	(2) **Sex act per week last 30 days**	(3) **Sex act per week last 14 days**
Treat × endline	0.139***	0.200***	0.197**
	(0.051)	(0.050)	(0.098)
Treat × endline × male condom at baseline	-0.105	-0.174**	-0.078
	(0.081)	(0.071)	(0.102)
Facilitator × endline f.e.'s	✓	✓	✓
Observations	863	536	367
Control mean	0.469	0.471	0.491

Notes: Regressions on the balanced diary sample, N=56. Dependent variables are binary indicators for whether a respondent had at least one sex act in a particular week. "male condom at baseline" is a binary indicator for whether a respondent reported at baseline that she was currently using male condoms. Column 1 refers to whether the respondent had at least one sex act per week in the full endline period, Column 2 whether she had at least one sex act in the last 30 days, and Column 3 whether she had at least one sex act in the last 14 days. All regressions in this panel are linear probability individual fixed effects models comparing the probability of a sex act in a week during the baseline period with the probability of a sex act in a week during the specified endline period, with the respondent-week as the unit of observation (N=863 for the full endline period, N=536 for the last 30 days, and N=367 for the last 14 days). "Treat × endline" is an indicator for observations in the treatment group (i.e. to the first round of the family planning training sessions) during the relevant endline period ("full endline", "last 30 days", or "last 14 days") as opposed to the control group (i.e. the second round of training sessions). Not all respondents assigned to treatment attended the sessions, thus the coefficient on "Treat × endline" is the intent-to-treat effect. All regressions include facilitator × endline fixed effects (N=16) since randomisation was stratified on facilitator. Standard errors (in parentheses) are robust to individual-level heteroskedasticity, since this was the level of randomisation. Significance levels $p < 0.10^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$