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Subjective expectations and demand for contraception☆

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ABSTRACT

One-quarter of married, fertile-age women in Sub-Saharan Africa report not wanting a pregnancy and yet do not practice contraception. We collect detailed data on the subjective beliefs of married, adult women not wanting a pregnancy and estimate a structural model of contraceptive choices. Both our structural model and a validation exercise using an exogenous shock to beliefs show that correcting women's beliefs about pregnancy risk absent contraception can increase use considerably. Our structural estimates further indicate that costly interventions like eliminating supply constraints would only modestly increase contraceptive use, while confirming the importance of partners' preferences highlighted in related literature.

1. Introduction

Total fertility rates in low-income countries remain high, averaging 4.6 children per woman (World Development Indicators, 2019). Importantly, these appear markedly higher than desired by women: in nationally representative surveys, about one quarter of married, fertile-age women in these countries state that they do not wish to become pregnant, but are also not using contraceptives — a phenomenon commonly referred to as "unmet need for family planning". This results in over 52 million unwanted pregnancies

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and about 70,000 maternal deaths due to unsafe abortions each year (Singh et al., 2014). However, there is surprisingly little systematic evidence about why this so-called unmet need persists.

On the supply-side, fewer than 10% of married women with unmet need across 52 low-income countries cite high cost or inadequate supply as the primary reason for not using contraceptives (Sedgh et al., 2016), and the results of randomized controlled trials providing subsidies for contraceptive use are mixed — e.g., Chin-Quee et al. (2010) and Desai and Tarozzi (2011) find no effect while Anukriti et al. (2021) and Athey et al. (2021) do, suggesting that the importance of supply-side constraints varies across settings. On the demand side, high fertility is strongly correlated with high *desired* fertility (Pritchett, 1994), but very little is known in quantitative terms about the causes of the gap between women's fertility intentions and the practice of contraceptive methods beyond evidence that partner's preferences matter for contraceptive use generally (see, e.g., Ashraf et al., 2014, 2018; Cassidy et al., 2021, for experimental evidence). Notably, however, nearly half of women not using contraceptives but desiring to avoid pregnancy cite either breastfeeding/amenorrhea or infrequent sex as the primary reason for not using contraception (44% across the 52 countries included in Sedgh et al., 2016) — and may therefore incorrectly believe that they face a low risk of pregnancy.[1] If many women underestimate pregnancy risk absent contraception, then simply recalibrating their beliefs may increase contraceptive use.

In this paper, we use detailed data on the subjective beliefs of women in Mozambique to study the role of both supply- and demand-side determinants of *whether*- and *what* contraceptive to use among adult women in union who do not wish to become pregnant. We quantify women's preferences over a broad set of contraceptive choices and attributes using a structural model and use estimates to predict how contraceptive use would respond to a range of potential technologies and family planning program strategies. We then conduct a validation exercise in which we create an exogenous information shock by informing women about the average risk of pregnancy in the population absent contraception. This provides an estimate of the ("first-stage") effect of this information treatment on beliefs about pregnancy risk and a ("reduced-form") effect on intentions to use contraception in the future, as well as allow us to evaluate our model predictions regarding *actual use* against this exogenous benchmark.

In doing so, we make four contributions to existing literature: two substantive- and two methodological ones. Substantively, our main contribution is to provide novel evidence – consistent across our structural estimates and reduced-form validation exercise – that women's own perceived probabilistic risk of pregnancy absent any form of contraception contributes to the widespread discrepancy between pregnancy intentions and contraceptive use. This is an important substantive contribution given the absence of previous evidence going beyond self-reported reasons for non-use or very coarse proxies such as a binary indicator for whether the woman believes her fecundity to be impaired (Nettleman et al., 2007; Mosher et al., 2015; Embafrash and Mekonnen, 2019; Gahungu et al., 2021).[2]

Our second substantive contribution is to document probabilistic beliefs about contraception (and the absence thereof) and use them to structurally model its demand *in a developing country*, a type of setting in which beliefs, preferences, and both economic and societal constraints are likely to differ substantially from those previously studied (namely, predominantly college students in the US in Delavande, 2008 and young Japanese women in Nakamura, 2016).

We further make two methodological contributions. First, in addition to estimating a structural model closely related to Delavande (2008), we obtain reduced-form estimates from an exogenous information shock. Namely, we carry out an information intervention at the end of our survey, in which we compare women before- and after- we provide them information about the WHO reference risk of pregnancy within 12 months when not using contraception (85%, communicated as "Studies show that, on average, out of every 20 sexually active women of reproductive age who do not use any contraceptive method, 17 will get pregnant within the next 12 months"). Further to directly testing for immediate changes in beliefs and in intended contraceptive use, we are able to compare the effect of the exogenous information provision on intended contraceptive use with the effect on *actual* contraceptive use that our model predicts given the observed exogenous change in beliefs.

Our second methodological contribution is to devise a new test of experimenter demand effects (EDE) to address the potential concern that the updates in beliefs and intentions we observe after our information intervention may be systematically biased — e.g., because the subject wants to please the person who gave them the new information. Specifically, we model EDE as a form of measurement error and derive testable implications of the presence of EDE in beliefs and in intentions to use contraception. These implications can then be tested by comparing different estimates of the effect of beliefs on intentions using data obtained both before- and after treatment. Intuitively, EDE — whether in beliefs or intentions or both — introduces bias in post-treatment estimates, so estimates using before- and after-treatment data should differ if EDE is present. "Within-subject experiments" comparing the beliefs of the same individuals before- and after they receive some information are the "most common approach to date in the literature" (Fuster and Zafar, 2022, , p. 119). They have higher power than between-subject experiments — whereby different subjects are randomized into receiving or not the information, but may be more prone to experimenter demand effects. A similar test to the one we propose can be applied in other contexts and complements prior approaches which are appealing but more costly

[1] Close to half (47%) of women reporting infrequent sex as a reason for not using contraception report having sex in the preceding three months. Most women reporting breastfeeding or post-partum amenorrhea as the main reason for not using contraception do not meet the World Health Organization (WHO) criteria for lactational amenorrhea as protection against pregnancy (Sedgh et al., 2016).

[2] Structural estimates in Delavande (2008) could be used to predict the effect of changing own perceived risk of pregnancy on non-use, but this aspect is not investigated in the study — understandably so since 97 out of the 100 women included in the analysis already use modern contraception. Nakamura (2016) also analyses demand for contraception in a similar subjective expected utility framework but focuses on the choice between different modern methods so that non-use is not modeled.

as they rely on either additional, qualitative data collection to validate survey data (Blattman et al., 2019) or on additional treatment arms in which experimenter demand is made more or less explicit (De Quidt et al., 2018; Mummolo and Peterson, 2019).

We first find, descriptively, that women generally hold accurate (or plausible) beliefs along many dimensions, but forty percent of respondents underestimate the probability of pregnancy absent contraception and the majority underestimates the efficacy of hormonal contraceptives (in the latter case, on average by as much as 3–5 times the true efficacy for injections and implants, respectively).

Identifying information gaps is a necessary condition for improved information to lead to changes in outcomes. It is however not a sufficient condition, since individuals may not take the variables on which they have miscalibrated beliefs into account when making decisions. Our structural model provides estimates of the utility "weights" associated with these variables, which enables us to predict the effect of a range of counterfactuals. One key finding of this exercise is that fully correcting beliefs about pregnancy risk absent contraception among women who underestimate this risk raises contraceptive use by about 6.7 pp among this group and by 2.7 pp overall. This is in contrast to correcting beliefs about contraceptive efficacy, which the model reveals would have a negligible effect despite the very large underestimation of the efficacy of hormonal methods prevailing in our sample.

Strikingly, our structural analysis also shows that, in our context, common supply-side interventions are unlikely to effectively increase use: even the most dramatic (and costly) increase in supply, removing all direct and indirect monetary costs of contraceptives, eliminating waiting times, and removing uncertainty about availability increases contraceptive prevalence by only 1.1 percentage points (pp). Similarly, new technologies with no side effects increase contraceptive prevalence by about 0.3 pp. Alternatively, changing men's fertility preferences and their 'approval' of contraceptives is more effective — if feasible. Aligning fertility preferences between women and their partners increases contraceptive prevalence by 2.4 pp, and setting women's expectations that their partners will approve available forms of contraception to 100% raises contraceptive prevalence by 7.5 pp.

The findings from our validation exercise further show that, once informed of the population average risk of pregnancy absent contraception, women realign their probabilistic beliefs about their own risk of pregnancy with this population statistic. The fact that beliefs about own risk of pregnancy strongly respond to information about average population risk suggests that the initial gap is less due to private information about own risk of pregnancy relative to the average woman than to incorrect beliefs about overall population risk.

Importantly, our structural estimates are consistent with findings based on exogenous variation in beliefs about own risk of pregnancy absent contraception. Among the main target of our information shock – namely women who, at baseline, believe to be at a lower risk of pregnancy absent contraception than the general population (i.e., below 85%) – our information intervention increases own expected risk of pregnancy absent contraception by 23.5pp and intention to use contraceptives in the future by 4.4pp. This is very close to our structural prediction of the effect of a 23.5pp change in beliefs on *actual* contraceptive use (4.8pp). Reassuringly, our tests do not suggest the presence of EDE on either beliefs or intentions to use contraception among this key group of women. Women whose baseline beliefs are above 85% revise their beliefs downwards, in line with our information message, but they do not decrease their intentions to use contraception, thus assuaging concerns about unintended consequences.

In addition to the prior literature reviewed above and to which our study most directly contributes, we add to the growing number of economic studies incorporating beliefs data — extensively reviewed in Bachmann et al. (2022), which have the advantage of allowing preferences to be disentangled from beliefs without assumptions about these beliefs — e.g., that the subjective expectation used by the individual when making decisions is equal to the average outcome observed in the population. Our work also complements existing research on the correlation between contraceptive use and demographic, socio-economic and community characteristics (e.g., Ainsworth et al., 1996; Stephenson et al., 2007; Wulifan et al., 2015; Gahungu et al., 2021) and on the impact of family planning programs (reviewed in Miller and Babiarz, 2016). Our study is further related to a rich literature which has produced mixed experimental evidence of the effect of providing information on health and education beliefs and behaviors in developing countries (Dupas and Miguel, 2017; Muralidharan, 2017; Ciancio et al., 2020).

In the rest of the paper, we provide details about context, data collection and surveyed women's characteristics (Section 2), describe the beliefs data (Section 3) and present the model and estimation approach (Section 4), before reporting our model estimates and counterfactuals (Section 5) and validation exercise (Section 6). Section 7 concludes.

2. Context, data collection and respondents' characteristics

2.1. Context

Even in Sub-Saharan Africa (SSA), where desired fertility is high (4 children), total fertility is 25% higher than desired fertility (5.1 children, on average across the 32 SSA countries studied in Sedgh et al., 2016). In addition, 24% of married women aged 15–49 in SSA have an unmet need for family planning (23.1% in Mozambique) (World Development Indicators, 2019). This gap between fertility desires and modern contraceptive use is only marginally filled by the use of traditional methods. Indeed, in Sub-Saharan Africa, 27.7% of married women aged 15–49 use modern contraception whereas 31.5% use either modern or "traditional" contraception such as periodical abstinence and withdrawal. The corresponding figures for Mozambique are 25.3% and 27.1% (World Development Indicators, 2019).

With a GDP per capita of only US $426 per capita in 2017, Mozambique is one of the poorest countries in the world. Fertility is just above the average in Sub-Saharan Africa of 4.8 children per woman, and has been decreasing only slowly: the Mozambican total fertility rate (TFR) was 5.9 in 1996, and 5.2 by 2017 (World Development Indicators, 2019).

In the three provinces in the south of the country in which we collected our data, according to MISAU, INE and ICF (2016) the TFR ranges from 2.5 children per woman in the capital city Maputo to 4.7 in Gaza Province and contraceptive prevalence ranges from 42% to 47% (as in Kenya or Malawi in 2010).

2.2. Data collection and respondents' characteristics

In keeping with the focus of our research – namely the causes of the gap between women's fertility intentions and contraceptive use – we only collected data from women who state that they do not want to have another child at least in the coming two years (following the Demographic and Health Surveys' cutoff) and who were likely to need contraception to achieve their fertility intention. Note that the wording of the questions about fertility desires follows the exact wording of the Demographic and Health Survey to speak directly to the policy debate surrounding unmet need. This, however, comes with the limitation that different respondents may give different answers if they have different perceived costs of contraception despite having the same fertility desires holding the cost of contraception constant. This could potentially result in women with high expected costs of contraception (monetary or otherwise) being less likely to be sampled.

More specifically, we used a screening questionnaire to identify women who: (1) were between 18 and 49, (2) were currently married or living maritally, (3) whose husband or partner, if working away, normally returned home at least once per month, (4) did not identify as infecund when asked about their pregnancy intentions, (5) were not pregnant, and (6) did not want any more children or wanted more but did not want another child in the coming two years. Out of the 758 women screened, 107 were deemed ineligible due to criteria (1) to (6). We also asked the remaining 651 women how likely they would be to state the same fertility intentions if the enumerator came one month later and asked them the same questions, and they all answered that they would either "certainly" (86%) or "probably" (14%) give the same answers.

The probabilistic beliefs survey instrument followed best practices in the area, including the inclusion of a training module and the use of visual aids (dried beans on a grid) (Delavande et al., 2011; Delavande and Kohler, 2012).[3] As part of the training module, respondents were asked questions about events they are familiar with such as the probability that they will go to the market in the coming 2 days/2 weeks, creating opportunities for the respondents to receive feedback on the consistency of their responses. After completing the training module, the respondents received no comments on their answers.

Using the same wording as in the DHS, we identified women's knowledge of contraceptive methods, prompting them with a brief description whenever they did not immediately say they knew of a method. For all the methods (modern or "traditional") that the respondent said they knew of, as well as for the "no method" alternative, we elicited women's probabilistic beliefs about all the main factors which previous literature has suggested may matter in the decision to use a contraceptive method. We asked about the expected direct costs and indirect costs (e.g., transport costs) of using each method they knew of, as well as about their expected chance of: pregnancy within 12 months; contracting a STD within 12 months; experiencing nausea or headaches; experiencing menstrual irregularities or vaginal infections; experiencing "other" negative side effects;[4] alteration of (their or their partner's) libido or sexual pleasure or interference with romance; getting pregnant within 12 months of discontinuation if wanting to get pregnant; obtaining the method when needed; approval by their partner; being able to use the method – or not using any method in the case of the "no method" alternative – without their partner's knowledge, if for any reason the respondent did not want their partner to know.[5] Responses to the latter question is our measure of perceived concealability. After eliciting women's probabilistic beliefs about contraception, we also asked, among others, about their intentions to use contraception in the future (following the DHS wording of "Do you intend to use a method to postpone or prevent getting pregnant, at some point in the future? Yes/No/Don't know"), about their partner's desired fertility, and about their sexual activity in the previous month and previous three months.[6]

Fig. 1 provides an overview of the survey structure. An English translation of the full questionnaire can be found in Appendix A-7.

The survey collected data across nine districts of three provinces in Southern Mozambique (Maputo city, Maputo Province and Gaza Province) between January and February, 2018. The door-to-door recruitment of respondents was guided by targets for the distribution of women's level of education based on the latest Demographic and Health Survey (DHS) at the time of fieldwork (DHS 2011) — the targeted proportions were achieved within a maximum 3 pp margin of error.

The enumerators carried out full interviews with 651 eligible women. Of these women, 20 are not sexually active (i.e., report not having had sex in the previous three months) and 24 qualify as infecund based on the DHS definition, and so we drop them from the sample.[7] We also drop 23 women who say they use family planning strategies other than the five main options we consider (injections, no family planning, contraceptive pill, implants and male condoms), such as IUDs (10 women) and traditional methods (6 women) as the number of women using each of these methods is too limited to allow estimation. Out of the 584 women in the resulting analytical sample, 14 women use a combination of methods (i.e., some combination of condom and hormonal method, except for one case combining the pill and implants). In the 13 cases combining a hormonal method with male condoms, we assign the woman to the hormonal method under the assumption that, in these cases, condoms are used mainly for protection against STDs

[3] Based on evidence presented in Delavande et al. (2011), we asked respondents to express their answers out of 20 rather than out of 10 to improve precision.

[4] After being asked about nausea/headaches and menstrual irregularities, respondents were asked about their chances of "experiencing other negative effects on their health or day-to-day activities as a result of using" each method. This question is aimed at capturing health concerns about contraceptive use, whether relating to actual risks (e.g., breast discomfort, acne, mood swings, etc…) or not.

[5] Pregnancy risk and risk of contracting a STD within 12 months combine expected frequency/timing of intercourse and perceived risk per intercourse. If some women under-report perceived risks over 12 months absent contraception to avoid the potential stigma associated with frequent sex, this may bias our estimates. But as discussed in Section 6.2 , our data suggests that this is unlikely.

[6] To limit respondent fatigue and for comparability with the DHS, we elicit binary intentions to use contraception instead of choice probabilities. See Stinebrickner and Stinebrickner (2014) for a thorough discussion of the benefits of eliciting choice probabilities.

[7] I.e., they started living maritally five or more years before the interview, are not currently using and have never used contraception, but have not had a child in the past five years and are not pregnant.

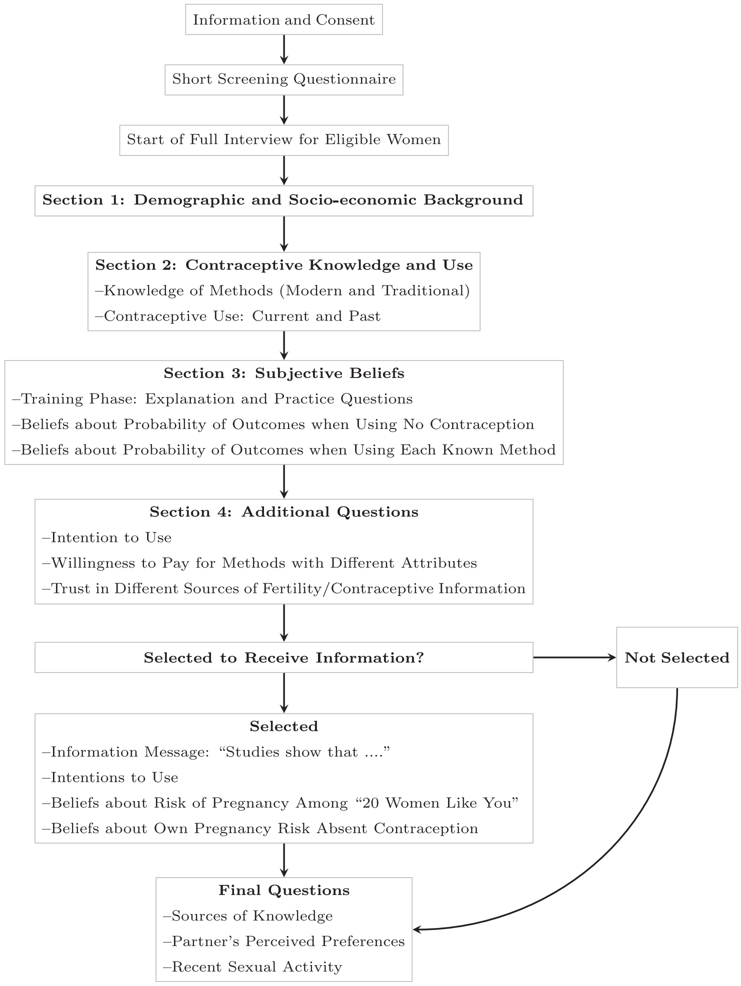

Fig. 1. Questionnaire overview. See Appendix A-7 for an English translation of the full questionnaire.

rather than family planning. In the remaining case in which the pill and implants are combined, we assign the woman to implants as it is the most effective of the two methods and it seems likely that the pill was prescribed in order to combat the implants' side effects such as to regulate bleeding.

Respondents' characteristics are described in detail (Table A-1) and compared to those from a representative survey (Table A-2) in Appendix A-1. To summarize, the modal age group in our sample is 25–34 and the typical woman has either some primary schooling (44%) or some secondary schooling or above (42%), and women have on average 2.6 children. Thirty percent of our respondents are not using any contraceptive method despite all saying that they do not want to have a child (at least in the coming two years) and respondents knowing, on average, 5.4 contraceptive methods. The most popular contraceptive method is injections, followed by the pill, implants and male condoms. This is largely similar to the method mix reported among comparable women in the latest relevant representative survey, the 2015 AIDS Indicator Survey (AIS).

3. Beliefs data

3.1. Data validity

To check the extent to which respondents understand the concept of probability — although the word "probability" was not used when eliciting beliefs, we asked respondents to show the enumerator the number of dried beans (out of 20) that best reflected their chance of getting pregnant in the coming year, and then in the coming 5 years. Under 8% of women responded a larger probability in the coming year than in the coming 5 years at their first attempt. After the enumerator explained to these women that she expected a response indicating a larger probability in the coming 5 years than in the coming year as she would have 4 more years, 5% of women still give a lower probability of getting pregnant within 5 than within 1 year. In a robustness check, we exclude these women from the sample and find similar results. Note that, in this training phase, respondents were asked about their perceived risk of pregnancy without specifying whether using contraception or not. Other than in this robustness check, answers to these training questions about the woman's perceived chance of pregnancy in the next 12 months or 5 years were not used in the analysis.

We also asked women to tell us, for four different months in the calendar year (April 2018, July 2018, October 2018, and January 2019), the number of beans which best reflected the probability that it would rain in any given day during this month. While in the years prior to the survey there was much year-on-year variability in the number of rainy days in April and July, women should know that January is the peak of the rainy season while October is a reliably mostly dry month.[8] Figure A-1 shows the distribution of the difference between the expected probability of rain in any given day in January and October. The average difference in answers for the two months is 3.6 beans, compared to an actual difference – expressed in 5-percentage point beans – of 6.2 (3.7) between 2015 and 2017 (2009 and 2018). This suggests that women understood the survey instruments well and elicited probabilistic beliefs are reliable.

Reassuringly, women answer 95.4% of beliefs questions on average, 72% of women have at most 5% of missing answers and only 2% of women have 25% or more missing answers. Table A-3 also reports details of missing values by method and by belief, and Section A-3 shows that our main findings are robust to excluding women with any missing answers. Another possible concern in these types of data is "bunching" at focal values like 0%, 50%, or 100% (see Dominitz and Manski, 1997). Only five respondents concentrate all their answers in the values 0, 5, 10, 15 or 20 out of 20 beans and our conclusions are unaffected by their exclusion from the sample (see Section A-3).

3.2. *Descriptive statistics*

Table 1 reports selected probabilistic beliefs statistics where answers out of 20 dried beans are converted in probabilities (out of 1) for convenience. For conciseness, in this subsection we only highlight some key features of our sample's beliefs about themselves.[9] Descriptive statistics for the other alternative-specific beliefs can be found in Table A-4, and a longer discussion of the beliefs held by the women in our sample is provided in Appendix A-2.

The women in our sample appear to have a very good knowledge of the risk of pregnancy when using condoms. They report this risk to be 17% on average, which is within the 13%–18% pregnancy risk under typical use reported by the WHO.[10] Their average expected probability of pregnancy when using no method is high (78%), but it is slightly lower than the risk in the general population of sexually active women according to the WHO (85%) (WHO/RHR, 2016; WHO/RHR and CCP, Knowledge for Health Project, 2018). While it is not possible to say exactly what the true risk of pregnancy is for the women in our sample under each method, the risk incurred when using methods such as implants, for which there is no variability coming from user's adherence to instructions, should be close to the WHO effectiveness statistics unless the quality of contraceptive products or insertion is questionable. Estimates under common use – and therefore taking into account unreliable/low quality supply issues and delays in renewal – range, across developed and developing countries, from a failure rate of 0.05% for implants to 6% for injections over the course of one year (WHO/RHR, 2016; WHO/RHR and CCP, Knowledge for Health Project, 2018; Polis et al., 2016), and failure rates in Mozambique are *below* the median based on data from 43 DHS surveys (Polis et al., 2016). Given this, women appear to vastly overestimate the risk of contraceptive failure associated with these methods, which are at least three times more effective than indicated by the average sample beliefs.[11] Since the smallest non-zero probability respondents can assign to an event is 5 pp (1 bean) and previous evidence supports the hypothesis that individuals have an aversion to hold or report beliefs close to certainty (reviewed in Benjamin, 2019), it is perhaps not surprising that respondents tend to over-estimate the risk of pregnancy when using implants. However, the average risk of pregnancy associated with implants is 25%, or much more than what can be explained by the limited range of possible responses. Interestingly, Table 3 shows that users of hormonal methods are not better informed about these methods' risk of failure suggesting little learning from own use, as further discussed in Section 5.3 — and consistent with the idea that women rely on information about their wider peer group or other common sources of information rather than extrapolating from their own, single experience.

As in many other developing countries today, family planning methods are available free of charge in government facilities in Mozambique, and are also available at a cost from private providers. Consistent with the fact that, except for male condoms, at least 85% of users in the last DHS (2011) obtained their contraceptives from public providers, expected direct monetary costs are low (from 14 to 27 Meticais per month or an annual cost of no more than about 1% of GDP per capita).[12]

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8 The number of rainy days by month between 2015 and 2017 is: 9 to 16 in April, 2 to 13 in July, 16 to 19 in January and 7 to 8 in October (https://www.worldweatheronline.com/maputo-weather-averages/maputo/mz.aspx).

9 We did not collect data on population beliefs or beliefs about "20 women like you" until women received the information shock described in Section 6.1.

10 See WHO/RHR (2016) and WHO/RHR and CCP, Knowledge for Health Project (2018). These are based on the "best available source as determined by authors" (p. 383 of WHO/RHR and CCP, Knowledge for Health Project, 2018). Data from self-reports in developing countries uncorrected for underreporting of abortion indicate a lower rate of unintended pregnancies with male condoms (median of 5.4% Polis et al., 2016).

11 One threat to adherence to the prescribed use of hormonal methods may be issues with method renewal. But the expected chance of obtaining hormonal methods when needed in our sample is very high (82%–86%, see Table A-4).

12 We are not aware of a survey of contraceptive prices in private facilities in Mozambique around the relevant time period, but follow Stover and Chandler (2017)'s advice of using data from Kenya as closest substitute, which we report in the top panel of Table 1. If costs in Kenya were similar to those in the three provinces of Mozambique in which we collected data, then it would suggest that respondents overestimate costs, although still expecting them to be relatively low. It is however possible that private facilities in these provinces charge more than the Kenyan average.

We also elicited women's expected probability of approval of each alternative contraceptive method by their coreligionists (i.e., individuals who share the same religion, whose opinions may or not align with the position of religious *authorities*), as well as their parents, friends and partner. Expected approval by coreligionists, friends and parents are thought of as capturing both opposition from people whose opinions women may value and opposition by the woman herself due to religious or cultural reasons. The women's expected probability of approval by others is generally low (60% or less), especially in the case of coreligionists. As expected, women who say that their partners want more children or want them earlier than them have a lower expected probability that their partners would approve of them using a method relative to not using a method.[13] Partners' fertility preferences – which do not vary within woman – are however not the only driver of differences in expected approval across alternatives, which vary within woman: the pairwise coefficient of correlation (ρ) in partner approval across the three hormonal methods is between .68 and .69, and that between condoms and hormonal methods between .37 and .47. Similarly, approval of the "no method" alternative is overall largely uncorrelated with that of specific contraceptive methods (ρ between -.12 and -.01) even though, unsurprisingly, over a quarter of women expecting a high chance (15/20 and above) of partner approval of injections expect a zero chance of approval of the no method alternative, for instance. Taken together, these data suggest that (i) many women believe that their partners are willing to use contraception to achieve the women's family plan even though they personally do not wish to avoid a pregnancy and (ii) method-specific attributes influence partners' willingness to use them.

In summary, women in our sample are, on average, well informed about the failure rate of the male condom method, but a large minority underestimates the probability of pregnancy when not using any contraception and the average respondent vastly overestimates (by a factor of 3 or more) the probability of pregnancy when using hormonal methods, resulting in a large underestimation of the ability of hormonal methods to protect women against pregnancy relative to using no method. Reassuringly, however, women do not generally appear to be under the misconception that hormonal methods have adverse effects on their ability to get pregnant after discontinuation. Women also understand perfectly well that only condoms protect against STDs, and have a high expected risk of contracting STDs when using no protection. Expected monetary costs, waiting times and other issues with supply are low. The expected probability of side effects is high and within a reasonable range compared to external sources, although our respondents do not fully appreciate the differences in risk levels between injections/implants compared to the pill. Finally, expected rates of "approval" by others are low for every available alternative that the women could choose including using no method.

Another important characteristic of these subjective beliefs data is their dispersion, even within groups defined by socioeconomic status and demographic characteristics.[14] If every woman with similar observable characteristics held the same beliefs, then there would be no need to collect subjective beliefs data to identify their preferences for different aspects of family planning — population averages (e.g., on the chance of pregnancy within 12 months for given observable characteristics) would suffice. This is however not the case. There is much variation in beliefs, as illustrated by the standard deviations reported in Table A-4. This is true even within demographic/SES group. For instance, the expected probability of pregnancy within 12 months varies much within age group, as shown in Fig. 2.

In the next section, we use these data to identify women's preferences regarding the wide range of contraceptive characteristics about which we elicited beliefs and predict the effect of several interventions on contraceptive use.

4. Model and estimation

4.1. Intuition

The idea of our modeling exercise is that women choose the alternative (no method, injections, pill, condoms or implants) associated with the highest utility when taking into account all the expected consequences of choosing each alternative in their choice set — i.e., all the methods they know of among injections, pill, condoms, implants plus the "no method" alternative. The combination of the contraceptive choice they make and their beliefs about the consequences of this choice provides information about how much they care about each of the perceived characteristics of each method. For illustration, consider the distribution of beliefs about partner approval for each potential method (rows) by method used (columns) (Table 2). Except for women using no method, for whom the highest expected level of partner approval would be achieved by using condoms, the method chosen is the one with the highest average expected rate of approval by partners. There is therefore a strong correlation between the perceived likelihood of partner approval and a woman's current method. If confirmed after controlling for women's method-invariant characteristics – including whether their partner wants more children or wants them earlier – and beliefs about the many other aspects of contraceptive methods, this would indicate that women have a strong preference for method approval by their partners.

Similarly, we can compare, for each method used, women's expected risk of pregnancy within 12 months (Table 3). On average, women do not systematically choose the method they believe to have the lowest pregnancy risk. On the other hand, compared to women using contraceptive methods, women who do not use any method also have the lowest expected risk of pregnancy when not using any method. Without controlling for other women's characteristics and perceived methods attributes, however, it is difficult to say how much utility women derive from a reduction in the risk of pregnancy.

[13] For instance, the expected probability of approval if using injections minus the expected probability of approval if not using any method is 25 (2) pp on average among women whose partners have similar (higher) fertility preferences.

[14] This is a recurrent finding in subjective beliefs data, and was first noted by Dominitz and Manski (1996).

Table 1
Summary Statistics for Selected Alternative-Specific Variables.
Source: Reference figures in italics: WHO/RHR (2016), WHO/RHR and CCP, Knowledge for Health Project (2018). Side effect risks are from Burkman (2001) and Odwe et al. (2020). Private practice prices come from Stover and Chandler (2017). Public facility prices are all free (Global Development Support, 2017). For all other figures: survey described in Section 2.2.

	If using:	Condoms	Implants	Injections	No Method	Pill
WHO P(Pregnancy w/i 12 months)		*0.18*	*0.01*	*0.06*	*0.85*	*0.09*
Average Monthly Costs (Metical): Private		*8.43*	*206.46*	*9.92*	*N/A*	*11.16*
Average Monthly Costs (Metical): Public		*0*	*0*	*0*	*N/A*	*0*
Nausea Risk		*N/A*	*0.01-0.03*	*0.02-0.04*	*N/A*	*0.2-0.4*
Menstrual Irreg.		*N/A*	*0.5-0.6*	*0.7-0.8*	*N/A*	*0.14-0.5*
Other Side Effects		*N/A*	*0.38*	*0.38*	*N/A*	*0.6*
P(Pregnancy within 12 months)	Mean	0.17	0.25	0.19	0.78	0.35
	SD	0.27	0.25	0.23	0.26	0.3
	Obs.	553	469	537	579	540
P(STD within 12 months)	Mean	0.14	0.79	0.78	0.75	0.78
	SD	0.27	0.24	0.24	0.27	0.24
	Obs.	557	494	550	566	549
E(Method Cost)	Mean	22.47	25.64	27.03	0	14.07
	SD	130.85	190.58	196.86	0	99.16
	Obs.	554	498	549	584	545
E(Other Costs)	Mean	22.58	27.37	36.55	0	24.07
	SD	171.70	194.50	249.78	0	208.58
	Obs.	554	498	550	584	547
P(Menstrual Irreg. or Vaginal Infections)	Mean	0.06	0.52	0.58	0	0.46
	SD	0.18	0.26	0.30	0	0.31
	Obs.	540	430	529	584	517
P(Nausea or Headache)	Mean	0.03	0.24	0.21	0	0.44
	SD	0.116	0.265	0.258	0	0.319
	Obs.	539	414	507	584	503
P(Other Negative Effects)	Mean	0.06	0.33	0.31	0	0.31
	SD	0.164	0.266	0.296	0	0.272
	Obs.	539	440	523	584	516
P(Altered Libido, Pleasure or Romance)	Mean	0.26	0.15	0.19	0	0.14
	SD	0.32	0.22	0.27	0	0.24
	Obs.	533	418	513	584	497
P(pregnancy after Discontinuation)	Mean	0.81	0.69	0.69	0.73	0.75
	SD	0.293	0.24	0.25	0.29	0.23
	Obs.	552	462	534	575	539
P(Partner Approval)	Mean	0.55	0.54	0.58	0.4	0.6
	SD	0.32	0.30	0.32	0.34	0.31
	Obs.	554	491	550	574	549
P(Hide from Partner)	Mean	0.05	0.32	0.42	0.32	0.38
	SD	0.18	0.30	0.34	0.33	0.32
	Obs.	558	487	550	573	551

P(·) stands for "probability of event happening" and E(·) is the expectation operator. "STD" refers to the perceived probability of contracting a STD. Costs are expected monthly costs. When the number of observations is less than 584, this is due to either some women not knowing of the relevant method and therefore the method not being in her choice set (see the last column of Panel B of Table A-1 for the number of women who know of each method), or to women not answering a question about a method (see Table A-3 for details of item non-response). Waiting time corresponds to the middle of the interval chosen by respondents and is expressed in minutes. Top 1% in terms of costs and waiting times removed.

Table 2
Perceived Probabilities of Approval by Partner.
Source: Survey described in Section 2.2.

	Current Users of:									
	No Method		Injections		Pill		Implants		Condoms	
	mean	*N*	mean	*N*	mean	*N*	mean	*N*	mean	*N*
No Method	0.46	173	0.38	172	0.37	118	0.37	56	0.41	55
Injections	0.49	161	0.70	178	0.56	112	0.49	50	0.58	49
Pill	0.52	164	0.61	162	0.70	118	0.56	53	0.63	52
Implants	0.49	149	0.54	141	0.53	99	0.65	56	0.56	46
Condoms	0.53	161	0.52	171	0.56	113	0.51	54	0.72	55
N	176		178		119		56		55	

Average perceived probabilities that the respondents' partners would approve of the woman choosing the alternative appearing in the row heading, by current method.

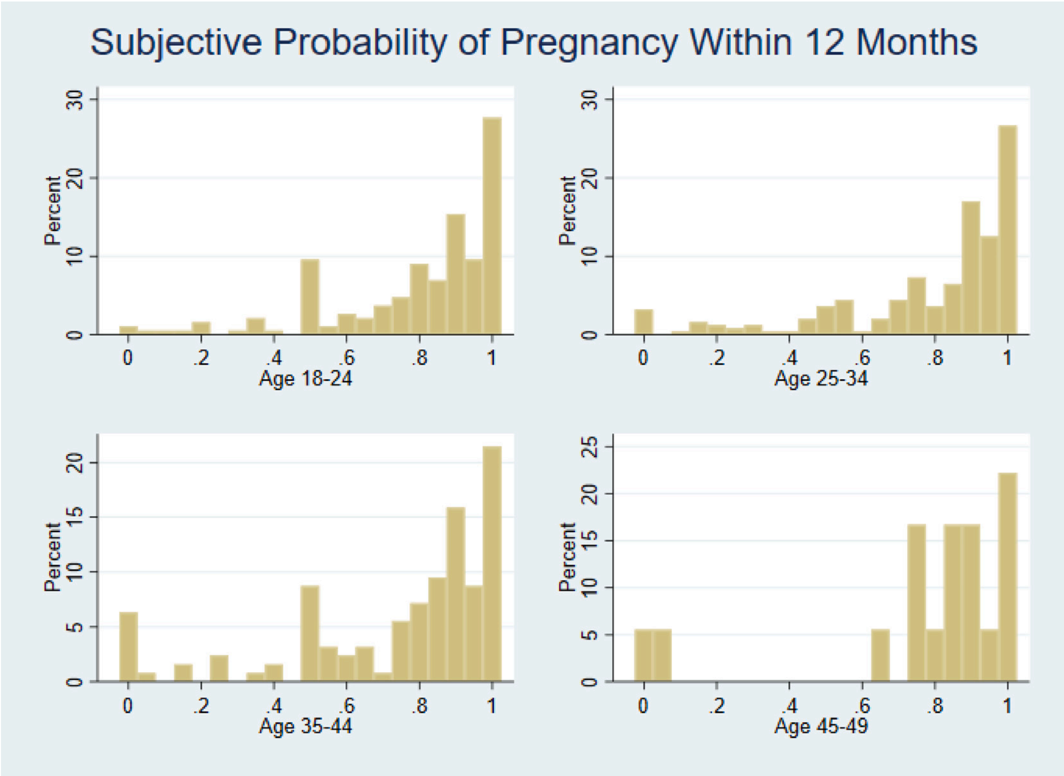

Fig. 2. Subjective Probability of Pregnancy within 12 Months by Age Group. *Source:* Survey described in Section 2.2. Baseline beliefs measured prior to the information treatment described in Section 6.

Table 3
Perceived Probabilities of Pregnancy within 12 Months.
Source: Survey described in Section 2.2.

	Current Users of:									
	No Method		Injections		Pill		Implants		Condoms	
	mean	*N*	mean	*N*	mean	*N*	mean	*N*	mean	*N*
No Method	0.71	171	0.82	178	0.84	119	0.77	56	0.76	55
Injections	0.20	158	0.18	176	0.21	104	0.20	52	0.17	47
Pill	0.35	157	0.38	161	0.32	119	0.38	52	0.36	51
Implants	0.25	138	0.25	135	0.25	98	0.23	55	0.22	43
Condoms	0.15	163	0.16	169	0.15	114	0.20	53	0.22	54
N	176		178		119		56		55	

Average perceived probabilities that the respondent would get pregnant within 12 months if she used the alternative appearing in the row heading, by current method.

4.2. Decision model

To shed light on women's preferences, we estimate an additive random utility model (ARUM) consistent with utility maximization, similar to Delavande (2008) but adapted to our context. In particular, we include beliefs about the method's concealability given findings in Ashraf et al. (2014), and study heterogeneity by partner's fertility preferences and women's intention to limit or simply delay pregnancy. Further notable departures from Delavande (2008) are that:

(i) we use a nested logit including a "no method" nest since many women in our sample use no contraception and we find evidence of correlation between hormonal methods' random shocks affecting method choice and

(ii) in our preferred specification, we include the default (i.e., absent contraception) risks of pregnancy and contracting an STD in the set of method-invariant characteristics, as explained in Section 4.3.

Formally, we start by modeling women as maximizing the following utility function:

$$\max_{m \in M_i} \left\{ \sum_{j=1}^{J} \int u_j(e_j, z_i) dP_{im}(e_j) + \beta_m^\top z_i - \alpha E_i(c_m) + \xi_m + \epsilon_{im} \right\},$$

where m corresponds to the contraception alternative and the index set M_i is woman i's choice set (i.e., all the methods she knows of among implants, injections, the pill, male condoms plus the "no method" method). We do not model demand for other methods as only 23 women use them, which is insufficient to estimate a model with more alternatives. The index j corresponds to the events for which we elicited beliefs in our survey (e.g., pregnancy within 12 months, contracting a STD within 12 months, …, listed in Section 2.2) . Each one of these possible events is represented by a binary random variable $e_j, j = 1, \dots, J$, recording whether the woman gets pregnant within 12 months, contracts a STD within 12 months, etc. The function u_j is the utility or disutility derived from event j happening and may also depend on z_i, a set of woman characteristics that do not vary by method. The perceived probability that the event j happens depends in turn on the contraception method adopted and is denoted by P_{im}. The method invariant characteristics z_i, encompassing, for example, age, education, …, may also affect the utility for the method differentially through $\beta_m^\top$. $E_i(c_m)$ is the subjective expected cost of using method m by woman i and ϵ_{im} is an idiosyncratic method×individual-specific random component of utility. Finally, ξ_m captures alternative-specific characteristics unobserved by us but relevant to the woman which we capture by alternative-specific intercepts as in the demand literature.[15]

With binary events e_j and data on the expected probability of event e_j happening and on the expected cost of each method, the probability of choosing method $\bar{m}$ can be written as:

$$\begin{aligned} & Pr(\bar{m} | z_i, \{P_{im}(e_j), E_i(c_m)\}_{j \in 1,\dots,n}^{m \in M_i}, M_i) \\ & = Pr\Bigg(\sum_{j=1}^{J} [\Delta u_j(z_i) P_{i\bar{m}}(e_j = 1)] + \beta_{\bar{m}}^\top z_i - \alpha E_i(c_{\bar{m}}) + \xi_{\bar{m}} + \epsilon_{i\bar{m}} > \\ & \sum_{j=1}^{J} [\Delta u_j(z_i) P_{im}(e_j = 1)] + \beta_m^\top z_i - \alpha E_i(c_m) + \xi_m + \epsilon_{im}, \forall m \in M_i, m \neq \bar{m} \Bigg) \end{aligned} \quad (1)$$

where $\Delta u_j(z_i) = u_j(e_j = 1, z_i) - u_j(e_j = 0, z_i)$ is the difference in utility levels resulting from event j happening rather than not happening. In the empirical implementation we model these $\Delta u_j(z_i)$ as j-specific parameters allowing for (linear) dependence on z_i (namely, individual- and partner fertility preference measures) for specific js. Given data on woman i's subjective beliefs $P_{im}(e_j = 1)$ for every event category j and each method m in their choice set, expected methods costs $E_i(c_m)$ (e.g., waiting time, direct and other monetary costs) for every method and a distributional assumption on ϵ_{im}, we can estimate Eq. (1) and thus identify women's preferences (Δu_j and α). Note that we use a subjective expected utility maximization approach, thus assuming that the precision of beliefs does not affect the decision process. Taking "deep uncertainty" into account would require further data and thus add substantially to an already long survey. In Giustinelli et al. (2022), for instance, beliefs about an individual's risk of dementia can be expressed as a range of probabilities in a follow-up question, or respondents could be asked to assign probabilities that the true probability falls within each of several bins. Taking into account beliefs precision would also require making assumptions about how this precision enters the utility function (e.g., maximin or minimax-regret in Giustinelli et al., 2022).

Consistent with our sample, which only includes women who express the wish to avoid pregnancy, we do not model the choice of having another child but control for whether women wish to limit or simply delay pregnancy. Relatedly, we do not explicitly model the decision to abort an unwanted pregnancy. However the parameter $\Delta u_j(z_i)$ associated with j ="pregnancy within 12 months" captures the woman's disutility from getting pregnant which depends on the strength of her desire to avoid pregnancy and includes the disutility associated with obtaining an abortion if she expects to terminate a pregnancy in case it occurs.

If we assume that the ϵ_{im} are independent Type I extreme value random variables, then the probability of choosing $\bar{m}$ can be modeled as a conditional logit. A limitation of this model is its implied independence of irrelevant alternatives (IIA): the relative choice probabilities for any two alternatives does not depend on characteristics of other methods. This assumption is unlikely to be satisfied for methods which share many similarities, which is the case for the three hormonal methods. We relax the IIA assumption by adopting instead a nested logit, in which women are thought of choosing between three independent top-level limbs (no method, condoms, or hormonal methods) as well as choosing between three bottom-level branches (injections, implants, or the pill) within hormonal methods as depicted in Fig. 3. Consequently the random shocks affecting the choice between no method, condoms, or hormonal methods are assumed to be independent, but random shocks affecting the choice between different hormonal methods are allowed to be correlated Type I extreme value random variables (see Cardell, 1997).

In this nested logit model, we estimate (i) the effect of method-invariant variables (z_i) on the choice of broad type of method (no method, condoms, or hormonal methods) using the variation between women in these variables (e.g., education level, desire to limit vs. desire to space fertility) and (ii) the effect of alternative-specific variables (P_{im} and $E_i(c_m)$) using the variation in beliefs within

[15] If income enters the indirect utility linearly, it cancels out in pairwise comparisons as highlighted in footnote 16. A richer specification, following Berry et al. (1995), would have the indirect utility for method m equal $(y_i - E_i(c_m))^\alpha \exp(\sum_{j=1}^{J} \int u_j(e_j, z_i) dP_{im}(e_j) + \beta_m^\top z_i + \xi_m + \epsilon_{im})$ where y_i represents income. Taking logs and using the approximation $\ln(y_i - E_i(c_m)) \approx \ln y_i - E_i(c_m)/y_i$ for $y_i \gg E_i(c_m)$, one gets a (log-)utility equal to $\sum_{j=1}^{J} \int u_j(e_j, z_i) dP_{im}(e_j) + \beta_m^\top z_i - \alpha E_i(c_m)/y_i + \xi_m + \epsilon_{im}$ plus the method-invariant term $\alpha \ln y_i$, which cancels out in pairwise comparisons. While we do not have data on income, specifications interacting expected monetary costs with age, age squared and education, usually employed in wage regressions, do not yield statistically significant estimates for those interactions. The p-value for a joint test on those coefficients is 0.29 and the effect of removing all supply-side barriers is $+1.02$p.p., even smaller than the one we encounter.

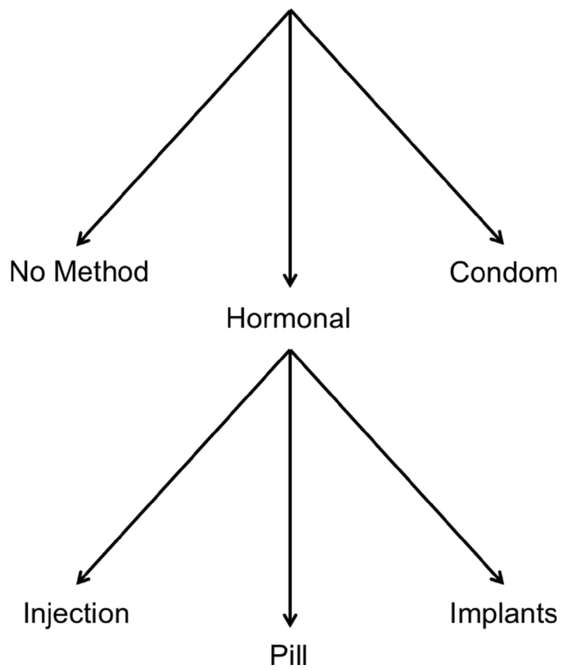

Fig. 3. Nested logit tree.

woman between methods. The logit specification implies that any woman-specific additive "fixed effect" affecting beliefs over a given characteristic of methods (e.g., over a given $e_j = 1$ and/or over $E_i(c_m)$) is "factored-out" as long as it applies to all methods.[16] For instance, if a woman systematically underestimates or understates her expected chance of approval by her partner irrespective of the method used, this tendency to underestimate expected approval could be systematically correlated with the choice of method without leading to bias in our estimates.

We then use our estimates to predict choice probabilities in our different counterfactual scenarios. More specifically, the choice probability for option $\bar{m}$ is given by $Pr(\bar{m}|z_i, \{P_{im}(e_j), E_i(c_m)\}_{j\in 1,\ldots,n}^{m\in M_i}, M_i) = \frac{\exp(V_{\bar{m}}/\tau(\bar{m}))}{\exp(\mathrm{IV}(\bar{m}))}\frac{\exp(\tau(\bar{m})\mathrm{IV}(\bar{m}))}{\sum_n \exp(\tau_n \mathrm{IV}_n)}$. The variable $V_{\bar{m}}$ denotes $\sum_{j=1}^{J}[\Delta u_j(z_i)P_{i\bar{m}}(e_j = 1)] + \beta_{\bar{m}}^{\top} z_i - \alpha E_i(c_{\bar{m}}) + \xi_{\bar{m}}$. IV_n denotes the "inclusive value" (i.e., expected utility) for nest n and is given by $\ln\left(\sum_{m\in B_n}\exp(V_m/\tau_n)\right)$, where B_n is the set of alternatives in nest n and $1-\tau_n^2$ is the correlation among alternatives in nest n. For limbs with only one alternative (condoms and no method), τ is equal to one, whereas the value of τ in the hormonal nest is estimated by the model. The notation $\mathrm{IV}(\bar{m})$ and $\tau(\bar{m})$ correspond to the inclusive value and τ for the nest to which alternative $\bar{m}$ belongs.

One limitation of our modeling approach is that husbands' beliefs and preferences do not directly feature in the model. Instead, we allow husbands' beliefs and preferences and any intrahousehold bargaining considerations to matter in contraceptive decisions only through the lens of women's perceptions about their husbands' beliefs and preferences. We therefore cannot shed light on important questions such as whether women's beliefs about partners' fertility preferences or contraceptive approval are accurate, how correlated the spouses' beliefs and preferences are, or how much weight each partner has in contraception decisions. These are all interesting questions which we explore in ongoing work.

4.3. Preferred specification

Our preferred specification includes *all* alternative-invariant variables such as woman's age group and alternative-specific variables — e.g., perceived probability of pregnancy with the index method. Alternative-invariant variables are summarized in Table A-1 (Panel A) and alternative-specific variables summarized in A-4 and listed on Section 2.2. In brief, the method-invariant covariates included in all specifications control for age, education, religion, urban location, province, having a partner who wants more children (if a woman does not want any more) or wants them earlier (if she simply wants to delay fertility), a woman's number of children, and a woman's desire to limit (as opposed to simply delay) fertility.

Additionally, to increase our model's flexibility, our preferred specification also includes in the set of method-invariant covariates (z_i) a woman's expected probability of becoming pregnant within 12 months absent contraception and a woman's expected probability of contracting a STD within 12 months absent contraception — i.e., her "default" pregnancy and STD risks. There

[16] More specifically, denoting P_{i1m} the subjective probability which woman i associates with event $e_1 = 1$ when using method m, then adding α_i to P_{i1m} for all methods m is cancelled out in pairwise comparisons.

are several benefits of doing so. First, this allows the alternative-specific expected pregnancy and STD risks to differentially affect the utility of the "no method" and other alternatives.[17] Second, doing so allows a woman's default pregnancy and STD risks to affect choices between alternatives other than "no method".[18]

We allow for heterogeneity in preferences for three alternative-specific variables by interacting them with individual- and partner fertility preference variables, as we next explain. Our sample comprises two groups: women who simply want to space fertility — i.e., they want to have another child after two years – and those who want to limit fertility – i.e., they do not want another child in the future. Women who want to limit fertility may care more about the ability of a method to protect them against pregnancy than women who simply want to space fertility. Similarly, women who want to have children in the future may care more about the ability to resume fertility after discontinuation of the method. We therefore model $\Delta u_j(z_i)$ as a linear function of z_i where j is, in turn: (1) the pregnancy risk and (2) the probability of managing to get pregnant within 12 months of discontinuation and z_i is, in turn, an indicator for having (i) a "need for spacing" or (ii) a "need for limiting" fertility.[19] Women may also value more the ability to conceal the use of a method from their partner if their partners disagree with their fertility intentions. Thus we also interact the subjective probability of being able to hide the use of the method from her partner with whether the woman's partner has or not higher fertility preferences.[20] In other words, we also model $\Delta u_j(z_i)$ as a linear function of z_i where j is the "probability of being able to hide the method" and z_i is, in turn, an indicator for having a partner who (i) has or (ii) does not have higher fertility preferences.

5. Estimation results and counterfactual analysis

5.1. Estimation results

In this subsection we discuss the findings obtained using the preferred model discussed in Section 4.3. Full nested logit estimates are reported in Table 4, which we use to produce the partial effects estimates of Table 5 and the counterfactuals of Section 5.2. We discuss the robustness of our findings to alternative specifications (including restricting the sample to women with no item non-response, including beliefs variables incrementally and using only variation between contraceptive methods) in Section A-3, and report estimates for a range of alternative specifications in Tables A-5, A-8 and A-10.

Confirming the pattern observed in the raw data, women are not significantly more likely to choose the alternative that they believe to be more effective to prevent pregnancy, but they are significantly less likely to go without contraception if their expected risk of pregnancy absent contraception – the woman's "default" pregnancy risk – is higher. The added flexibility coming from the inclusion of the woman's expected probability of pregnancy absent contraception in z_i (discussed in Section 4.3) therefore turns out to be empirically important. If beliefs about pregnancy risks across the different contraceptive methods were very highly correlated within woman, it could explain why the effect of the alternative-specific pregnancy risk is not statistically significant. There is however quite a lot of within-woman variation, as shown in Table A-6, where only two pairwise correlation coefficients are above 0.5 (0.515 and 0.717).

Women also respond to their expected probability of experiencing side-effects: they are less likely to use methods associated with higher risks of nausea/vomiting, less likely to use methods associated with side effects not listed in our questions ("other negative effects"), but more likely to choose methods associated with menstrual irregularities — presumably because they value not having their periods or having lighter periods.

In addition, women prefer methods associated with a higher expected chance of conceiving after discontinuation, irrespective of their desire to have another child after two years. This suggests that women value fecundity in itself and/or believe that they may change their minds in the future.

The strongest explanatory factor in the choice of method is however a woman's expected probability that her partner would approve of the alternative. Recall that these estimates are net of the effect of the method-invariant variables listed in Table A-1 (Panel A) including whether the woman's partner has higher fertility preferences than her. Therefore, here we find that a woman's expected approval by her partner is a key factor in her choice of family planning (FP) strategy even after conditioning on perceived disagreement between partners about fertility targets.

Interestingly, women whose partners have similar fertility desires to themselves are significantly *less* likely to opt for more concealable FP approaches, whereas concealability has no effect on method choice for women whose partners have higher fertility

[17] For instance, in Eq. (1), the utility associated with the "no method" alternative can now be affected by the perceived risk of pregnancy absent contraception through the relevant Δu_j, which is constant across alternatives, *and* through the alternative-specific coefficient associated with the perceived pregnancy risk absent contraception included in z_i.

[18] When eliciting beliefs about pregnancy (STD) risk under the use of each method, we ask the respondent to choose the number of beans which best reflects her chance of getting pregnant (contracting a STD) "as long as she continues to use the method (and assuming that she is using the method with all her partners, if there is more than one)". In their answers, women may therefore not reflect that they expect their use of the method to be discontinuous. Including the risk of pregnancy (STD) absent contraception in z_i addresses that since it is the pregnancy (STD) risk women revert to when they do not use a condom, miss pills, or are late for their next injection. For instance, if women expect to not use condoms every time they have sex, then their "default" pregnancy risk may influence their choice of condoms relative to injections.

[19] Note that we do not include a constant in this linear function as the two categories "need for spacing" and "need for limiting" exhaust all the possibilities given our sample selection criteria.

[20] I.e., whether she thinks or not that her partner wants more children (if she does not want to have any more) or wants another child sooner than her (if she simply wants to delay for at least 2 years).

desires. This suggests that women have a distaste for concealability – consistent with Ashraf et al. (2014)'s finding that using concealable methods has a psychological cost – but that they are more willing to incur this utility cost when their partners do not want them to use contraception.

In our main specification, the effect of alternative-specific characteristics is estimated both from variation between contraceptive methods and variation between the "no method" alternative and contraceptive methods. In Section A-3, we discuss results from a specification modeling only the choice between contraceptive methods and find that the same alternative-specific characteristics significantly affect decisions as when choosing between all possible alternatives including the "no method" alternative.

There is also much to learn from characteristics which do not appear to matter in women's choices. Strikingly, women do not choose methods associated with a lower risk of contracting STDs, suggesting that the decision to use protection against STDs studied, e.g., in Cassidy et al. (2021), may be largely independent from that of using contraception in the setting we examine. This is not to say that women do not respond to STD risk when deciding whether to use condoms. Following the DHS wording, we asked women whether they "currently used any method to delay or prevent a pregnancy", and find similar rates of condom use (Table A-2). Due to the question wording, women who use condoms exclusively to prevent STDs may not report using them. Given our focus on modeling demand for contraception, this wording is however appropriate — if instead we categorized women as choosing the condom alternative when they are not doing so to prevent pregnancy, we may overstate the role of STD prevention in contraception decisions.[21] The expected probability of reduced libido and/or sexual pleasure of either partner and/or interference with romance does not appear to affect contraceptive choices.[22] In stark contrast with expected approval by her partner, expected approval by coreligionists, parents, or friends do not have any significant effect on the woman's choice of method when controlling for expected partner's approval, which points towards the importance of communication and/or bargaining between partners as opposed to fundamental religious or cultural barriers to contraceptive use.[23] Finally, none of the supply-side factors have a statistically significant effect except for expected costs of travel and other indirect costs, which have a negative effect on demand.

Table 5, which reports selected average partial effects and their standard errors indicate that standard errors associated with alternative-specific variables are small enough to detect subtle effects, suggesting that lack of statistical power is not driving our finding that a number of variables do not significantly affect demand.

Turning now to the effect of women's socioeconomic and demographic characteristics, we find that older women, women whose partners have higher fertility preferences and atheists are more likely to use no method relative to their likelihood of using a hormonal method, while women who do not want any more children are less likely to use no method.[24] Women who have more children are less likely to use condoms relative to their likelihood of using hormonal methods. Finally, belonging to a small religious category (accounting for 3% of the sample or less) also affects the probability of using condoms (e.g., Protestants are less likely to use them).

The signs of the nested logit coefficients show the direction of their effect on the probability of choosing each alternative. And provided the regressors are measured in the same unit (e.g., probability of pregnancy out of 20 and probability of nausea/vomiting out of 20), the magnitude of the coefficients reflects the relative importance of each method characteristic in the choice of method. Selected average partial effects are reported in Table 5 to illustrate the economic significance and precision of the point estimates. We report own- and cross-partial effects on the probabilities of choosing no method and choosing the most popular method (injections) for a range of variables. Expressing the effects of small deviations in terms of a one-unit change, a one-bean (5pp) increase in the probability of pregnancy absent contraception corresponds to a negative average partial effect on the probability of choosing no method of 1.1pp, and about half of this decrease translates into a positive average partial effect on the use of injections. Even considering the type of side effect with the largest nested logit coefficient ("other negative effects"), a one-bean (5pp) decrease in the probability of injections side effects only produces a negative 0.1pp partial effect on non-use. A one-bean (5pp) increase in the probability of the partner approving of injections leads to a 3.4pp partial effect on the use of injections, but most of this increase comes from substitution away from other methods, with a negative partial effect on non-use of only 0.43pp. The effect of increasing the indirect cost of using injections by one unit (Metical) is small, as the partial effect on the demand for injections is only negative 0.04pp. If we went from none- to all the women's partners having higher fertility desires than them, non-use would increase by 8.8pp and demand for injections would decrease by 3.6pp. This is not dissimilar to the effect of going from all women wanting to limit fertility to simply wanting to space it (11pp and 3.2pp, respectively).

In Section 5.2, we present a number of counterfactuals which illustrate further the absolute- and relative importance of different barriers to contraceptive use.

[21] If beliefs about STD risks across the different contraceptive methods were very highly correlated within woman, it could explain why the effect of alternative-specific pregnancy risk is not statistically significant. Table A-6 shows that pairwise correlation between STD risk within-woman is below 0.5 except for the correlation of this risk between hormonal methods.

[22] This is the case whether we control for partner's expected approval of the method or not (full results available on request).

[23] While positively correlated, expected approval across these different dimensions appears to be sufficiently distinct to disentangle the independent effect of each. The correlation coefficients across the chance of approval by parents, coreligionists, friends, and husband indeed take values between 0.25 (for approval by husband vs. coreligionists) and 0.65 (for approval by friends vs. parents).

[24] The finding regarding atheists would be surprising if, as one may have expected, women who say that they do not have a religion were more likely to be more "modern". In our sample, however, the few (21) atheists are not easy to categorize. While they are 6 pp more likely to live in the capital city, they are more than twice as likely to have no schooling and they are 14 pp more likely to say that their partners have higher fertility desires than them.

Table 4
Preferred Specification Full Results.
Source: Own survey data described in Section 2.2, which provides details regarding our treatment of (14) women using a combination of methods and (23) women using methods other than the ones we model here.

	Effect of Alternative-Specific Variables on Choice of Alternative	Effect of Alternative-Invariant Variables on Type of Alternative Relative to Hormonal	
		No Method	Condoms
Spacing ×P(pregnancy)	0.001		
	(0.006)		
Limiting ×P(pregnancy)	−0.009		
	(0.007)		
P(STD)	0.003		
	(0.010)		
P(nausea)	−0.009*		
	(0.004)		
P(menstrual irreg.)	0.010**		
	(0.005)		
P(other neg. effect)	−0.014**		
	(0.006)		
P(affect libido romance)	0.006		
	(0.006)		
Spacing ×P(pregnancy after disc.)	0.019**		
	(0.009)		
Limiting ×P(pregnancy after disc.)	0.024**		
	(0.010)		
P(parents approval)	0.011		
	(0.008)		
P(coreligionists approval)	0.004		
	(0.009)		
P(partner's approval)	0.061***		
	(0.012)		
P(friends' approval)	0.007		
	(0.009)		
Partner wants the same ×P(hide method)	−0.013**		
	(0.006)		
Partner wants more kids ×P(hide method)	−0.002		
	(0.011)		
P(obtain when needed)	0.011		
	(0.009)		
E(waiting time)	−0.002		
	(0.002)		
E(direct costs)	0.001		
	(0.001)		
E(other costs)	−0.001*		
	(0.000)		
Age 25–34		0.069	0.367
		(0.279)	(0.374)
Age 35–44		0.954**	0.942
		(0.402)	(0.582)
Age 45–49		1.680**	0.296
		(0.718)	(1.025)
Some primary schooling		0.343	0.271
		(0.353)	(0.569)
Secondary schooling and above		−0.235	0.270
		(0.399)	(0.594)
Urban		−0.049	0.366
		(0.286)	(0.402)
Maputo Province		0.109	0.829*
		(0.373)	(0.481)
Gaza Province		0.349	0.511
		(0.362)	(0.406)
Partner wants more kids		0.531**	0.216
		(0.246)	(0.353)
No. of children		−0.011	−0.496***
		(0.085)	(0.155)
Limiting		−0.524*	0.571
		(0.302)	(0.421)

(*continued on next page*)

Table 4 (*continued*).

	Effect of Alternative-Specific Variables on Choice of Alternative	Effect of Alternative-Invariant Variables on Type of Alternative Relative to Hormonal	
		No Method	Condoms
Catholic		−0.221	−0.057
		(0.347)	(0.465)
Muslim		0.385	0.995
		(0.649)	(0.764)
Protestant		0.888	−14.615***
		(0.582)	(0.502)
Other religion		0.001	−0.156
		(0.257)	(0.370)
Atheist		1.101**	−0.324
		(0.487)	(1.281)
Does not know religion		0.278	2.932**
		(1.842)	(1.262)
P(pregnancy) absent contraception		−0.068***	−0.055*
		(0.022)	(0.033)
P(STD) absent contraception		0.027	−0.039
		(0.022)	(0.034)
Method-Varying Missing Value Indicators	Yes	N/A	N/A
Method-Invariant Missing Value Indicators	N/A	Yes	Yes
Alternatives	2761		
Women	584		

* Robust standard errors in parentheses, p<0.10.

** Robust standard errors in parentheses, p<0.05.

*** Robust standard errors in parentheses, p<0.01.

Missing values are set to zero. The method-specific intercept for the "No Method" alternative is normalized to zero. The effect of method-invariant variables on the utility associated with alternatives in the hormonal nest is normalized to zero. Alternative-specific intercepts relative to "No Method" and their associated standard errors are: −0.39 for condoms (SE:1.337), 0.243 for implants (SE: 0.731), 0.437 for injections (SE:0.731), 0.334 for the pill (SE: 0.730). The "No Method" nest τ and Condom nest τ are set to one, while the Hormonal nest τ is estimated to be 0.189 (SE: 0.047).

Table 5
Selected Average Partial Effects Estimates.

Average Partial Effect on Probability of Choosing :	No Method	Injections
Probability of Pregnancy Absent Contraception	−0.011	0.005
	(0.003)	(0.001)
Probability of Other Negative Effect of Injections	0.001	−0.008
	(0.004×10^{-1})	(0.003)
Probability of Partner Approving of Injections	−0.004	0.034
	(0.001)	(0.008)
Indirect Cost of Injections	0.005×10^{-2}	-0.004×10^{-1}
	(0.002×10^{-2})	(0.002×10^{-1})
Partner Wants More Kids	0.087	−0.036
	(0.039)	(0.020)
Woman Wants to Limit- Rather than Space Fertility	−0.11	0.033
	(0.043)	(0.026)
Sample size	584	556

Authors' calculations based on the preferred specification motivated in Section 4.3 whose results are reported in Table 4, expressed in terms of a one-unit increase. Units are beans for the first three rows and Meticais for the fourth row. Standard errors obtained by the Krinsky-Robb method using 1,000 replications in parentheses (Krinsky and Robb, 1986; Krinsky et al., 1990; Dowd et al., 2014). Point estimates in the first four rows are obtained by taking the relevant derivative of the choice probabilities (stated in Section 4.2), evaluating it at the values of the regressors for each observation, and then averaging over the sample. For the binary indicators corresponding to the last two rows, point estimates are obtained by taking the difference in the choice probabilities when the binary indicator is equal to one and when it is equal to zero, for each observation, and then averaging over the sample. Source: own survey data described in Section 2.2.

5.2. Counterfactual analysis

We now turn to predicting the effect of alternative interventions on the method mix using estimates from our preferred specification (shown in Table 4). We consider the effect of alternative interventions on the predicted probabilities of using each of the five family planning strategies considered in our estimation. Results are reported in Fig. 4 and in Table 6. For concision, here we focus mostly on the effect on the predicted probability of not using any method.

First, we estimate the effect of increasing the expected risk of pregnancy absent contraception to 85% (the WHO reference risk) for women who have a baseline expected probability under 85%. This is estimated to increase contraceptive use by 6.7 pp among

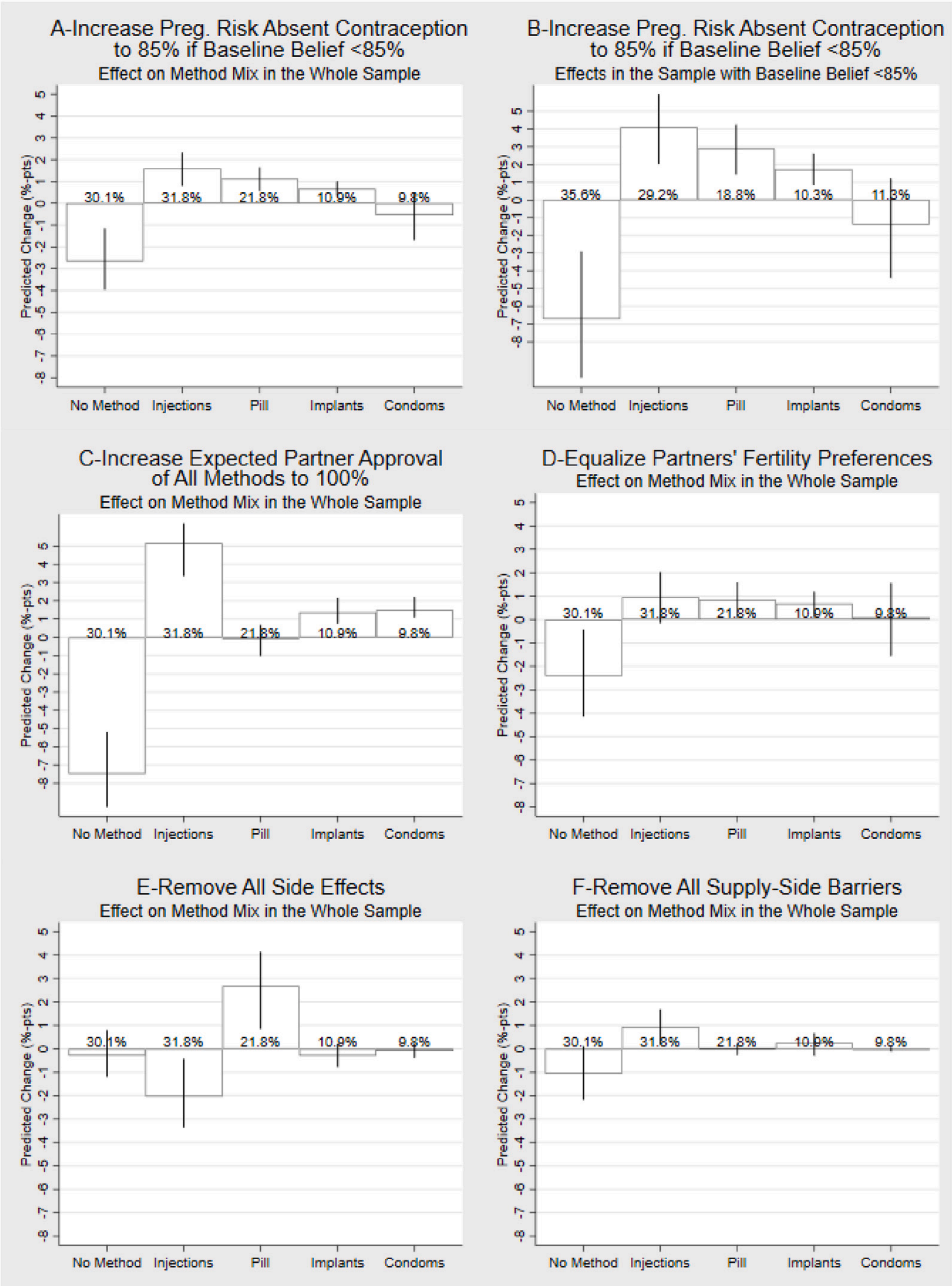

Fig. 4. Counterfactuals.
Notes: 95% confidence intervals obtained by the Krinsky-Robb method using 1000 replications are presented as vertical lines (Krinsky and Robb, 1986; Krinsky et al., 1990; Dowd et al., 2014). The baseline share for each alternative is the share of women who choose the alternative among those who know of the alternative. Shares therefore add up to slightly more than 1 (up to 1.05). Since "No method" is in every woman's choice set, the reported changes in the share of women using no contraception can be interpreted as changes in prevalence for the whole sample.

Table 6
Counterfactual Analysis.
Source: Own survey data described in Section 2.2, which provides details regarding our treatment of (14) women using a combination of methods and (23) women using methods other than the ones we model here.

	Condom	Implants	Injections	No Method	Pill	*N*
P(0) = 17 if P(0)<17						
P(0)<17 Sample	−0.014	0.017	0.041	−0.067	0.029	1,076
Whole Sample	−0.005	0.007	0.016	−0.027	0.011	2,761
Full Approval	0.015	0.014	0.052	−0.075	−0.001	2,761
Same Fertility Preferences	0.001	0.007	0.010	−0.024	0.009	2,761
No Side Effects	−0.001	−0.003	−0.020	−0.003	0.027	2,761
No Supply Barriers	−0.001	0.002	0.009	−0.011	0.000	2,761
Correct Failure Rates	−0.001	0.001	−0.002	−0.001	0.003	2,761

Predicted changes in the probability of choosing each alternative based on the model reported Table 4, estimated on 2,761 observations. Side effects are defined as nausea or headaches, menstrual irregularities or vaginal infections, and "other" side effects. Supply barriers refer to direct and indirect monetary costs as well as waiting times and the inability to obtain the method when needed. P(0) stands for "perceived probability of pregnancy within 12 months absent contraception." "Same Fertility Preferences" means that the partners of all women want to limit (space) fertility if the woman says she wants to limit (space) it.

this group of women (Fig. 4-B) or 2.7 pp overall (Fig. 4-A).[25] Interestingly, this increase in perceived risk of pregnancy absent contraception leads to an increase in the use of hormonal methods rather than condoms. This is consistent with the idea that, if women do not use a condom every single time they have intercourse or if the condom fails, they revert to their risk of pregnancy absent contraception — and indeed the coefficient associated with this risk in the condom nest is negative. Women in our sample believe that method effectiveness in preventing pregnancy is much lower than population estimates suggest. But recall that our model estimates show that women do not significantly choose contraceptive methods that they believe to be more effective to prevent pregnancy, so we should not expect much change in demand from recalibrating beliefs about failure rates. Indeed, in a counterfactual setting women's beliefs about method effectiveness to be equal to population estimates, contraceptive prevalence only increases by 0.1pp (see last row of Table 6).

Second, we consider policies involving partners. Increasing to 100% the expected rate of approval by partners of all modern methods would increase contraceptive use by 7.5pp (Fig. 4-C) mostly in favor of injections, while aligning the woman's partner's preferences for fertility with the woman's would increase contraceptive uptake by 2.4pp (Fig. 4-D).

Third, we turn to an intervention targeting side effects. A major scientific breakthrough removing all side effects accompanied by a successful campaign convincing women of this progress would only increase contraceptive use by a statistically insignificant 0.3pp overall (Fig. 4-E), and would mainly result in substitution of the pill — which respondents correctly believe to come with a higher risk of nausea — to injections. This is not to say that women do not care about side effects: rather, they value some side effects (menstrual irregularities — likely due to mild or no periods) while avoiding methods associated with a higher chance of nausea/headaches and of other negative effects. Indeed, if one could remove only the perceived negative side effects of hormonal methods but not their perceived side benefit, our model would predict an increase in contraceptive use by 1.8pp driven by an increase in the use of the contraceptive associated with the highest perceived chance of nausea/headaches, namely the pill (2.3pp). From a policy point of view, however, this does not seem feasible since the same hormones used in contraceptives are responsible for multiple side effects, good and bad.

Fourth, we turn to interventions targeting access to contraceptive supply both in terms of direct- and indirect monetary costs and in terms of supply reliability and availability. Removing all supply-side constraints – i.e., setting the expected probability of obtaining the method when needed to 100% and setting all monetary costs and waiting times to zero – would reduce unmet need by 1.1pp, an effect which is not quite statistically significant at 5% (Fig. 4-F).

These counterfactual scenarios broadly match the main reasons generally self-reported for not using any contraception despite not wanting to get pregnant (low perceived risk of pregnancy, side effects, disapproval by the women themselves or those close to them, Sedgh et al., 2016), and additionally consider the effect of removing all supply-side barriers. Of these four approaches to reducing unmet need for family planning, two would likely be very costly (removing side effects and removing supply-side constraints). Our predictions indicate that they would also not be particularly effective in our setting, suggesting low cost-effectiveness. Much more encouragingly, increasing perceived method approval by partners and aligning fertility preferences within the couple would be a powerful tool to decrease unmet need, thus suggesting a fruitful direction for future work. The cost of increasing the rate of method approval by partners is however unclear *a priori* and may be very high if it is due to aversion to contraceptive methods deep-rooted in patriarchal social norms. Although decreasing men's fertility preferences is possible (see, e.g., Ashraf et al., 2018), doing so to the extent that they would match the women's is likely to be costly too. Our counterfactuals however suggest that sizeable increases in contraceptive uptake would result from a potentially low-cost recalibration of women's beliefs about the risk of pregnancy absent contraception.

Having investigated the individual effect of addressing one type of barriers to contraceptive use at a time, we now illustrate what our estimates tell us about what would be needed to drastically reduce unmet need in our setting.

25 A counterfactual in which we set all beliefs about the pregnancy risk absent contraception to 85% irrespective of baseline belief leads to an overall predicted increase in use of 1.5 pp, compared to 2.7 pp in the counterfactual we report in Fig. 4 (Panel A). See Section 6.3 for a discussion of asymmetric responses to news that the risk is higher vs. lower than expected.

We first assess the overall contribution of demand-side factors to unmet need. The three demand-side interventions considered so far target, in turn, beliefs about the risk of pregnancy absent contraception, partners' fertility preferences, and partners' contraceptive approval. In an illustrative scenario where these three sources of unmet need are simultaneously and successfully addressed (namely, the expected risk of pregnancy absent contraception is set to 17 out of 20 for women with beliefs below 17, all partners are set to have the same fertility preferences as their wives, and the expected chance of partner approval is set to 20 for all four methods), unmet need is predicted to decrease by as much as 39% (from about 30 ppts to 18 ppts). If, in addition, we set all supply-side beliefs at the most favorable level (namely, set direct and indirect monetary costs to zero, all waiting times to zero, all perceived probabilities of being able to obtain the method when needed to 100%, and set the probability of side effects to zero), unmet need is predicted to decrease by 42%.

Finally, we ask how much of the gap between fertility intentions and contraceptive use we can account for using the variables which statistically significantly influence the decision to use contraception according to our model estimates. The two following scenarios are not plausible policy outcomes but provide a useful accounting exercise. We first predict the effect of fully removing all the barriers to use contraception without changing women's characteristics, their own fertility preferences (i.e., whether women want to space or limit fertility), or leveraging women's taste for hormone-induced menstrual changes or their distaste for concealability.[26] In this scenario, unmet need is predicted to decrease by 51%. If in addition we assign all women to the 18–24 age group, assume that they all wish not to have any more children as opposed to some women simply wanting to wait at least two years, set the perceived chances of experiencing menstrual irregularities when using contraception to 20 out of 20 and finally set the probability of being able to hide the use of all methods to 0 when men and women have similar fertility preferences, our model would predict a 74% decrease in unmet need.

5.3. Threats to identification

As explained in Section 4, the variation used to identify our model coefficients comes from both within-woman variation in beliefs about the attributes of each alternative and from between-women differences in characteristics and use. One limitation of the counterfactuals of Section 5.2, as with any modeling exercise relying on observational data, is therefore that confounding factors correlated with both beliefs and contraceptive choices might bias estimates — although this risk is mitigated here by the collection of data covering a large array of factors that may influence contraceptive decisions and which would normally fall in the "unobservables" category.

In particular, one concern may be that women systematically report more favorable beliefs about the alternative they are currently using in order to justify their choices — i.e., they may practice "ex-post rationalization".[27] Or there might be learning effects — i.e., women's beliefs such as those regarding partner's expected approval may be influenced by use. If this were the case, then this may bias the nested logit estimates so that our model predictions may not be informative regarding the effect of changing beliefs.

Ex-post rationalization and learning effects do not, however, seem likely to be an important issue in our data for two reasons. First, women do not report more favorable beliefs about all aspects of the method they are currently using. For instance, women do not report a systematically lower risk of pregnancy for the contraceptive method they are currently using (Table 3). In particular, women using methods where the user has little role in the method's efficacy do not hold significantly more accurate beliefs about these methods' failure rates (t-test p-value: .34 (.59) for injections (implants)). Second, there is no evidence that women who have been using a contraceptive method for a longer period of time are more likely to report favorable beliefs about this method (including a higher expected probability of approval by their partners). As noted by Delavande and Zafar (2019), ex-post rationalization should arguably be stronger among individuals who have been with their current alternative for a longer period of time — i.e., their chosen university in the case of Delavande and Zafar (2019). However, in our data as in theirs, there is no indication that individuals who have been with their current alternative for a longer period of time report more favorable beliefs about this alternative. Table A-11 reports estimates obtained when regressing each belief variable in turn on the year the woman started using the contraceptive method she is currently using, a constant, and all the method-invariant characteristics included in Panel A of Table A-1. Only 2 out of 16 coefficients are statistically significant, and only marginally so. In one case (women who have started using the method more recently report higher probabilities of menstrual irregularities), the sign of the significant coefficient does not suggest ex-post rationalization.[28] In the other (women who have started using the method more recently report higher expected waiting times), the magnitude of the effect is very small — starting use one year later increases the expected waiting time by less than 30 seconds. More generally, the weakness of the correlation between stated beliefs and the duration of use of contraceptive methods also suggests that learning from use – which could bias our estimates – is limited. Taken together, the data are consistent with women relying on

[26] More specifically, we set all beliefs about the chances of experiencing nausea and any other negative side effect to zero, set beliefs about the chances of managing to get pregnant within 12 months of discontinuation of a method to be equal to the highest probability across all alternatives in the woman's choice set, set the expected chance of approval by partners of all contraceptive methods to 20 (out of 20), set partners' fertility preferences to align with those of the respondents, set indirect monetary costs to be equal to zero, and set the expected risk of pregnancy absent contraception to 20.

[27] Ex-post rationalization bias has previously been discussed in the context of fertility intentions — an area in which women may be thought to be particularly prone to ex-post rationalization since admitting that a child was unwanted may bear a high psychological cost. Pritchett (1994), however, finds that actual fertility is equally correlated with different measures of self-reported desired fertility, irrespective of whether the measure is retrospective, suggesting very low bias.

[28] Recall that the estimates reported in Table A-5 indicate that women prefer methods associated with menstrual irregularities (e.g., because this generally means light or no periods).

information about their wider peer group or other common sources of information rather than extrapolating from their own, single experience when forming beliefs about themselves — thus meeting a precondition for women to respond to new information based on population-level statistics.

Another concern might be that women state beliefs to justify their choices. The structure of the questions however means that a significant degree of sophistication would be required to provide a pattern of answers that artificially points to a particular reason for choosing a method. Women are never asked directly why they chose their current alternative. Instead, they are asked, in turn for each event, about the chances of an event happening under each method in turn. If, for instance, women wanted to "pretend" that they had chosen their current alternative because of partner approval instead of side effects, for the effect of side effects to not appear significant in the demand model they would have had to manipulate answers to questions about beliefs about side effects without knowing that questions about beliefs about their partner's approval were coming. One particular concern may be that women report a high expected chance of side-effects and/or unreliable supply with methods which they do not use for some more difficult reason to acknowledge (e.g., their partner disapproves). However in this case we would find these two factors to play an important role in contraceptive decision, which, as reported in Section 5.2 is not the case.

In the next section, we present findings based on an exogenous information shock which do not suffer from the same identification threats and yet corroborate our model estimates, hence bolstering our confidence in these estimates.

6. Validation exercise

To test the plausibility of our model predictions, we created an exogenous "shock" to beliefs about the probability of pregnancy absent contraception. First, this allows us to evaluate — without making any modeling assumptions — the effect of a simple information message on the perceived risk of pregnancy absent contraception and on intentions to use contraception in the future. We then compare the observed effect on intentions to use contraception to the effect on contraceptive use predicted by our model for the observed change in beliefs following our information message.[29]

6.1. Information treatment

After eliciting the woman's beliefs about contraceptive methods, we asked her whether she intended to use contraception in the future (following the DHS wording of "Do you intend to use a method to postpone or prevent getting pregnant, at some point in the future? Yes/No/Don't know"). We then asked a number of questions including questions about the respondent's level of trust in health information messages obtained from (nine) different potential sources.[30]

Next, we proceeded to our information intervention. We selected a random subsample of women whom the enumerator informed that:[31]

> "Studies show that, on average, out of every 20 sexually active women of reproductive age who do not use any contraceptive method, 17 will get pregnant within the next 12 months"

The enumerator then asked the respondent again about their intention to use contraceptives in the future, as well as asking them *two* questions about the expected probability of pregnancy within 12 months if not using any contraceptive. The first question was worded closely to the information message the participants had just received, except for asking specifically about women "like them":

> (i) "Imagine 20 women exactly like you at this moment. That is, 20 women identical in all aspects, including with the same lifestyle as yourself, a husband identical to yours, etc... Choose the number of beans which best reflects, in your opinion, the number of women among these 20 who will get pregnant in the coming 12 months, if they do not use any contraception?"

This is the first time in the survey that women are asked a question about their beliefs about the pregnancy risk of others.

The second question asked specifically about the respondent herself, and in exactly the same way as when the question was put to them in the main beliefs module — 40 or so minutes earlier:

> (ii) "Choose the number of beans which best reflects, in your opinion, the chance that you will get pregnant in the coming 12 months, if you do not use any contraception?"

[29] Unlike Wiswall and Zafar (2015), for instance, we do not exploit the information treatment for the purpose of identifying our structural model. This would have required eliciting again all the subjective beliefs variables we include in the model and either observing actual choices between alternatives after the information shock, or modeling (changes in) the subjective probability of choosing each alternative instead of actual choices.

[30] We found that there was a high level of trust in health professionals, especially in government facilities: 80.6% (93.9%) of respondents said that they would certainly trust a message about pregnancy risks if it came from a nurse (doctor) in a government facility compared to 70% if this information came from a radio or TV program, 63.9% if it came from a pharmacist or 47% if it came from a school teacher, for instance.

[31] We did not treat all the women in our sample in case further funding became available to measure additional outcomes in follow-up surveys. This, however, did not materialize within the time frame during which the IRB permitted us to retain respondents contact details (12 months). The randomization however ensures that the average treatment effect on the treated should be equal to the average treatment effect on the non treated. See Table A-12 for a comparison of characteristics of women who received- and did not receive our information message.

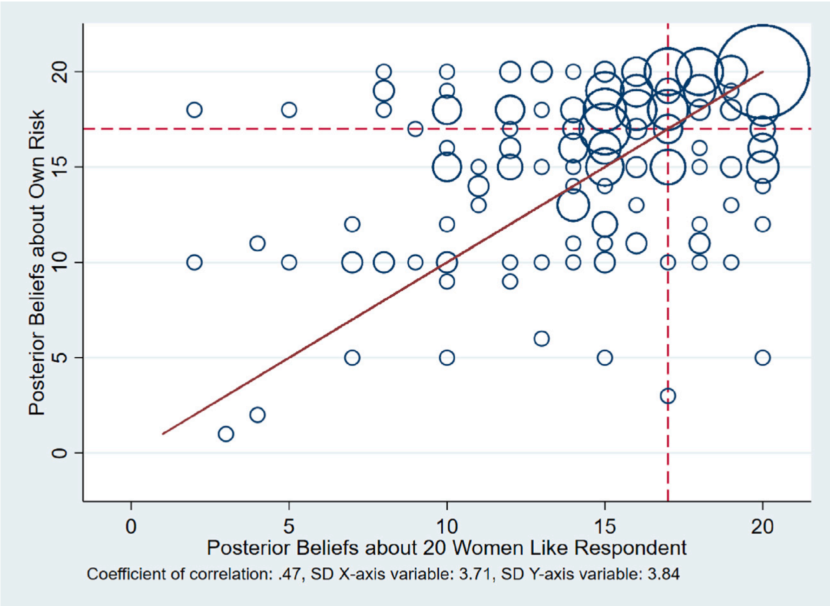

Fig. 5. Posterior beliefs about own risk of pregnancy absent contraception vs. Risk among 20 women like respondent.
Note: Beliefs about risk among others were not elicited prior to receiving the information about population risk.
Source: Survey described in Section 2.2.

We decided against asking again the control group about their intentions to use contraception and about their beliefs regarding pregnancy risks. While it would be good to know whether respondents revise their responses even in the absence of any new information, being asked the same question twice might also confuse the respondents (Haaland et al., 2023), and/or suggest that their first answer was wrong.

The exogenous variation exploited in the present analysis is the difference between answers given by the same women before and after they received our information message. In the next subsection, we discuss how we address the concern that women may just say what they think the experimenter wants to hear after receiving the information message.

6.2. Mitigating experimenter demand effects

Experimenter demand effects (EDE) – defined here as the difference between true and reported post-treatment outcomes – are a pervasive concern in experimental work. Recent studies find variable levels of treatment effect biases due to measurement error, with smaller levels found in common survey- and lab-experiment tasks in high-income countries (De Quidt et al., 2018; Mummolo and Peterson, 2019) than in a field experiment in a low-income country (Blattman et al., 2019). We address EDE concerns in three ways.

First, we look for indicative signs of EDE by studying the two measures of posterior beliefs we elicit. Our design gives respondents an opportunity to meet experimenter demand – if they perceive some – in a way that does not affect our analysis, by asking them about the risk of pregnancy "out of 20 women like them" (question (i) in the previous subsection). This may offer respondents an opportunity to "please" the interviewer if they wish to do so without affecting our estimates of the effect of the information message since we do not use responses to question (i) in our impact evaluation. Enumerators then ask the more personal question of what respondents think is their own probability of pregnancy absent contraception, which we use for impact evaluation purposes. Interestingly, we can reject that the average answer to the first question (15.7) is 17 (p-value of less than 0.0001), but not that the average answer to the second question (16.7) is 17 (p-value: 0.12). This does not suggest the presence of EDE since a question more closely worded to the information message would seem likely to encourage more social desirability bias. Fig. 5 then plots answers to questions (i) and (ii). Unsurprisingly, answers are positively correlated ($\rho = 0.472$) but very few women simply answer 17 at either question, which is also encouraging from the point of view of EDE.[32]

While we did not probe women about differences in their answers to questions (i) and (ii), the pattern of responses would be consistent with respondents believing that women "like them" are less fecund than average, but that they themselves are more fecund than the average woman which they understood as being "like them". A comparison of answers to question (i) and (ii) also suggests that women are unlikely to under-report their expected pregnancy risk within 12 months to avoid the potential stigma

[32] The dispersion of both variables is similar (3.84 for answers to (i) and 3.71 for answers to (ii)), suggesting that the use of beans in question (ii) does not introduce additional sampling variation.

associated with frequent sex. Indeed, if this were the case we would not expect women to report a *higher* expected risk of pregnancy for themselves than among 20 women like them.

Second, after reporting our results on the effect of an information shock on beliefs, we test formally for EDE. Appendix A-6 shows that the presence of EDE in either beliefs about pregnancy risk absent contraception or intended use would lead to inconsistent estimates of the effect of beliefs on intentions in the post-treatment data. Comparing estimates of the effect of beliefs on intentions before and after receiving the information treatment can thus provide a combined test of EDE on beliefs and intended use.

To fix ideas, let reported intended take-up by individual i in period $t = 0$ ("before information provision") or $t = 1$ ("after information provision") be denoted by y_{it}, and reported beliefs in period t be denoted by b_{it}. The probability model for y_{it} is then given by

$$y_{it} = \mathbf{1}[\beta_0 + \beta_1 b_{it} - u_{it} \geq 0].$$

Noting that $b_{i1} = b_{i0} + \Delta b_i$, we can express the regression for period $t = 1$ as

$$y_{i1} = \mathbf{1}[\beta_0 + \beta_1 b_{i0} + \beta_1 \Delta b_i - u_{i1} \geq 0].$$

In the presence of experimenter demand effects on beliefs in response to the information message, $b_{i1} = b^*_{i1} + v_i$ and $b_{i0} = b^*_{i0}$, where $b^*_{it}, t = 0, 1$ are true beliefs and v_i is the EDE on beliefs. The MLE for the regression of y_{i0} on b_{i0} provides a consistent estimator of β_1 whether or not beliefs or contraceptive intentions are misreported after the information treatment. But, as discussed in Appendix A-6 in the context of a logit model, when there is EDE, the MLE estimator for the coefficients on b_{i0} and on Δb_i in a regression of y_{i1} on b_{i0} and Δb_i usually leads to an asymptotic bias for β_1 (see Stefanski and Carroll, 1985).

Setting now aside its repercussions for beliefs, if experimenter demand affects reported intended take-up, then

$$\mathbb{E}(y_{i1}|b_{i0}, \Delta b_i) = \alpha_0 + (1 - \alpha_0 - \alpha_1)F(\beta_0 + \beta_1 b_{i0} + \beta_1 \Delta b_i),$$

where $\alpha_0 = \mathbb{P}(y_{i1} = 1|y^*_{i1} = 0)$ and $\alpha_1 = \mathbb{P}(y_{i1} = 0|y^*_{i1} = 1)$ are miss-classification probabilities and y^*_{i1} is true take-up intention as opposed to reported take-up intention, y_{i1} (see Hausman et al., 1998). Following Hausman et al. (1998), it can then be shown, for mis-classification probabilities close to zero, that the MLE will be inconsistent. All in all, if when regressing y_{i0} on b_{i0} and y_{i1} on b_{i0} and Δb_i, we cannot reject that the three coefficient estimates associated with beliefs are the same, there is no evidence for experimenter's demands effects on *either* beliefs or reported take-up intention.

Finally, we carry out our validation exercise. Namely, we compare the effect of the information shock on intentions to use contraception to the effect on *actual* contraceptive use which our ARUM model would predict given the observed pre-post information shock change in beliefs. Finding consistent results is reassuring both in terms of the soundness of our ARUM model and in terms of EDE concerns.

6.3. Results

In Table 7, we report, for four samples of treated women, changes in average beliefs about the risk of pregnancy absent contraception, changes in intentions to use contraception in the future, and the p-values corresponding to two tests. The first is a t-test of differences in the before- and after-information answers. For the binary outcome, we also implement a McNemar test, which is a popular test for before-after treatment comparisons of this type of outcomes (Fagerland et al., 2013).[33]

We find that women update their stated expected chance of pregnancy in line with the new information (from 15.8 to 16.7 out of 20, on average, Table 7 Panel A) and these updates are statistically significant. As can be seen in Panel B, as expected a much larger upwards beliefs revision is observed among women who expected a risk of pregnancy absent contraception below 17 at baseline. The extent of the recalibration is striking, as it nearly fully realigns the women's beliefs with the information provided: women who expected a risk lower than 17 increase their belief by 0.90 (standard error: 0.08) bean for each bean below 17 at baseline. Conversely, women who at baseline expected a risk equal to 17 or larger reduce their belief of the risk of pregnancy by 0.98 (standard error: 0.23) bean for each bean above 17 at baseline, resulting in an average drop from 18.9 to 17.2 in this subsample (Table 7 Panel C).[34] This suggests that, while women may have private information about how their own fecundity and frequency of sexual intercourse differs from the population average, most of the baseline discrepancy between the sample's beliefs and the population average is due to miscalibrated beliefs about the population average.

Next, we test for the presence of EDE. More specifically, we first estimate a binary logit model regressing baseline future contraceptive intentions on baseline beliefs about the risk of pregnancy when not using contraception (b_0), controlling for all the woman characteristics listed in Panel A of Table A-1. We then estimate a logit model regressing post-treatment intentions on baseline beliefs about the risk of pregnancy when not using contraception and their before-after treatment change in this belief (Δb), controlling for the same woman characteristics. We do so separately for women who have a baseline own expected risk below the reference figure of 17 (85%) and for those with baseline beliefs equal to 17 and above, and then compare, within each of these

33 We follow (Fagerland et al., 2013)'s recommendation and use the "mid-p" version of the test. The mid-p test avoids the loss of power associated with the exact test version while not violating the nominal level of the test in any of Fagerland et al. (2013)'s simulations, and it is well-suited to cases where the binary indicator has a small number of "zeroes" as we have here.

34 While we cannot estimate exactly the updating regression used in Haaland et al. (2023)'s discussion of typical effect sizes due to only observing beliefs once for women who do not receive the information message, the short-term learning rates we obtain here are at the high end of the range reported in Haaland et al. (2023), namely 0.18 to 0.8.

two groups, the three estimates of the effect of beliefs on intentions. If we cannot reject that all three estimates are the same, then we cannot reject the absence of EDE. To increase the power of our test to reject the null of no EDE, our regressions of baseline intentions on baseline beliefs use all available observations, whether or not they were randomized into receiving the information treatment. Note that we cannot instead split the sample by baseline *population* beliefs since we did not elicit these beliefs prior to informing respondents of the average risk in the population.

One concern could be that our information, while it is narrowly targeted at one belief, might also change other beliefs that matter for contraceptive decisions. If this were the case, then it would bias our post-treatment estimates of the effect of beliefs about the risk of pregnancy absent contraception on intended contraceptive use and would make it *more* likely to reject the null of no EDE.

The analysis is done separately for women who have priors below- and above the value of 17 provided in the information intervention because they would seem likely to perceive different experimenter demand effects, if there were such effects. In particular, if there are experimenter demand effects on intentions to use contraception, then the estimated effects of beliefs on stated intentions depend on two misclassification probabilities: the probability to report intending to use contraception when in fact the woman does not intend to use it (α_0) and vice-versa (α_1). These two misclassification probabilities are likely to differ depending on women's prior beliefs being above or below 17 since the latter may feel expected to over-report intending to use contraception but not the former.

Table 8 reports these results. We cannot reject the absence of EDE on either beliefs or intentions either for women with $b_0 < 17$ or $b_0 \geq 17$, with p-values for joint χ^2 tests of equality between the three estimates for the effect of beliefs on intentions equal to a minimum of 0.281 (among women with $b_0 \geq 17$). While no test of a null of "no EDE" can completely rule out the presence of EDE, and the power of our statistical test is limited by the size of the available sample, the three point estimates are broadly of the same magnitude for the main target – women who underestimate the risk of pregnancy absent contraception at baseline – which would be unlikely to be the case if there was sizable EDE in either beliefs about pregnancy risk or intentions among this group. For women with $b_0 \geq 17$, there is a statistically insignificant but substantial difference between the estimated effects of Δb and b_0, so that we are cautious not to put as much weight on results for this group — who is also not the main group of interest for our treatment.

The results of our EDE test also speak indirectly to two distinct potential concerns. First, one concern could have been that women do not trust the information we provide, or do not take it into consideration (e.g., due to some private information). But finding no statistically significant difference between the marginal effects of belief revisions and baseline beliefs on intention to use contraception among women underestimating this risk at baseline suggests that these women appear to both trust the information we provided and largely internalize perceived *increases* in the risk of pregnancy. Second, finding no statistically significant difference in estimated marginal effects before and after receiving the information message makes it unlikely that the effect on intentions simply comes from a salience effect. One concern could have been that we observe an increase in intentions to use contraception simply because women temporarily put more weight on pregnancy risk after receiving our information message. But in this case one would expect a larger marginal effect of expected pregnancy risk absent contraception on intended use post-treatment.

On the other hand, the very small estimated effect of beliefs updates for women who do not underestimate the pregnancy risk at baseline, although statistically indistinguishable from the effect of their baseline beliefs, suggests that women are less responsive to *reductions* in the perceived risk of pregnancy. The asymmetric responses to "good" and "bad" news are consistent with women preferring to err on the side of caution. This finding is reassuring because one potential concern about our information intervention would have been that, when we inform women with $b_0 > 17$ of the population average risk, they may *reduce* their contraceptive use, which is not the case here. In fact, they *increase* slightly their intention to use contraception (by 2.9 percentage points) despite decreasing their expected risk of pregnancy, on average (Table 7 Panel C). This could be due to, e.g., the information message leading to more precise beliefs about the high risk of pregnancy absent contraception, or to a degree of EDE since our EDE test is less conclusive for this group.

Finally, we investigate the effect of our information shock on intention to use contraception in the future and compare these reduced-form estimates to our structural model estimates. Among women with baseline beliefs about the risk of pregnancy without contraception below 17 (Panel B of Table 7), the average increase in the expected probability of pregnancy without protection is 4.7 beans out of 20 (and the *p*-value of a t-test comparing before- and after- treatment beliefs is < 0.001). A counterfactual increasing beliefs among women who expect a risk below 17 at baseline by the average change observed in the data and thus matching this increase in beliefs on average predicts an increase by 4.8pp in contraceptive use among this group (based on the model in Table 4).[35] In our validation exercise, we find that intention to use contraception among this group increases by 4.4pp after receiving our information shock. Although less statistically significant than the effect observed in the (much larger) full sample (Panel A of Table 7), this figure is close to our model prediction of 4.8pp, which is reassuring both from the point of the reliability of our structural model estimates and in terms of EDE concerns.

Finding similar results is also reassuring from the point of view of other concerns which our information shock alone could have raised. One concern might have been that women's stated intentions may abstract from their partners' preferences. If this were the case, however, we would expect the structural estimates, which take partner's expect approval and fertility preferences into account, to be much smaller, which is not the case.

Women who are not currently using contraception are likely to be more responsive to new information about the risk of pregnancy absent contraception, although we cannot model this heterogeneity in our ARUM model in which not using is a possible outcome.

[35] For 36 women, this leads to beliefs of 20.7 out of 20. If we cap beliefs at 20, the counterfactual analysis predicts an increase by 4.7pp. If instead we restrict the sample to treated women only and predict the change in contraceptive use based on their revised individual beliefs, the model predicts an increase in contraceptive use of 5.3pp among this group.

Table 7
Effects of the Information Intervention.

	Before	After	#Obs	Difference	P-value of T-test	P-value of McNemar Mid-P test
Panel A: Whole sample receiving the information message						
Expected probability of pregnancy within 12 months (out of 20 beans)	15.84	16.68	287	0.85	0.010	
Intends to use contraception in the future	0.88	0.91	288	0.035	0.007	0.007
Panel B: Sample of women with baseline beliefs <17						
Expected probability of pregnancy within 12 months (out of 20 beans)	11.20	15.92	113	4.73	0.000	
Intends to use contraception in the future	0.85	0.89	113	0.044	0.058	0.070
Panel C: Sample of women with baseline beliefs ≥17						
Expected probability of pregnancy within 12 months (out of 20 beans)	18.85	17.18	174	−1.67	0.0000	
Intends to use contraception in the future	0.90	0.93	175	0.029	0.059	0.070
Panel D: Sample of women not using contraception						
Expected probability of pregnancy within 12 months (out of 20 beans)	15.07	16.56	84	1.49	0.020	
Intends to use contraception in the future	0.64	0.72	85	0.082	0.019	0.021

Details of the intervention are provided in Section 6.1. As in the t-test, the null hypothesis of the McNemar test is that the treatment has no effect. "Expected probability of pregnancy within 12 months" refers to perceived own risk. Beliefs about risk among others were *not* elicited prior to receiving the information about population risk.

Table 8
Testing for Experimenter Demand Effects.

	$b_0 < 17$			$b_0 \geq 17$		
	b_0	Δb	N	b_0	Δb	N
Panel A: Logit Coefficients						
Before Treatment	0.086 (0.038)		231	0.254 (0.178)		327
After Treatment	0.173 (0.108)	0.124 (0.084)	106	0.684 (0.551)	0.004 (0.133)	159
P-Value Difference	0.744			0.281		
Panel B: Marginal Effects						
Before Treatment	0.010 (0.004)		231	0.021 (0.015)		327
After Treatment	0.013 (0.008)	0.009 (0.006)	106	0.019 (0.016)	.0001 (0.004)	159
P Value Difference	0.743			0.285		

Estimated effect of baseline beliefs about pregnancy risk absent contraception (b_0) and before-after treatment changes in these beliefs (Δb) on intentions to use contraception. Logit model estimates with dependent variable defined either as baseline intentions to use contraception ("Before" row) or post-treatment intentions to use contraception ("After" row), controlling for all the woman characteristics listed in Panel A of Table A-1. The last row of each panel is the p-value of a joint χ^2 test of equality across the three coefficients of interest. To increase power, regressions of baseline intentions on baseline beliefs include all women, whether or not they were randomized into receiving the information. See Appendix A-6 for the econometric results underpinning our tests.

Among women who are not using contraception, our treatment increases intention to use contraception by as much as 8.2pp (p-value of McNemar test: 0.03). Unsurprisingly, this is much larger than the predicted effect using the coefficients obtained when estimating the ARUM model on the whole sample — namely a 1.6pp increase in actual use.[36]

7. Conclusion

Many women in low-income countries are not using contraception despite wanting to avoid pregnancy. This is especially puzzling given policy efforts to ensure that modern contraceptives are readily available at low- or no cost to the user. In this paper we document, in a Mozambican setting, the subjective beliefs regarding contraception of women who wish to avoid pregnancy. We

[36] This is the predicted effect on contraceptive use when increasing beliefs by the 1.5 beans average increase in the expected probability of pregnancy absent contraception observed in the sample of women who are currently not using contraception (see Table 7 Panel D).

find that they hold plausible beliefs overall, except that a large minority underestimates the risk of pregnancy absent contraception and the majority overestimates the risk of failure associated with hormonal methods.

Using these data to estimate a structural model of the choice between the main alternatives adopted by women in this country (including using no contraception), we find that supply issues and side-effects taken as a whole do not contribute much to low take-up, which calls for interventions beyond the current policy focus of improving the quantity and quality of contraceptive supply. Our structural estimates also point to the importance of partners' preferences for contraceptive methods — as well as- and independently to partners' fertility preferences. Our findings therefore highlight the importance of involving men in interventions aimed at increasing contraceptive take-up. The extent to which men's preferences are amenable to change may however be limited in the short run.

Crucially, we identify a new, promising avenue for immediate change, namely recalibrating beliefs about the risk of pregnancy absent contraception. We find support for this intervention via two independent exercises: first, in our structural model – identified from variation in beliefs and actual contraceptive use in our observational data – and second, through a validation exercise comparing women's beliefs and intentions to use contraception before- and after we inform them of the pregnancy risk absent contraception in the general population. Importantly, our structural model estimates and predictions based on those estimates hold constant a rich set of other constraints including cost and partner approval. In addition, the concordance between our structural estimates and our findings based on an exogenous information shock suggest that miscalibrated beliefs about pregnancy risk act as a barrier to contraceptive use independently of other barriers such as partner disapproval.

More precisely, our structural estimates indicate that increasing by 23.5pp the expected pregnancy risk absent contraception among the women who underestimate this risk would increase contraceptive take-up by about 4.8pp among this group (1.9pp overall). Among this group of women, our experiment increases the expected risk of pregnancy absent contraception by 23.5pp and intention to use contraceptives in the future by 4.4pp, which is close to our structural estimate of 4.8pp. Among women not currently using contraception, intention to use contraceptives increases by as much as 8.2pp after informing them of the pregnancy risk absent contraception in the general population.

In Mozambique, modern contraceptive use (unmet need for contraception) went from 20.8% (18.9%) in 2003 to 25.3% (23.1%) in 2015. In Sub-Saharan Africa as a whole, contraceptive use (unmet need for contraception) went from 16% (25.6%) in 2000 to 26.3% (24%) in 2014 (all figures taken from World Development Indicators, 2019). Given this slow pace of progress — and even negative trend in the case of unmet need for contraception in Mozambique, an information message targeting low perceived risk of pregnancy could be a valuable low-cost instrument to increase contraceptive take-up in the short run. Two open questions, which we address in ongoing work, are to what extent low perceived risk of pregnancy contributes to low contraceptive take-up in different high-fertility contexts, and how, in practice, to effectively address information gaps in this domain.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Áureo de Paula, as both co-author of this manuscript and managing co-editor of the Journal of Econometrics, did not act in any capacity in the review process for this manuscript.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jeconom.2025.105997.

References

Ainsworth, M., Beegle, K., Nyamete, A., 1996. The impact of women's schooling on fertility and contraceptive use: A study of fourteen sub-saharan African countries. World Bank Econ. Rev. 10 (1), 85–122.
Anukriti, S., Herrera-Almanza, C., Karra, M., 2021. Bring a friend: Strengthening women's social networks and reproductive autonomy in India. Tech. rep., Working Paper.
Ashraf, N., Field, E., Lee, J., 2014. Household bargaining and excess fertility: An experimental study in zambia. Am. Econ. Rev. 104 (7), 2210–2237.
Ashraf, N., Field, E., Voena, A., Ziparo, R., 2018. Maternal mortality risk and the gender gap in desired fertility. Mimeograph.
Athey, S., Bergstrom, K., Hadad, V., Jamison, J.C., Ozler, B., Parisotto, L., Sama, J.D., 2021. Shared decision-making: Can improved counseling increase willingness to pay for modern contraceptives? World Bank Policy Research WP 9777, The World Bank.
Bachmann, R., Topa, G., van der Klaauw, W., 2022. Handbook of Economic Expectations. Elsevier.
Benjamin, D.J., 2019. Errors in probabilistic reasoning and judgment biases. Handb. Behav. Econ.: Appl. Found. 1 2, 69–186.
Berry, S., Levinsohn, J., Pakes, A., 1995. Automobile prices in market equilibrium. Econometrica 63 (4), 841–890.
Blattman, C., Jamison, J., Koroknay-Palicz, T., Rodrigues, K., Sheridan, M., 2019. Measuring the measurement error: A method to qualitatively validate survey data. J. Dev. Econ. 120, 99–112.
Burkman, R.T., 2001. Oral contraceptives: Current status. Clin. Obstet. Gynecol. 44 (1), 62–72.
Cardell, N.S., 1997. Variance components structures for the extreme-value and logistic distributions with application to models with heterogeneity. Econometric Theory 13 (2), 185–213.
Cassidy, R., Bruinderink, M.G., Janssens, W., Morsink, K., 2021. The power to protect: Household bargaining and female condom use. J. Dev. Econ. 153, 102745.

Chin-Quee, D.S., Wedderburn, M., Otterness, C., Janowitz, B., Chen-Mok, M., 2010. Bridging emergency contraceptive pill users to regular contraception: results from a randomized trial in Jamaica. Contraception 81 (2), 133–139.

Ciancio, A., Delavande, A., Kohler, H.-P., Kohler, I.V., 2020. Mortality risk information, survival expectations and sexual behaviors. Mimeograph.

De Quidt, J., Haushofer, J., Roth, C., 2018. Measuring and bounding experimenter demand. Am. Econ. Rev. 108 (11), 3266–3302.

Delavande, A., 2008. Pill, patch, or shot? Subjective expectations and birth control choice. Internat. Econom. Rev. 49 (3), 999–1042.

Delavande, A., Giné, X., McKenzie, D., 2011. Eliciting probabilistic expectations with visual aids in developing countries: How sensitive are answers to variations in elicitation design? J. Appl. Econometrics 3 (26), 479–497.

Delavande, A., Kohler, H.-P., 2012. The impact of HIV testing on subjective expectations and risky behavior in malawi. Demography 49 (3), 1011–1036.

Delavande, A., Zafar, B., 2019. University choice: The role of expected earnings, non-pecuniary outcomes and financial constraints. J. Political Econ. 127 (5), 2343–2393.

Desai, J., Tarozzi, A., 2011. Microcredit, family planning programs, and contraceptive behavior: evidence from a field experiment in Ethiopia. Demography 48 (2), 749–782.

Dominitz, J., Manski, C.F., 1996. Eliciting student expectations of the returns to schooling. J. Hum. Resour. (ISSN: 0022166X) 31 (1), 1–26.

Dominitz, J., Manski, C., 1997. Using expectations data to study subjective income expectations. J. Amer. Statist. Assoc. 92 (439), 855–867.

Dowd, B.E., Greene, W.H., Norton, E.C., 2014. Computation of standard errors. Health Serv. Res. 49 (2), 731–750.

Dupas, P., Miguel, E., 2017. Impacts and determinants of health levels in low-income countries. In: Handbook of Economic Field Experiments. vol. 2, Elsevier, pp. 3–93.

Embafrash, G., Mekonnen, W., 2019. Level and correlates of unmet need of contraception among women in extended postpartum in Northern Ethiopia. Int. J. Reprod. Med. 2019.

Fagerland, M.W., Lydersen, S., Laake, P., 2013. The McNemar test for binary matched-pairs data: Mid-P and asymptotic are better than exact conditional. BMC Med. Res. Methodol. 13 (1), 91.

Fuster, A., Zafar, B., 2022. Survey experiments on economic expectations. In: Bachmann, R., Topa, G., van der Klaauw, W. (Eds.), Handbook of Economic Expectations. Elsevier.

Gahungu, J., Vahdaninia, M., Regmi, P.R., 2021. The unmet needs for modern family planning methods among postpartum women in sub-saharan Africa: A systematic review of the literature. Reprod. Heal. 18 (1), 1–15.

Giustinelli, P., Manski, C.F., Molinari, F., 2022. Precise or imprecise probabilities? Evidence from survey response related to late-onset dementia. J. Eur. Econ. Assoc. 20 (1), 187–221.

Global Development Support, 2017. Seventh survey on the availability of modern contraceptives and essential life saving maternal/reproductive health medicines in health facilities of mozambique: Final report. Tech. rep..

Haaland, I., Roth, C., Wohlfart, J., 2023. Designing information provision experiments. J. Econ. Lit. 61 (1), 3–40.

Hausman, J., Abrevaya, J., Scott-Morton, F., 1998. Misclassification of the dependent variable in a discrete-response setting. J. Econometrics 87, 239–269.

Krinsky, I., Robb, A.L., 1986. On approximating the statistical properties of elasticities. Rev. Econ. Stat. 715–719.

Krinsky, I., Robb, A.L., et al., 1990. On approximating the statistical properties of elasticities: A correction. Rev. Econ. Stat. 72 (1), 189–190.

Miller, G., Babiarz, K.S., 2016. Family planning program effects: Evidence from microdata. Popul. Dev. Rev. 7–26.

MISAU, INE and ICF, 2016. Inquérito de Indicadores de Imunização, Malária e HIV/SIDA em Moçambique (IMASIDA) 2015: Relatório de Indicadores Básicos. MISAU/Moçambique, INE, and ICF, Maputo/Moçambique.

Mosher, W., Jones, J., Abma, J., 2015. Nonuse of contraception among women at risk of unintended pregnancy in the United States. Contraception 92 (2), 170–176.

Mummolo, J., Peterson, E., 2019. Demand effects in survey experiments: An empirical assessment. Am. Political Sci. Rev. 113 (2), 517–529.

Muralidharan, K., 2017. Field experiments in education in developing countries. In: Handbook of Economic Field Experiments. Vol. 2, Elsevier, pp. 323–385.

Nakamura, S., 2016. Determinants of contraceptive choice among Japanese women: Ten years after the pill approval. Rev. Econ. Househ. 14 (3), 553–575.

Nettleman, M.D., Chung, H., Brewer, J., Ayoola, A., Reed, P.L., 2007. Reasons for unprotected intercourse: analysis of the PRAMS survey. Contraception 75 (5), 361–366.

Odwe, G., Obare, F., Machiyama, K., Cleland, J., 2020. Which contraceptive side effects matter most? Evidence from current and past users of injectables and implants in western Kenya. Contraception: X 2, 100030.

Polis, C.B., Bradley, S.E., Bankole, A., Onda, T., Croft, T., Singh, S., 2016. Contraceptive Failure Rates in the Developing World: An Analysis of Demographic and Health Survey Data in 43 Countries. Guttmacher Institute, New York.

Pritchett, L.H., 1994. Desired fertility and the impact of population policies. Popul. Dev. Rev. 20, 1–55.

Sedgh, G., Ashford, L.S., Hussain, R., 2016. Unmet Need for Contraception in Developing Countries: Examining Women's Reasons for Not Using a Method. Guttmacher Institute, New York.

Singh, S., Darroch, J.E., Ashford, L.S., 2014. Adding It Up: The Costs and Benefits of Investing in Sexual and Reproductive Health 2014. New York New York Guttmacher Institute 2014.

Stefanski, L., Carroll, R., 1985. Covariate measurement error in logistic regression. Ann. Stat. 13 (4), 1335–1351.

Stephenson, R., Baschieri, A., Clements, S., Hennink, M., Madise, N., 2007. Contextual influences on modern contraceptive use in sub-saharan africa. Am. J. Public Health 97 (7), 1233–1240.

Stinebrickner, R., Stinebrickner, T.R., 2014. A major in science? Initial beliefs and final outcomes for college major and dropout. Rev. Econ. Stud. 81 (1), 426–472.

Stover, J., Chandler, R., 2017. Expenditures on Family Planning in FP2020 Focus Countries in 2015. Track20 Project for the International Family Planning Expenditure Tracking Advisory Group, Washington (DC).

WHO/RHR, 2016. Selected Practice Recommendations for Contraceptive Use, 3rd Edition. World Health Organization Department of Reproductive Health and Research.

WHO/RHR and CCP, Knowledge for Health Project, 2018. Family Planning: A Global Handbook for Providers (2018 update). CCP and WHO, Baltimore and Geneva.

Wiswall, M., Zafar, B., 2015. Determinants of college major choice: Identification using an information experiment. Rev. Econ. Stud. 82 (2), 791–824.

World Development Indicators, 2019. World Development Indicators. The World Bank.

Wulifan, J.K., Brenner, S., Jahn, A., De Allegri, M., 2015. A scoping review on determinants of unmet need for family planning among women of reproductive age in low and middle income countries. BMC Womens Health 16 (1), 1–15.