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Shifting the Value of Norms: Fast Internet, Premarital Sex, and the Erosion of Female Genital Cutting

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Abstract

Health-harmful norms persist because they fulfill a socially valued function. In many Nigerian communities, female genital cutting (FGC) is practiced because it is believed to discourage sex outside marriage, outweighing its perceived costs for many households. This paper examines the impact of the expansion of fast internet on FGC in Nigeria. Our findings indicate that exposure to fast internet reduces both the prevalence of FGC and support for it. The effect does not appear to be driven by exposure to explicit anti-FGC content online. Instead, we find that fast internet affects FGC by reducing premarital sex stigma, thereby decreasing the perceived benefits of the practice. These findings provide evidence on how health-harmful norms evolve as the value of their function changes, with implications for designing effective interventions.

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Keywords

harmful norms, cultural change, female genital cutting

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1 Introduction

Despite widespread awareness campaigns and investments in prevention, health-harmful practices such as female genital cutting (FGC), breast ironing, and other harmful bodily modifications remain prevalent in many communities, affecting hundreds of millions of women worldwide. But why do these norms persist? As damaging for health as they are, these norms typically serve an important function in some communities. For example, in many communities in Nigeria, where sex outside marriage is highly stigmatized, FGC is believed to discourage premarital and extramarital sex, such that the perceived benefits of FGC outweigh its costs for many households.

This paper provides evidence on how health-harmful practices, what the literature often calls harmful norms, evolve when the function they serve loses value, decreasing the benefits of the practice. Using difference-in-differences methods and granular data on FGC and 3G availability, we assess how the staggered expansion of 3G in Nigeria, which increases fast internet access and exposes individuals to other cultures and values through films, music, and social networks, affects the evolution of FGC. We first show that the expansion of 3G substantially increased internet access and significantly reduced the prevalence of FGC. 3G availability in the village at the time of birth decreases the probability of undergoing FGC by 2.3 percentage points—approximately 14% of the mean prevalence in the sample. This effect is driven by rural areas, which have historically been more traditional, less exposed to foreign cultural content before the arrival of 3G. Using a sample of men and women 15 or older, we also find that 3G availability at the time of the survey reduces support for the practice.

We also show that the decline in FGC prevalence is closely tied to 3G reducing stigma around premarital sex. First, we find strong effects of 3G on sexual behavior, shifting attitudes toward more progressive stances: 3G decreases the reported age at first sex without affecting the age at marriage, increases the reported number of lifetime sexual partners outside marriage and extramarital relations, and reduces premarital sex stigma. Second, the effect of 3G on FGC is driven by areas where the practice is justified on the grounds of premarital sex stigma. In areas where FGC is justified as a rite of passage for social acceptance, for hygienic reasons, or on religious grounds, but not for preventing premarital sex, the effect is zero. Likewise, 3G has no effect in areas where premarital sex was already common prior to the arrival of the internet. Taken together, these results show that by reducing premarital sex stigma, and thus undermining the value of the function that sustains FGC, 3G reduced the prevalence of this harmful norm.

But fast internet constitutes a multidimensional shock whose effects on FGC could, in principle, operate through various alternative mechanisms beyond the destigmatization of premarital sex. We examine and rule out several potential channels that could plausibly account for the observed effects. Specifically, we find no evidence that the results are driven by exposure to explicit anti-FGC online content or campaigns, or simply by 3G affecting household economic welfare, reducing religiosity, improving educational attainment, or expanding the marriage market.

We examine the robustness of our results through several empirical exercises. First, we show that the effects are robust to alternative difference-in-differences estimators, specification checks, and analytical samples. Second, we show that the main conclusions are not driven by 3G delaying the age at cutting or by affecting the reporting of FGC rather than the true incidence of the practice. Third, by showing that the effect on FGC is not driven by 2G technology, we show that the effect is linked to fast internet specifically, rather than to other phone functionalities. Fourth, we rule out the hypothesis that the effect of 3G is confounded by major policies implemented in Nigeria around the same time, which could have affected FGC or its reporting, or by an increase in the presence of the state or increased infrastructure resulting from the expansion of 3G. Finally, we show that the results are not simply the result of households more opposed to FGC migrating towards 3G covered areas.

Nigeria provides an ideal setting to examine the effect of fast internet on the evolution of FGC. First, this country is the largest mobile broadband market in Africa, with around 170 million mobile connections in 2019 (Bahia et al., 2024). Second, while the prevalence of FGC in Nigeria is not as high as in other countries such as Somalia, Mali or Guinea, Nigeria has the third largest number of cut women after Egypt and Ethiopia. It is estimated that 10% of all women who have undergone FGC worldwide are Nigerian.[1] Third, unlike in many other countries, the vast majority of cuts in Nigeria occur during childhood. This is especially important to define the risk of being cut over the children's first years of life, which is an essential part of the identification strategy used in this paper. Finally, rich granular data from Nigeria enable our proposed analysis. We merge several geocoded individual-level data sources from Nigeria that include information on FGC, support for the practice, and sexual behavior, covering both the period before and after the arrival of 3G in the early 2010s, with yearly-level data on 3G availability at the 1km×1km grid level until 2018. We complement these datasets with focus groups that we

[1] See https://www.fgmcri.org/blog/nigerias-battle-against-female-genital-mutilation-a-hard-look-at-the-numbers-and-the-fight-ahead/

implemented in December 2024 to gain better insights about internet use and its perceived effects on social norms in Nigeria.

Our study speaks to different streams of research.

First, we contribute to the multidisciplinary literature on the evolution of social norms by providing empirical evidence that supports the hypothesis that norms erode when the social functions they fulfill become obsolete. This perspective aligns with theoretical frameworks developed in Bicchieri (2005), Henrich (2015), Giuliano and Nunn (2020), Henrich (2020), Henrich and Muthukrishna (2021), and Lowes (2024), which highlight how norms are maintained through social learning, coordination dynamics, and their adaptive value to communities. In other words, norms persist and evolve to solve social problems (Henrich et al., 2001; Henrich and Muthukrishna, 2021). In the same spirit, but using an economic lens, Fernández (2025) reviews seminal economic work and proposes a framework for norms change based on incentives, showing how cultural practices adapt when the incentives underpinning them shift, altering their benefits and costs. Our study shows that FGC tends to be less frequent when premarital sex is normalized, as the value of FGC's social function—preventing sex outside marriage—declines and the underlying social incentives for cutting are reduced. More broadly, our results suggest that norm change can be understood as a function of shifts in cultural relevance of the behaviors that norms are designed to regulate, contributing to broader debates about the co-evolution of culture and norms.

Second, our study contributes to the body of evidence on what works to fight FGC. This harmful norm has lasting health consequences (Jones et al., 1999; Berg et al., 2014; Wagner, 2015). However, despite the substantial resources invested in fighting FGC (Katz et al., 2021), the practice affects 4 million girls every year (WHO, 2025). Novak and Bussbergt (2023) review the literature on the effectiveness of anti-FGC policies and conclude that public policies have rarely been rigorously evaluated, and those that have been show only limited observable impacts. In particular, maternal education and campaigns about the health costs of FGC, the interventions that attract the most resources and attention from policymakers, seem to have limited effects on this practice.[2] The review emphasizes that fostering changes in FGC is difficult because it requires tackling the cultural and identity roots of the practice, which vary substantially across ethnic groups. Evidence on the effectiveness of such approaches, however, remains scarce (Corno and La Ferrara, 2019; Congdon Fors et al., 2024). We add to this literature by examining the role of fast internet, arguably one of the most powerful catalysts of cultural change in sub-Saharan Africa

[2]See Section 2 for a broader discussion on the effects of anti-FGC policies.

in the 21st century. While the expansion of fast internet may have adverse effects on other outcomes, our findings suggest that interventions weakening the value of the social functions that sustain harmful norms can be an effective strategy to reduce FGC and similar practices.

Third, our study contributes to the economics literature on the evolution and nature of FGC. Becker (2024) argues that infibulation, the most severe form of FGC, developed in pastoralist societies to control female sexuality and reduce extramarital sexual activity during husbands' prolonged absences and La Ferrara et al. (2020) show that the Red Sea slave trade increased the prevalence of the practice, which was used to signal sexual chastity among enslaved women. Poyker (2023) shows how regime stability can facilitate the abandonment of FGC, and Gulesci et al. (2023) use data from Somalia to document how FGC practices can shift rapidly from more severe to less severe forms, consistent with the idea of incremental norm change through "stepping stones". Novak (2020), Bellemare et al. (2015), and Efferson et al. (2015) examine whether FGC operates as a social coordination norm in different sub-Saharan African countries. They find no evidence of a single tipping point and show that much of the variation in prevalence reflects household-level characteristics. Our study provides the first empirical evidence supporting the anthropological hypothesis that links FGC to beliefs and stigmas around sex outside marriage (Koso-Thomas, 1987; Shell-Duncan and Hernlund, 2001; Ahmadu, 2001).

Finally, our study contributes to the growing literature on the transmission of norms and culture. Previous literature has highlighted the role of TV shows, social media or migrants in the spread of norms and the formation of values in developing countries (Jensen and Oster, 2009; La Ferrara et al., 2012; Diabate and Mesplé-Somps, 2019; Ahmed et al., 2025). More specifically, a handful of studies have explored the role that new communication technologies and internet have on social norms and behaviors. Zhuravskaya et al. (2020) and Guriev et al. (2020) delve into the influence of 3G networks on political outcomes, Manacorda and Tesei (2020) reveals the mobilization and protest-facilitating role of mobile phone coverage (2G) in Africa, and Frezza (2023) uncovers adverse effects on women's welfare and justification of intimate partner violence in West Africa stemming from the arrival of both terrestrial and submarine cables.[3] We show that fast internet contributes to broader cultural change, impacting harmful norms such as FGC and sexual behaviors.

The rest of this paper is structured as follows. Section 2 characterizes the practice of FGC, presenting stylized facts, and summarizing the evidence on the effectiveness

[3]The effects of new communication technologies on economic outcomes are discussed in Hjort and Poulsen (2019) and Bahia et al. (2024).

of anti-FGC policies. Section 3 describes the expansion of fast internet in the analysis and why it might have changed FGC. Sections 4 and 5 introduce the empirical strategy and the data used in the main analyses. Section 6 presents the results of the expansion of 3G on the prevalence of FGC. Section 7 shows that the main effects on FGC are driven by 3G-induced changes in sexual behavior. Section 8 examines and rules out alternative hypotheses that could explain the effect of 3G on FGC. Section 9 discusses the results of the qualitative analysis on which types of internet content may be driving the effect of 3G on sexual behaviors. Section 10 concludes.

2 Female genital cutting: How widespread is it, why is it practiced, and what works against it?

Defined as the total or partial removal of female genitalia for reasons unrelated to health, the practice of FGC affects around 230 million women worldwide (UNICEF, 2024). Figure A1 in Appendix A shows the prevalence of the practice among women aged 15–49 across countries where it is practiced. The figure also displays how prevalence varies across generations, suggesting that while the practice is decreasing in some countries such as Burkina Faso or Sierra Leone, it remains largely unchanged in others such as Somalia or Guinea.

But why is FGC practiced? A multidisciplinary literature has examined its meanings and determinants, which vary across societies. Gruenbaum (2001) and Koso-Thomas (1987) highlight that in Sudan and Sierra Leone, FGC signals adherence to societal norms, rites of passage, and the preservation of tradition. Within the Kono community in Sierra Leone, Ahmadu (2001) documents that FGC can be also seen as a marker of female empowerment and identity. Mandara (2001) argues that in Nigeria, FGC is believed to reduce women's sexual desire, thereby encouraging loyalty and discouraging premarital sex. Khalifa (2022) and García-Hombrados and Salgado (2022) show that in Egypt and Senegal, FGC facilitates marriage and may lead to a higher bride price. Overall, the literature documents that within contexts where FGC is practiced, it is often deeply linked to women's identity (Shell-Duncan and Hernlund, 2001), reflecting characteristics that are socially valued and esteemed, including femininity, purity, sexual loyalty to the husband, maturity, and stability.

A common belief among policymakers and the general public is that FGC is the result of low maternal education or low women's bargaining power within the household. While there is a well-established negative correlation between maternal education and the likelihood of FGC, De Cao and La Mattina (2019) show that maternal education has no causal effect on either the prevalence of FGC or its support. Moreover, DHS data reveal that in most countries, support for FGC is similar among women and men.[4] Considering that women are already the primary decision-makers in most cutting decisions (Novak and Bussbergt, 2023; Shell-Duncan et al., 2021), it is unclear whether improving mothers' bargaining power would lead to a significant reduction in FGC.[5]

So, what works to reduce FGC? Novak and Bussbergt (2023) review the evidence on which policies are effective in combating FGC, concluding that there is very little rigorous evidence on what works. The largest effects are found for interventions and shocks that target the cultural roots of FGC, such as the adoption of alternative rites of passage (Corno and La Ferrara, 2019) or spillover effects from returned migrants (Diabate and Mesplé-Somps, 2019). In line with the relevance of targeting the cultural roots of the practice, Congdon Fors et al. (2024) show that Christian missions in sub-Saharan Africa decreased the current prevalence of FGC, and that this effect was not driven by better education or economic development. The evidence on the effects of legal bans is more mixed: some studies suggest positive impacts in some countries, while others find no effects or even unintended negative consequences in terms of the age at cutting (Camilotti, 2015; Cetorelli et al., 2020; Crisman et al., 2016; García-Hombrados and Salgado, 2022; Bertelli et al., 2026). Finally, interventions focused on information provision, campaigns, or advocacy can reduce the prevalence (Vogt et al., 2016; Corno and La Ferrara, 2019; Khalifa, 2022) or the severity of the practice (Gulesci et al., 2020), though they can also provoke backlash (Gruenbaum, 2001).

2.1 FGC in Nigeria

The most recent round of the Nigerian DHS, conducted in 2018, indicates that approximately 20% of women aged 15–49 have undergone FGC.[6] Figure 1 shows the prevalence of FGC by year of birth in Nigeria. Despite a significant decline among women born in the last decades of the 20th century, prevalence stabilized in the late 1990s and experienced a slight increase in the following years, before decreasing again for cohorts born in the 2010s, coinciding with the expansion of 3G. The survey also shows that most procedures involve partial or total removal of the

[4] See Figure A2 in Appendix A.

[5] An exception is provided by Harari (2019), who shows that in Kenya, the expansion of women's inheritance rights reduced the prevalence of FGC.

[6] While a MICS survey was conducted in Nigeria in 2021, we use the 2018 Nigerian DHS to present descriptive evidence on FGC, as this is the last year for which information on 3G is available and therefore the last year included in our study period. The prevalence of FGC in the 2021 MICS among women aged 15-49 is 16%.

clitoral glans; infibulation is extremely uncommon,[7] and the procedures are typically performed by traditional circumcisers. Unlike in other settings, our DHS data for Nigeria show that more than 80% of cuts occur within the first year of life, and more than 95% before age 3.[8] FGC is deeply rooted in the traditions of Nigeria's most populous ethnic groups, including the Yoruba, Igbo, and Hausa. Figure 2 shows the prevalence in our analytical sample throughout the country, with most focal points in the North and the Southwest.[9] In most communities surveyed in the DHS data, FGC is practiced on less than half of the relevant population, suggesting that in Nigeria it is unlikely to function purely as a social coordination norm and that decisions vary across households within the same communities.

FGC in Nigeria shares important features with other contexts, as it is used to promote socially valued behaviors, particularly virginity and loyalty (Orubuloye et al., 2001). Indeed, across most ethnicities, FGC is widely believed to reduce sexual desire and discourage premarital and extra-marital sex (Mandara, 2001; Orubuloye et al., 2001), behaviors that are strongly stigmatized in many communities. Consistent with this, the latest Nigerian DHS data on perceived benefits of FGC (2008 round) highlight the preservation of virginity as the most commonly cited benefit (see Figure 3).[10] Other non-mutually exclusive benefits of FGC cited by the survey respondents include better marriage prospects, social acceptance, improved hygiene, more sexual pleasure for men, and, less frequently cited, religious approval.[11][12] While the importance of virginity is sometimes associated with women's prospects in the marriage market, our qualitative analysis suggests that, in Nigeria, virginity carries a broader social meaning. Beyond its potential implications for marriage, remaining a virgin until marriage is often seen as a marker of moral integrity and family honor, conferring higher social status and greater respect from peers, relatives, and even ancestors (Ademiluka, 2023; Taiwo et al., 2023).

[7]In our analytical sample, infibulation affects less than 1% of individuals, accounting for 4.7% of circumcised females.

[8]For example, in some traditional Igbo communities, FGC was sometimes performed during the naming ceremony, seven days after birth.

[9]While Figure 2 shows the prevalence by county for the analytical sample (females born between 2007 and 2018), Figure A3 in Appendix A shows the prevalence by county for all females aged 0-49. DHS surveys are not representative at the county level, but rather at the regional level for women aged 15–49. The prevalence for this age group at the regional level in 2018 is presented in Figure A4 in Appendix A.

[10]The questionnaire does not include extra-marital sex as an option.

[11]The link between religion and FGC is discussed in detail in Section 6.3.

[12]Unlike in other countries, in Nigeria FGC is not believed to increase fertility.

3 The spread of 3G in Nigeria and how it might affect FGC

To explore the effect of fast internet on FGC, we exploit the rollout of third (3G) and fourth (4G) generations of mobile telecommunications. 3G and 4G technology provides enhanced mobile communication capabilities, including fast data transmission and expanded multimedia capabilities, allowing for fast internet access from mobile phones. While we consider both 3G and 4G for our analysis, 4G was first introduced in Nigeria at the very end of our study period and typically in areas that previously already had 3G. For simplicity, we use the term 3G throughout the paper.

This technology operates through cell towers or base stations that communicate with user terminals in their vicinity using electromagnetic signals to connect these terminals to the core network and provide fast internet. The reach of cell towers can extend up to 15 km, depending on topography, buildings, transmission power, and weather conditions. Introduced first in the main Nigerian cities, 3G networks gradually extended nationwide during the 2010s. By the end of 2019, Nigeria had 170 million mobile connections (60% of which used 3G or 4G mobile broadband technologies), which makes Nigeria the largest mobile broadband in Africa (Bahia et al., 2024). Figure 4 shows the expansion of 3G availability throughout the country.

In Sub-Saharan Africa, where cable connections, DSL and fiber optic infrastructures are limited and costly (less than 0.5 subscriptions per 100 inhabitants (World Bank, 2024)), 3G mobile networks, accessed via smartphones, serve as the predominant means of internet access. Using data from the Nigerian General Household Survey (NGHS), Figure A5 in Appendix A shows how internet access started increasing from 2012, when the rollout of 3G networks began, with mobile phones becoming the main means of access (see Figure A6 in Appendix A). In Section 6, we use the NGHS to document large causal effects of 3G availability on internet access, particularly among young women.

We hypothesize that fast internet can erode the practice of FGC through several mechanisms. We provide a brief overview of the two main potential mechanisms here, with a fuller discussion in Sections 7 and 8. First, the internet facilitates the dissemination of information about the health costs of FGC and other explicit anti-FGC content. While pro-FGC content is also available online, it is far less common (Babbs et al., 2023). This mechanism might be particularly relevant if individuals are unaware of the health consequences of the practice. A detailed discussion of anti-FGC online campaigns and efforts is provided in Section 8.1. However, most of the internet content accessed by individuals is unrelated to FGC. Could non-explicitly FGC content decrease FGC? FGC is widely practiced in communities with rigid norms around female sexuality, as it is believed to discourage women from engaging in premarital and extramarital sex. However, the internet may expose individuals in these communities to cultural content-such as music, YouTube videos, movies, and social media—as well as role models that portray or normalize sexual behaviors that contrast sharply with local norms, including premarital sex and more open expressions of female sexuality. As individuals are increasingly exposed to these alternative representations, prevailing beliefs about the need to control women's sexual behavior through FGC may weaken, potentially reducing the perceived benefits of FGC. On the other hand, exposure to different cultures, behaviors, or simply anti-FGC content could also trigger a cultural backlash (Blumenstock et al., 2022; Gruenbaum, 2001), raising questions about the direction of the effect—an issue that remains an open empirical question. Finally, fast internet is also a broad socioeconomic shock that may have multidimensional consequences, some of which may ultimately affect the prevalence of FGC. Section 8 examines and rules out several alternative mechanisms including improved economic conditions, reduced religiosity, marriage markets, and higher educational attainment.

4 Empirical strategy

To assess the impact of fast internet on FGC, we leverage information obtained from the daughters of women participating in the 2018 and 2013 rounds of the Nigerian Demographic Health Survey (DHS) and in the 2021 and 2016 rounds of the Nigerian Multiple Indicator Cluster Survey (MICS) that were born between 2007 and 2018, the years for which we have granular information about 3G availability. The information is collected from the birth registry module which includes information on FGC status for every daughter of women aged 15-49.[13]

Our empirical approach relies on variation in the availability of 3G network at the time of birth in the place of residence.[14] Because FGC in Nigeria occurs mainly within the first year of life, those girls born after the introduction of this technology in the village/ward of residence are considered exposed to 3G while, those born before 3G network is available in the location or in locations with no 3G network

[13]While the female module collected self-reported information on FGC for women aged 15 and above, all girls born between 2007 and 2018 were 14 or younger at the time of the survey. Consequently, the FGC status for all girls in the analytical sample is reported by their mothers.

[14]The DHS and MICS datasets do not include the coordinates for the place of birth. We show in Section 6.3 that the results are robust to the exclusion of migrant households.

available during the study period, are considered unexposed. Formally, we estimate the following difference-in-differences model:

$$FGC_{ibv} = \delta_0 + \delta_1 \mathit{3G\ available}_{bv} + \theta_b + \gamma_v + u_{ibv} \quad (1)$$

where FGC_{ibv} is equal to 1 if girl i, born in year b and living in village v is cut and 0 otherwise. $\mathit{3G\ available}_{bv}$ indicates whether village/ward v in year b is covered by 3G network or higher generation. δ_1 is the parameter of main interest and it measures the effect of 3G network availability at the time of birth on the probability of FGC. θ_b and γ_v are year-of-birth and village fixed effects to control for time-invariant village-level characteristics and birth-year specific events. Standard errors are clustered at the village/ward level (the survey cluster).

Because the introduction of 3G throughout Nigeria is staggered, the standard OLS model may lead to the negative weights problem identified by Goodman-Bacon (2021). We decompose the weights and find that less than 1% of the weights used in the OLS estimation are negative, alleviating concerns about the use of the canonical TWFE model. Nonetheless, as a robustness check, we also estimate the average treatment effects using difference-in-differences methods for staggered treatment adoption developed in Sun and Abraham (2021), Callaway and Sant'Anna (2021), and Chaisemartin and D'Haultfœuille (2020), and find nearly identical estimates. The deployment of 3G networks over time was unlikely to be random and was more likely driven by the costs and potential returns of expansion.[15] However, the validity of our difference-in-differences approach does not require the expansion to be random. Instead, the key identifying assumption in our strategy is the parallel trends condition: In absence of 3G network, the evolution of the prevalence of FGC would be similar across cohorts exposed and unexposed to 3G. We examine the plausibility of this assumption by estimating event-study specifications.

We also assess the effect of 3G network availability on other outcome variables, mainly, the support for FGC and sexual behavioral outcomes. Information on these variables at the time of the survey is included for women aged 15-49, and for men aged 15-59 in DHS rounds 2003, 2008, 2013 and 2018.[16] Unlike in the analysis of the FGC prevalence, exposure to 3G is not defined based on the availability of 3G network at the time of birth, but rather at the time of the survey, and the population of interest are not the young daughters but rather men and women who are at least 15 years at the time of the survey. As the DHS data are repeated cross-sections

[15] These, in turn, may depend on factors such as topography, population density, and grid availability, among others.

[16] Not all the variables are available in every survey round for both men and women.

and the survey clusters are different in every round, village fixed effects cannot be estimated as this would remove any time variation. We circumvent this limitation by converting our treatment variable of interest, 3G exposure, into a variable representing the proportion of the population covered by 3G networks in each county (Local Government Area, LGA), the vast majority of which are surveyed in every DHS round.[17] Defining the treatment at the county level enables us to incorporate county fixed effects and cluster observations by county, allowing *de facto* the estimation of difference-in-differences models. We estimate the following specification:

$$Support\ FGC_{itl} = \delta_0 + \delta_1 Sh\ population\ with\ 3G\ available_{tl} + \mu_t + \nu_l + X_{itl} + u_{itl} \quad (2)$$

where $SupportFGC_{itl}$ indicates the outcome of interest for individual i, living in county l interviewed at time t, $Sh\ population\ with\ 3G\ available_{tl}$ is the share of the population in county l at time t that has 3G network available. μ_b and ν_v are year-of-interview (survey) and county (LGA) fixed effects. Finally, u is the error term. Standard errors are clustered at county level. Unlike in the analysis of FGC, the results of the Goodman-Bacon decomposition calls for caution about the potential problems of negative weights for most outcomes. Thus, we also use the staggered difference-in-differences estimator presented in Chaisemartin and D'Haultfœuille (2020). The latter approach is the only difference-in-differences estimator for staggered adoption that allows for the use of continuous treatment variables.

To test the feasibility of the parallel trends condition in this specification with a continuous treatment indicator and staggered expansion, we estimate the placebo analysis proposed in Chaisemartin and D'Haultfœuille (2020). Additionally, we test whether changes in the outcome of interest between the 2003 and 2008 surveys—prior to the start of 3G deployment in Nigeria—are correlated with the degree of 3G availability in the county in 2018.

As a robustness check, we define exposure to 3G at the time of the survey at the individual level to estimate the association between 3G network availability at the time of the survey and these outcomes in Appendix B, showing consistent estimates.

[17] There are 774 Local Government Areas (LGAs) in Nigeria. These are equivalent to counties in many other countries and represent the administrative level above wards. LGAs are responsible for local governance and the provision of basic public services.

5 Data

This research combines quantitative data from multiple sources and qualitative data collected by the authors in the field. Below, we provide information on each of the databases used.

Nigerian Demographic and Health Surveys (DHS): We use information from four rounds of the Nigerian DHS conducted in 2003, 2008, 2013, and 2018. DHS data include repeated cross-sections of individual-level information from a nationally representative sample of women aged 15-49 in Nigeria. The questionnaire provides information on sociodemographic and health characteristics, including self-reported information on their FGC status, support for FGC, beliefs about FGC, and sexual behavioral outcomes. Moreover, in the 2018 and 2013 rounds, the survey asked these women about the FGC status for each living daughter of the interviewed women, which is used in the main analysis. Information on the perceived benefits of FGC is only included in the 2003 and 2008 surveys. The survey also includes a male module that collect information on a nationally representative sample of men aged 15-59. The men sample is smaller since only one third of the interviewed households were selected for the male module. Moreover, the male module only includes information on support for FGC in the 2003, 2008, and 2013 rounds. All the DHS rounds considered include information on the latitude and longitude of the survey cluster (village for rural areas and wards for urban areas).[18]

During the survey implementation and in particular the FGC module, enumerators are instructed to ensure privacy, though achieving complete seclusion from other family members may not always be feasible. The words and methods employed by enumerators are specifically designed and trained to avoid underreporting due to social desirability bias and other causes (USAID, 2011). Nonetheless, some degree of underreporting of the FGC status of daughters is expected, and in Section 6.3 we explore the different forms in which underreporting might affect the main estimates and show that our conclusions are not driven by it.

Nigerian Multiple Indicator Cluster Surveys (MICS) We use geolocated information from the 2016 and 2021 rounds of the Nigerian MICS on the FGC status of each living daughter of a nationally representative sample of women aged 15–49. This complements the DHS data from the 2013 and 2018 rounds, which are used to analyze the effect of 3G availability at the time of birth on FGC. The MICS data

[18]To avoid personal identification, survey clusters are randomly displaced by up to 2 km in urban areas and up to 5 km in rural areas, which may introduce measurement error in the variable on 3G availability. Since this measurement error in the treatment variable is random, our estimates might be thought to be a lower bound for the effect of 3G networks on the outcomes of interest.

collection process follows procedures and protocols similar to those of the DHS.

3G data: We leverage yearly data on 3G and 4G mobile networks coverage in Nigeria available for the period 2007 and 2018.[19] This dataset includes coverage data at the 1x1-kilometer grid level provided by the Global System for Mobile Communications Association (GSMA).[20] The available information allows therefore to determine whether the individuals interviewed in the different geolocated surveys have 3G or 4G network available at a certain point in time. 4G was first introduced at the very end of our study period and typically in areas that previously already had 3G. Therefore, most of the variation used in the study in exposure to fast internet arises therefore with the deployment of 3G. Thus, while we consider both 3G and 4G to define the treatment variable, we use the term 3G throughout the paper for simplicity.

While we provide evidence that 3G increases internet usage using the Nigerian General Household Survey, our main analysis focuses on 3G (fast internet) availability rather than internet usage for two reasons. First, the DHS dataset, which is the primary dataset including information on FGC outcomes, does not include information on internet usage.[21] Second, 3G availability in the community may also affect households in the community who do not have direct access to the internet. This can occur if, for example, internet users share information and content with non-users in their community, or through the assimilation of behaviors exhibited by internet users in their community.

Other quantitative datasets: Following Guriev et al. (2020), we merge the NASA map of population density at the 1x1 km level[22] with the GSMA dataset on 3G availability to calculate the proportion of population in each Nigerian county every year with 3G network available. This variable serves as the main indicator of treatment exposure in the analysis of the effect of 3G on support for FGC and sexual behavior outcomes. To validate the implicit assumption that 3G network availability increases internet use relevantly, we use information from rounds 2010, 2012, 2015, and 2018 of the Nigerian General Household Survey (NGHS), which collects information on internet use for a nationally representative sample of households. Finally, we use yearly rainfall data collected by the University of Delaware

[19] The version of the data to which the authors had access does not include information on signal quality. Existing information from OpenSignal indicates that, in 2019, the average mobile internet speed in Nigeria was 9.87 Mbps, one of the highest in sub-Saharan Africa and slightly above other major countries in the Global South, such as India.

[20] The GSM Association serves as the representative body for the collective interests of mobile network operators worldwide.

[21] Only the 2018 round includes this information, which is provided only at the time of the survey and does not allow for use in the retrospective analysis conducted in the main analysis.

[22] The data can be downloaded using this link: https://neo.gsfc.nasa.gov

at the grid level for the period 1900-2018. Following McGavock and Novak (2023), we use this dataset to assess the effect of rainfall shocks on FGC in Nigeria, testing whether the estimated impacts of 3G are simply driven by an improvement in economic welfare.

Table 1 shows the descriptive statistics for the data used in the two main analyses. In Panel A, we present descriptive statistics for the sample of females included in the main analysis of the effect of 3G at the time of birth on FGC. The sample consists of daughters of women surveyed in DHS 2013 and 2018, and MICS 2016 and 2021, restricted to those daughters born between 2007 and 2018, the years for which granular data on 3G availability are available. This sample includes cohorts of females born up to five years before the deployment of 3G networks in Nigeria began. The prevalence of FGC in the analytical sample is 16.9%, with 10% of them born in an area covered by 3G at the time of birth. Their ages at the time of the survey range from 0 to 14, with an average age of 4.9 years.

In Panel B, we present descriptive statistics for the sample of males and females included in the analysis of the effect of 3G at the time of the survey on support for FGC, sexual behavior, and other outcomes. The sample consists of men aged 15–59 and women aged 15–49 surveyed in the DHS rounds of 2003, 2008, 2013, and 2018. The number of observations varies substantially across variables and gender because the FGC module was applied only to a subsample of surveyed households, because some questions only targeted ever married women, and because while all women in surveyed households were interviewed, only one-third of the eligible men in these household were selected for the survey. Indeed, more than 70% of the analytical sample is female. The data also show that surveyed individuals are on average around 30 years old, and approximately 30% of respondents believe that the practice of FGC should continue, with the same share for men and women. Age at marriage is low, particularly among women, who have a mean age at first marriage below 18. Extra-marital sex is also uncommon among women, with the average number of lifetime sexual partners excluding husbands being 0.6, while this number is substantially higher for men, at 2.4. Further details about the data sources for the outcome variables used in the paper are provided in Table A1 in Appendix A.

Qualitative data: We complement the quantitative analysis with focus groups conducted in the field. In December 2024, two of the authors, in collaboration with local translators, conducted 10 focus groups in Igbo, Yoruba, Hausa, Efok, Ekoi and Ibibio rural communities throughout Nigeria. In them, we collect information on internet use and its perceived effects on social norms, particularly sexual behavior and premarital sex stigma. Details on data collection and analysis are provided in

Appendix C.

6 Results

6.1 The effect of 3G network on internet use

Before presenting the main estimates of the effect of 3G on FGC, we start by examining the effect of 3G availability on internet access. Because information on internet use is not included in Nigerian DHS,[23] we use data from rounds 2010, 2012, 2015, and 2018 of the NGHS. Because the mentioned database surveys the same villages over time, we can estimate a slight variation of equation 2 using individual level internet access as the dependent variable, village-level fixed effects, and defining treatment exposure as a dichotomous variable indicating whether the village had 3G network coverage in the survey year.[24]

The results of this analysis are depicted in Figure 5 using the Sun and Abraham estimation procedure and in Figure A7 in Appendix A using the TWFE.[25] The results of our preferred specification show that the availability of 3G network increases the probability of internet use by approximately 20 percentage points for both men (an increase of 250% relative to pre-3G levels) and women (an increase of 405% relative to pre-3G levels). The effect on internet access is immediate and particularly pronounced among women under 30, increasing by 31 percentage points. These results are not surprising, since 3G is the primary technology for internet access in Nigeria (see Figure A6 in Appendix A), and use of internet in 3G covered areas in Nigeria is large, particularly among young people.[26] On the other hand, infrastructure for cable connections, DSL, and optic fiber is expensive and deficient outside major cities in sub-Saharan Africa (World Bank, 2024).

[23] Only 2018 DHS round includes information on the use of internet, and this is not asked retrospectively.

[24] While the survey was initially designed as a household panel, the attrition rate was high and many households were replaced. Thus, we set the fixed effect level at the village level. The results were however nearly identical with the fixed effects set at the household level.

[25] Negative weights account for 16–17% of the weights used in the TWFE specification, suggesting that staggered difference-in-differences estimators, such as the one developed by Sun and Abraham (2021), may provide more reliable estimates in this analysis than TWFE estimates.

[26] Round 2018 of the NGHS shows that nearly 55% (66%) of women (men) below 30 living in 3G covered areas declared having access to internet. The % of individuals among the full population in 3G covered areas that access internet is smaller: 39% for women, and 54% for men.

6.2 The effect of 3G network on FGC

The primary focus of the study centers on examining the impact of 3G network availability on the prevalence of FGC. The results of this analysis are reported in Table 2. The effect of 3G availability on the prevalence of FGC ranged from 2.1 to 2.3 percentage points, depending on the difference-in-differences estimator used. While small in percentage points, these magnitudes correspond to nearly 12% and 14% of the sample mean. The results of the event study reported in Figure 6 reveal that the effects are not driven by pre-existing differential trends.[27] Moreover, the estimates show that the effect already seems to operate for women born in the year when 3G was deployed (t_0 in Figure 6). Although cultural traits are often thought to be highly persistent, social norms can sometimes change quite rapidly. A growing body of research shows that exposure to diverse cultural content or new forms of social interaction has, in some contexts, triggered abrupt shifts in prevailing norms and behaviors, rather than the gradual transitions typically expected (Jensen and Oster, 2009; Chong and Ferrara, 2009; La Ferrara et al., 2012; Fernández, 2025; Ahmed et al., 2025).

We then explore the heterogeneous effects of 3G network availability along three dimensions: areas where FGC is the dominant norm versus those where it is not, rural versus urban areas, and Muslim versus non-Muslim populations. To do so, we re-estimate equation 1 including the relevant characteristic that defines each heterogeneity dimension, as well as its interaction with 3G network availability. The coefficient on this interaction captures the differential effect of 3G availability on FGC across that particular dimension of heterogeneity. The results reported in column 1 of Table 3 show nuanced evidence of the heterogeneous effects of 3G availability by whether FGC is the dominant rule. While the magnitude of the effect is approximately 68% larger in survey clusters where the prevalence of FGC is more than 50%,[28] the effects in survey clusters where FGC is the prevalent norm are not statistically different from those in areas where it is not. These result should be interpreted with caution because, in only about 20% of these clusters, women subjected to FGC are in the majority. The results for the comparison between urban and rural areas are reported in column 2. While the prevalence of FGC is slightly higher in rural than in urban areas (17.7% vs 15.5%), our results show that the effect

[27] Figure A8 in Appendix A show that the effects are similar when estimated using the event study method developed in Sun and Abraham (2021).

[28] The cluster prevalence in this analysis is calculated using the sample of women aged 15–49 in the cluster. Women in this age range were at least 9 years old when 3G was first deployed, and their FGC status is therefore unlikely to have been affected by 3G. Moreover, these women are not included in the analytical sample.

of 3G availability on FGC is fully driven by rural areas. The effect on urban areas is small and largely insignificant. These results are consistent with the hypothesis that the effect of exposure to fast internet is stronger in communities with lower levels of exposure to other cultures before the deployment of 3G network. Finally, the results reported in column 3 show that the coefficient on the interaction between 3G availability and being Muslim is negative. While this negative coefficient in principle consistent with a larger effect for Muslims, prevalence is higher among this group (24.2% vs. 8.1%), so that the effect is larger in percentage points but smaller in relative terms for this group.

6.3 Robustness of the results

This subsection explores the robustness of our findings to different empirical exercises and identification threats.

We re-estimate specification 1 adding controls for age, electricity access, TV, and radio. Columns 2 and 3 of Table 4 report the results, while column 1 replicates the benchmark estimates from Table 2. The estimated effect of 3G remains virtually unchanged.

Second, a key concern in our analysis is potential measurement error in FGC data. The DHS follows a standardized protocol to maximize reliability.[29] Despite the efforts, some measurement error remains unavoidable. If misreporting is correlated with the availability of 3G network at the time of birth, our estimates of the effect of 3G on FGC would be overestimated. This may happen, for example, if fast internet makes women less likely to report that they have subjected their cut daughters to FGC. We believe this is not a major identification concern in our analysis. Our specification exploits within-cluster variation, comparing girls born before and after the arrival of 3G, with FGC status measured at the same time regardless of whether the girl was born before or after 3G. As a further robustness check, we re-estimate the main equation including household fixed effects, restricting variation to daughters within the same household born before or after 3G, with information for all household daughters collected at the same time from the same respondent (the mother).[30] The results, reported in column 4 of Table 4, remain statistically significant at conventional confidence levels, providing reassurance about our findings. While the coefficient of interest is smaller in the household fixed-effects estimation, this analysis relies only on variation from households with at least one

[29]Women are interviewed privately about their own FGC status and that of their daughters, usually by trained female interviewers, to minimize reporting bias on this sensitive topic. However, these measures are not always perfectly implemented.

[30]The average number of daughters per household in the analytical sample is 1.65.

daughter born before and one daughter born after the arrival of the internet. These daughters tend to have older parents, who may be less affected by 3G.[31]

Third, a potential concern is that the observed effect may be driven not by 3G connectivity itself, but by the broader infrastructure and state presence associated with its deployment, such as access roads, electricity, or maintenance facilities. This is unlikely because 3G is typically deployed on the same towers already used for 2G, meaning that most of the physical infrastructure and accompanying state presence were already in place. Moreover, if the effects were driven by improvements in infrastructure and state presence that may accompany the construction of towers, rather than by 3G connectivity itself, we would expect to observe a similar effect from 2G coverage. In Appendix A, we show that 2G has no effect on FGC. To further test this hypothesis, we examine the effect of 3G availability at the time of the survey on four measures of state presence: the number of public schools opened in the county, access to electricity, and whether the respondent owns a radio or a TV. While access to electricity and ownership of radio and TV do not depend exclusively on state presence and public infrastructure, they are arguably influenced by it. We estimate equation 2 using a panel of yearly data on schools opened at the county level for the period 2007–2018, and information on access to electricity, radio, and TV from the DHS rounds 2003, 2008, 2013, and 2018. The results of these analyses are reported in Table A2 and Figure A9 in Appendix A. Although the presence of negative weights (ranging between 39% and 42%) calls for caution when interpreting the TWFE estimates, the results are consistent across methods for most measures, suggesting very limited effects of 3G availability on state presence.

In Appendix A, we conduct additional robustness checks showing that the estimates of interest are not simply capturing migration of households less prone to FGC towards areas covered by 3G, a delay in the age at cutting, or confounding effects from policies introduced in the 2010s that could have affected FGC, including the staggered introduction of anti-FGC legislation. We also discuss the extent to which the main estimates might be affected by spillover effects of 3G, the inclusion of partially treated young girls as controls, or the random displacement of the exact coordinates of DHS clusters. Finally, we show that 2G technology, which enhances communication but did not provide fast internet, did not have any effect on FGC.

[31]Figure 5 shows larger effects of 3G on internet access for younger individuals.

7 Shifting the value of FGC

This section first shows that 3G reduced support for FGC and then presents evidence consistent with the hypothesis that the effect of 3G on FGC is driven by a reduction in the value of the social function served by the practice, which is the preservation of virginity and, more broadly, the prevention of sex outside marriage.

7.1 The effect of 3G network on support for FGC

We start by assessing how 3G networks at the time of the survey affect support for FGC, estimating equation 2 for men aged 15–59 and women aged 15–49, the groups for which information on support for FGC is available in the DHS data. The variable *Support for FGC* is defined as a discrete variable equal to 1 if the respondent does not want the practice to continue, 2 if it depends, and 3 if the respondent wants the practice to continue. As dependent variables, we use both the discrete measure itself and a dichotomized version. The latter takes the value 0 if the individual does not want the practice to continue, and 1 if the individual answers "depends" or "yes" to the question of whether he/she wants the practice to continue.

The results of the analysis are presented in Table 5.[32] Since the treatment variable in this analysis is the share of population with 3G network available in the county, we can only rely on the estimator developed in Chaisemartin and D'Haultfœuille (2020) and on TWFE.[33] While the Goodman-Bacon decomposition suggest that the Chaisemartin and D'Haultfœuille (2020) might work better in this analysis[34], our findings are stable across different estimators. They reveal that 3G network availability at the time of the survey decreases the support for FGC. Our preferred estimator, reported in column 1, shows that an increase in 10 percentage points in the proportion of people covered by 3G networks decrease by 0.067 points the discrete measure of support for FGC, measured in a scale from 1 to 3, while it reduces in 3.5 percentage points the binary indicator of support for FGC. The estimated effect is sizeable, and the parallel trends tests, along with the event studies

[32] We also present results incorporating information on support for FGC from the 2016 MICS survey. These results, reported in Table A3 in Appendix A, yield similar estimates. The main estimations reported in Table 5, however, rely exclusively on DHS data to ensure consistency in the measurement of support for FGC and in the construction of the lead and lag periods, since DHS surveys are conducted every five years. The 2021 MICS survey cannot be used, as 3G coverage data are only available up to 2018, and the treatment variable in this analysis is measured as 3G availability at the time of the survey.

[33] Callaway and Sant'Anna (2021); Sun and Abraham (2021) estimators can only be used with a binary treatment.

[34] We decompose the weights and find that 45% and 54% of the weights used in the OLS estimation are negative, which might pose challenges on the use of the TWFE model.

reported in Figures A10 and A11 in Appendix A, indicate that the effects are not driven by pre-existing differential trends.

The results by gender in columns 3 to 6 suggest that the observed effect of 3G on support for FGC is primarily driven by women. While the effects are large and statistically significant for women, the coefficients measuring the impact of 3G on men's support for FGC have the opposite (positive) sign and, although sizeable, are statistically insignificant at conventional confidence levels. Nonetheless, the results for men should be interpreted with caution for two reasons. First, the male sample size is substantially smaller.[35] Second, Figures A10 and A11, displaying the event studies, shows that men's support for FGC seems to follow a pre-3G upward trend.

7.2 The effect of 3G network on sexual behavior

Most of the online content consumed by Nigerians is unrelated to FGC. Our qualitative analysis and data from Google trends reported in Appendix C highlights that individuals in Nigeria use the internet to access cultural content such as videos, music, social media, and films. For many, access to the internet represents an unprecedented window to other cultures and gender norms. We hypothesize that fast internet exposes these communities to cultural content and identities where premarital sex is less stigmatized and, more broadly, sexual norms are more relaxed. While not directly linked to FGC, this cultural content might change sexual behavior by reducing the stigma around sex premarital sex, decreasing the value of the social function played by FGC and eventually eroding this practice. However, while exposure to alternative values and identities might transform one's own values to resemble more closely those of the exposed identities (La Ferrara et al., 2012; Balbo and Barban, 2014; Miho et al., 2023), it may also lead to a resurgence and strengthening of one's own culture (Gruenbaum, 2001; Blumenstock et al., 2022).

In this subsection, we examine the extent to which fast internet affected sexual behavior. We estimate equation 2 using information reported in the DHS for men aged 15-59 and women aged 15-49 on the age at first sex, age at marriage, number of lifetime sexual partners, number of lifetime sexual partners minus number of formal unions, whether the person had sex outside marriage in the last 12 months, and the use of condom in the last sexual relation.[36]

[35] Only one man in three households is interviewed in DHS rounds 2003, 2008, and 2013. Moreover, the male module in the 2018 survey round does not include information on support for FGC. Since 3G first arrived in Nigeria in 2012, the effect on support for male can only be estimated over one year period.

[36] These were the outcomes identified in the DHS that were reported in more than a survey round that were associated with the values of purity and sexual activity only within marriage.

Table 6 and Figures A12 and A13 in Appendix A present the results of the effect of 3G network availability at the time of the survey on these behavioral outcomes using the staggered difference-in-differences method developed in Chaisemartin and D'Haultfœuille (2020). The results for the TWFE are reported in Table A4 in Appendix A. While the TWFE estimates are less reliable due to the presence of a significant proportion of negative weights,[37] the main conclusions are overall consistent across estimation methods. Panel A shows the results for women. 3G availability at the time of the survey has no effect on age at marriage but has a strong negative effect on age at first sex for women, suggesting an increase in premarital sex.[38] More broadly, we also find that exposure to 3G network increases the reported number of lifetime sexual partners and extra-marital sex, which are also traditionally stigmatized in most Nigerian communities. On the other hand, we do not observe any effect on the probability of using condom during the last sexual relation. Taken together, these results suggest that fast internet is shifting behaviors around female sexuality in communities where restrictive sexual norms have historically prevailed, moving them to a more progressive stance. Once again, the results of the parallel trends tests and the event studies reported in Figure A12 in Appendix A indicate that, overall, the estimates are not the result of pre-existing differential trends. Our results are also consistent with previous evidence showing that exposure to Western media culture can transform beliefs and behaviors towards more progressive views (Jensen and Oster, 2009; La Ferrara et al., 2012).

In many Nigerian communities, sex outside marriage is traditionally taboo, particularly for women. A natural question is whether the observed changes in premarital sex and other sexual behaviors reflect greater willingness to report these behaviors rather than actual behavioral change. While we cannot disentangle an effect on behavior from an effect on reporting, both could be an indication of the destigmatization of these sexual behaviors. In line with this hypothesis, Table A5 in Appendix A shows that 3G also reduced the age at first sex among women older than 30, most of whom arguably had their sexual debut many years before the arrival of the internet. This result suggests that 3G affected the reporting of premarital sex for this group of women, providing additional evidence in favor of the normalization

[37] The proportion of negative weights in the estimation of treatment effects in the TWFE for these outcomes vary between 39% and 42%, highlighting that the Chaisemartin and D'Haultfœuille (2020) method is more appropriate in these estimations.

[38] An accurate measure of premarital sex cannot be constructed because age at first sex and age at marriage are reported in age-years rather than specific dates, so when marriage and first sex occur within the same age-year, it is not possible to determine whether sex occurred before marriage. However, in a context where sex after marriage is typically immediate, a reduction in the age at first sex, coupled with an increase or no change in the age at marriage, suggests an increase in premarital sex.

of premarital sex and against the hypothesis that the increase in premarital sex occurred without destigmatization.

Panel B of Table 6 reports the estimated effects of the 3G availability at the time of the survey on sexual outcomes for men. While the coefficients are sizeable, the estimates of the effects are statistically insignificant at conventional confidence levels and the sign of the coefficients vary in each outcome. While the smaller sample of men surveyed and the results of the event study reported in Figure A13 in Appendix A require cautious interpretation, the results suggest that 3G does not make men less traditional in terms of sexual behavior. A potential explanation for the weaker cultural effects is that, as suggested by the descriptive statistics, traditional values emphasizing purity and sexual activity only within marriage were more prominent for women than for men in most Nigerian communities. Therefore, the expected shock from exposure to cultures where such behaviors are more common might be smaller for men.

7.3 Linking the reduction in FGC to the normalization of premarital sex

While the previous subsection shows that 3G destigmatized premarital sex and shifted sexual behavior toward more liberal attitudes among women, this does not necessarily imply that the effect of fast internet on FGC operates through this channel. To examine the mechanism more directly, we conduct the following analyses.

First, we explore whether the effect of 3G availability is stronger the more FGC is linked to the preservation of virginity. We expand equation 1 by adding an interaction between the 3G availability variable and a regional indicator of the degree to which FGC is linked to the preservation of virginity, measured before the arrival of 3G.[39] Column 4 of Table 3 shows that the interaction term is negative and statistically significant, indicating that the effect of fast internet on FGC is larger in areas where the practice is more strongly linked to the preservation of virginity.

Second, we estimate the effect of 3G availability on FGC in a set of placebo settings. The ideal placebo setting consists of areas where FGC is widespread but practiced for reasons unrelated to the preservation of virginity, and where premarital sex is stigmatized. If 3G affects FGC through the destigmatization of premarital sex, two results should hold in this placebo sample: 3G should change sexual behavior, but should have no effect on FGC.

[39] This indicator is built using information from the 2008 DHS survey on the perceived benefits of FGC. The regional indicator is the share of individuals in the region who report that the preservation of virginity is a benefit of FGC. This indicator is not available in later rounds.

To construct this placebo sample, we restrict the analytical sample to areas satisfying three conditions: (1) the most commonly cited benefits of FGC prior to the arrival of the internet is not the preservation of virginity (e.g., unfounded beliefs about hygiene or religion), while the preservation of virginity is rarely cited as a benefit (in fewer than 3% of responses);[40] (2) FGC is practiced at non-negligible rates (at least 5%), with a mean prevalence of 13% across these communities; and (3) premarital sex was stigmatized for women before the arrival of 3G.[41]

The results of this placebo analysis are reported in column 1 of Table 7. Consistent with the proposed mechanism, we find no effect of 3G on FGC in this placebo sample. Panel A of Table A6 in Appendix A shows that 3G does increase sex outside marriage among this group, confirming that the null effect on FGC is not driven by an absence of changes in sexual behaviors. One concern with the results is the reduction of the sample size for this placebo analysis, which may affect the statistical significance of the results on FGC. However, the point estimate on FGC in this placebo sample is less than one third of the size of the main estimate, suggesting that the null result is not simply due to reduced statistical power. Furthermore, the point estimates of the effect of 3G on sexual behavior outcomes, estimated also on a reduced sample, remain sizeable and statistically significant at conventional significance levels, confirming that the absence of an effect on FGC is not driven by a lack of statistical power in this placebo sample.

To further address this concern, we also estimate less restrictive versions of this placebo exercise, focusing either on regions that satisfy conditions (1) and (2), or condition (3) alone. While less suitable to test the full mechanism, these variants have the advantage of imposing fewer sample restrictions.[42] The results, reported

[40]We identify the motives for FGC in each region using information from the 2008 DHS survey, conducted years before the arrival of 3G to Nigeria.

[41]Using data from the 2008 Nigerian DHS, collected before the arrival of 3G, we calculate the mean number of lifetime sexual partners excluding husbands. We define regions where this mean exceeds one as having no premarital sex stigma prior to the internet. An alternative definition would rely on information from the Murdock Atlas on ethnic groups where premarital sex has not traditionally been stigmatized. In Nigeria, however, only two minor groups meet this criterion: the Wodaabe and the Maguzawa. This analysis cannot be conducted because these ethnicities are not identified in the DHS or MICS surveys used in the analysis.

[42]These placebo samples are less suitable for testing the main hypothesis. In the sample where FGC is practiced but not linked to the preservation of virginity, we should not observe an effect of 3G on FGC. However, premarital sex may already be less stigmatized in this sample than in the full sample, making the expected effect on sexual behavior less clear. Consistently, we find no effect on FGC and mixed effects on sexual behavior outcomes. Results for sexual behavior outcomes are reported in Panel B of Table A6 in Appendix A: while 3G increases sexual activity outside marriage, the effect on premarital sex — which is already more common in this sample — is less pronounced. In the sample where premarital sex is common, we should not expect an effect of 3G on FGC if the mechanism operates through the destigmatization of premarital sex. An alternative explanation for the null effect on FGC is that FGC itself is less prevalent in this sample.

in columns 2 and 3 of Table 7, show no effect of 3G on FGC in either case.

Finally, we estimate the effect of 3G on FGC among the Kanuri-Beriberi, a predominantly Muslim ethnic group concentrated in the northeast of the country, known for its strong traditional values and relatively closed communities. In this group, the preservation of virginity is the primary motivation for FGC, and reported premarital sexual activity is virtually nonexistent. Unlike other Muslim ethnic groups such as the Hausa or the Fulani, 3G did not increase premarital sexual activity among the Kanuri-Beriberi; if anything, it reduced it, as shown in panel (d) of Table A6. If 3G affects FGC through the destigmatization of premarital sex, the absence of any effect on sexual behavior in this group implies that we should find no effect on FGC either. While caution is warranted given the small sample size, the estimates in column 4 of Table 7 suggest that, if anything, 3G increases FGC among females in this subsample.

Taken together, these analyses provide evidence not only that fast internet reduced support for FGC and transformed sexual behavior toward more liberal attitudes, but also that the erosion of traditional norms linking FGC to the preservation of women's virginity is the channel through which fast internet reduces FGC.

8 Alternative hypotheses

8.1 The effect of explicit anti-FGC content on-line

The effects of fast internet on the support for FGC and on the prevalence of FGC might also be driven by exposure to explicit anti-FGC online content, rather than by reducing premarital sex stigma. Indeed, the internet facilitates the dissemination of explicit content related to FGC, granting individuals the opportunity to access such materials. Nigeria stands out globally for its substantial efforts in countering FGC through online platforms and social media channels.[43] Approximately 14% of all FGC-related tweets originated from Nigerian users, and while not all online discussions on FGC are explicitly critical of the practice, the vast majority are

Results for sexual behavior outcomes are reported in Panel C of Table A6 in Appendix A, showing limited effects of 3G on premarital sex, consistent with this practice already being widespread in this sample.

[43] For example, the "Sarah's Cross" series, available on YouTube, successfully reached an audience exceeding 200,000 individuals within Nigeria. The #endcuttinggirls Twitter campaign, spanning various social media platforms, effectively engaged nearly 8 million people across the country. Additionally, an anti-FGC documentary titled "Female Genital Mutilation in Nigeria" garnered 600,000 views (UNFPA-UNICEF, 2018). In the year 2020, Nigeria demonstrated heightened online activism against FGC, emerging as the second country, following Kenya, to generate a significant volume of tweets discussing the issue.

(Babbs et al., 2023).

Explicit anti-FGC online content might be particularly effective in reducing FGC if individuals are not fully aware of the health risks associated with the practice. However, evidence suggests that awareness of these risks is already widespread. The Nigerian 2003 DHS data show that nearly 23% of women who circumcised their daughters reported that their older daughter experienced severe health consequences, including excessive bleeding, difficulty urinating, swelling, or infection.[44] In a context where the total fertility rate is approximately 4.5, and where extended family living arrangements are common, many women are likely to have directly or indirectly observed the health consequences of FGC. Consistent with this interpretation, and using survey data from 400 men and women interviewed in Cross River State prior to the arrival of 3G, Iheanacho et al. (2013) show very high levels of awareness regarding the risks of FGC: 95% knew that FGC increases the risk of hemorrhage during childbirth; 95% associated it with fear, anxiety, prolonged pain, and mental distress; 88% were aware of the risk of death due to excessive bleeding; 80% mentioned chronic pelvic infection; 70% infertility resulting from fallopian tube infection; 69% obstruction during labor due to narrowing of the vaginal canal; and 63% recognized that it facilitates the spread of HIV/AIDS. Overall, these findings suggest that a large share of the population was already aware of the health risks of FGC before 3G arrival. Persistence of the practice therefore likely reflects a perceived trade-off in which its social benefits are viewed as outweighing its health costs for many households.

However, even if the population is fully aware of the negative health consequences of the practice, advocacy campaigns that portray FGC negatively may still foster its abandonment. To better understand what effect explicit anti-FGC online content and campaigns could have, we assess the short-term effects on support for FGC of the anti-FGC online campaign for the International Day of the Girl Child, celebrated on October 11, 2018.[45] This campaign is launched on the same date every year by UNICEF in collaboration with the Nigerian Ministries of Health and Social Welfare; and of Women Affairs and Social Development. Through these collective efforts, the campaign strives to engage a broad audience. Figures A15 and A16 in Appendix A show that October 11th is the day of the year with a higher number of anti-FGC tweets and that Google searches about FGC peak every year on October 11th. The

[44]The 2003 DHS is the only publicly available database that includes information about the health cost of FGC.

[45]Examples of anti-FGC tweets issued the October 11, 2018 are provided in Figure A14 in Appendix A. Key hashtags like #endcuttinggirls or #EndFGM trend on Twitter and Instagram, amplified the campaign's reach.

campaign highlighted both the harmful health consequences of the practice and, more broadly, emphasized that it constitutes a violation of human rights.

We focus in the 2018 edition of the campaign because it was launched in the middle of the 2018 round of the Nigerian DHS survey fieldwork, which lasted from August to December 2018.[46] To estimate the short term effects of the campaign, we use a regression discontinuity design (RDD) in time, which compares the support for FGC among those women aged 15-49 interviewed just before and after October 11th 2018 in areas where 3G is available. Because the male module of the 2018 survey round does not include questions on support for FGC, the analysis is conducted only for women. Specifically, we estimate the following regression:

$$\textit{Supports FGC}_i = \alpha_0 + \alpha_1 Post_i + \alpha_2 F(\textit{Days to October 11th}_i) + \mu_i \tag{3}$$

where *Supports FGC* is the main outcome. The variable *Post* is a dummy variable equal to 1 if woman i is interviewed on the 11th of October 2018 or later and 0 if is interviewed before the mentioned date. The main parameter of interest is α_1, which measures the effect of being interviewed just after the anti-FGC online campaign on October 11th. $F(\textit{Days to October 11th})$ is a function of the number of days between the survey interview and October 11th, and μ is the error term. Equation 3 is estimated using both non-parametric methods and parametric methods with first and second order polynomials for the running variable. The non-parametric estimation is calculated using the local polynomial regression-discontinuity estimation method with robust bias-corrected confidence intervals developed in Calonico et al. (2019). The parametric regressions include survey cluster fixed effects. Standard errors are clustered at the village level (DHS survey cluster). As a robustness check, we also estimate these regressions excluding from the analysis those women that were interviewed during the week before the start of the campaign to examine the robustness of the results to potential anticipation effects during pre-campaign days.

The results of this analysis are presented in Table 8. They show null short-term effects of the campaign on the support for FGC for individuals living in areas with 3G network available. The estimates are consistently small and statistically insignificant at conventional confidence levels across estimation methods and samples. Figure 7 shows graphically the effect of the October 11th campaign for individuals with 3G network available in their location, showing small and largely insignificant coefficients.[47] The graph also shows null effects for those women that live in ar-

[46] The previous DHS survey was launched in 2013, before the start of the anti-FGC online campaigns for the International Day of the Girl's Child in Nigeria.

[47] Figure A17 in Appendix A shows similar effects for the dichotomous measure of support for FGC.

eas with no 3G network available, which serves as a placebo test. While the RDD approach used only measures the short-term effects of the anti-FGC campaign, it is likely that if these campaigns have no impact in the short term, the long-term effects would also be limited.

8.2 Income shock

Fast internet may reduce the prevalence of FGC even if 3G availability does not diminish support for the practice. If poverty plays a pivotal role in FGC, and parents cut their daughters to secure a higher bride price (Khalifa, 2022; García-Hombrados and Salgado, 2022), then a positive effect of fast internet on income may lead some parents at the margin to refrain from cutting their daughters, even if their support for FGC does not change. This mechanism is unlikely in Nigeria, where FGC is not typically discussed in bride price negotiations and where communities with near-universal prevalence of FGC are rare. Our cumulative suggestive evidence indicates that, if anything, this factor plays only a limited role.

To assess this mechanism empirically, we first examine the economic effects of 3G using DHS data. The results, reported in columns 1 and 2 of Table A7 in Appendix A, suggest that 3G coverage did not increase household wealth.[48] Our results, however, contrast with those of Bahia et al. (2024), who, using a different dataset, find that 3G coverage increases consumption and labor force participation, and reduces poverty in Nigeria.

Thus, while our results show no effect of 3G coverage on wealth, we cannot rule out a positive economic effect, given previous evidence and the fact that the DHS may not be the most suitable dataset to measure key economic dimensions such as income or consumption. We therefore propose a different strategy to test this mechanism: we examine the effect of rainfall shocks, which crucially affect economic welfare. If the effect of 3G on FGC were purely driven by income shocks caused by 3G, other shocks affecting economic welfare—such as rainfall shocks—should similarly affect the prevalence of FGC. Specifically, we replicate the multi-country analysis conducted by McGavock and Novak (2023) focusing on Nigeria. The latter study examines the effect of adverse rainfall shocks during the age of highest risk of cutting on the prevalence of FGC. The results, reported in Table D1 in Appendix D, show that negative income shocks do not increase the prevalence of FGC in Nigeria. This finding is consistent with McGavock and Novak (2023), who report no

[48] The results of the parallel trends tests reported in Table A7 in Appendix A, together with the event studies shown in Figures A18 and A19, suggest that the findings are not driven by pre-existing differential trends. While 3G does not appear to increase women's labor force participation, Table A8 in Appendix A shows that 3G increases bargaining power for women and reduces it for men.

effect of rainfall shocks on FGC among ethnic groups where the practice is typically conducted early in life, as in the case of Nigeria. A detailed description of this analysis is provided in Appendix D. Overall, these results suggest that, if existent, potential improvements in income or wealth caused by 3G are unlikely to drive the observed effect of 3G on FGC.

8.3 Marriage markets

An alternative mechanism through which fast internet may decrease the prevalence of FGC, even if it does not stigmatize premarital sex, is through the expansion of marriage markets. While the preservation of virginity is broadly linked to status in the community, it may also facilitate marriage. In this context, fast internet may provide access to social media and dating applications that expand the marriage market beyond immediate social circles and the local community, which could increase the probability of marriage for women who engage in premarital sex. For these women, the expansion of the marriage market driven by internet access might decrease the penalty associated with premarital sex, and thus reduce the value of the function served by FGC, even if fast internet does not reduce premarital sex stigma in the community.

To further explore this hypothesis, we assess whether fast internet expands marriage markets by facilitating marriage with people outside the local community. Specifically, we test the effect of fast internet on the probability of interethnic marriage and marriage outside the DHS cluster. If internet access expands the marriage market, we should observe changes in these two outcomes. Table A9 presents the results for the full sample of women and for young women. The estimates indicate that fast internet has no observable effects on the probability of marrying outside the community or on interethnic marriages.

Another hypothesis is that fast internet affects FGC through changes in marriage market matching. If internet access influences partner selection, women may marry men whose characteristics or preferences are associated with a lower probability that their daughters undergo FGC. To test whether marriage market matching might be driving the results, we re-estimate the main analysis restricting the sample to daughters of couples who married before the arrival of the internet. The results, reported in column 9 of Table 4, show nearly identical estimates ruling out this mechanism.

8.4 Decreased religiosity

Although the practice of FGC is not theologically grounded in any major religion (Adewole and Adayonfo, 2017; Burrage, 2016), some communities across Africa perceive certain forms of FGC as religiously motivated.[49] While in Nigeria this belief is relatively uncommon and the practice is not endorsed by the main religious authorities of any religion (Burrage, 2016), DHS data from 2018 show that 10% of women aged 15–49 (14% among Muslim women) believe that FGC is linked to religion.

If fast internet reduces religiosity, it may also reduce FGC among those that believe it is a religious practice. While the proportion of individuals in Nigeria who report having no religion is very small (below 1%)[50], one might argue that fast internet reduces the intensity of religiosity, potentially weakening the practice of FGC if it is motivated mainly by religious reasons. To test this hypothesis, we use individual-level DHS data for women aged 15–49, which includes a question on whether they believe that FGC is a religious requirement. We use this information to estimate the differential effect of 3G on FGC by whether the girl's mother believes that FGC is a religious requirement. If the reduction in FGC were driven by decreasing religiosity, we should observe a significant decline in the prevalence of FGC precisely among those who believe it is religiously mandated.

The results of this analysis are reported in column 5 of Table 3. They show that the interaction term *3G availability* × *FGC linked to religion* is positive and has the same magnitude but the opposite sign as the main *3G availability* coefficient. While the interaction is not statistically significant, it suggests that the overall effect is driven by households that do not believe FGC is a religious requirement, whereas the effect among those who do believe so is small and largely statistically insignificant.[51] Taken together, these results suggest that the effects of 3G on FGC are unlikely to be driven by a decline in religiosity.

8.5 Increase in education

Finally, one may wonder whether internet was used for educational purposes, potentially increasing educational attainment. We believe that this mechanism is unlikely. While there is a negative correlation between maternal education and FGC, existing causal evidence from Nigeria shows that the expansion of women's education has no

[49] This is the case, for example, with the Sunna form of mutilation practiced among Somali groups in East Africa (Mehari, 2023).

[50] This information comes from the sample of men and women surveyed in the 2018 round of the DHS.

[51] The analytical sample is smaller in this analysis because the MICS data do not include information on whether families believe FGC is linked to religion.

effects on their support for FGC and on the prevalence of FGC among their daughters (De Cao and La Mattina, 2019). To explore further this potential mechanism, we assess the effect of 3G on education. We conduct two different analyses.

First, focusing on the sample of individuals aged 18 or older, we estimate the effect of 3G on educational attainment and on taking secondary education by measuring the number of years of exposure to 3G during the educational period, which in Nigeria lasts from age 6 (when students start compulsory education) to age 18 (when individuals who do not repeat grades complete secondary education). Specifically, we estimate the following regression:

$$SchoolAttainment_{ibv} = \delta_0 + \delta_1 \, Years\ Exposed\ to\ 3G_{bv} + \theta b + \gamma_v + u_{ibv} \quad (4)$$

where $SchoolAttainment_{ibv}$ is the educational attainment of individual i, aged b and living in village v. The *SchoolAttainment* variable takes the value 0 if the individual has no education, 1 if primary education, 2 if secondary education, and 3 if higher education. *Years Exposed to 3G* indicates the number of years the individual was exposed to 3G during his/her educational years, which in Nigeria go from age 6 to age 18. In principle, the variable can range between 0 and 13 years and varies at the village v and year-of-birth b level. δ_1 is the parameter of main interest and measures the effect of one additional year of 3G network availability during the educational years on educational attainment or on taking secondary education. θ_b and γ_v are year-of-birth and village fixed effects to control for time-invariant village-level and year-of-birth specific events. Standard errors are clustered at the village level (DHS survey cluster). We also estimate the regression using a binary dependent variable indicating whether the individual has taken secondary education.

The results of this analysis are reported in columns 1 and 2 of Table A10 in Appendix A.[52] The coefficients are negative and small in magnitude, but statistically significant at conventional confidence levels, suggesting that, if anything, 3G reduces educational attainment and secondary education rather than increasing it.

As a second exercise to test the effect of 3G availability on educational outcomes, we also estimate equation 2 using school enrollment at the time of the survey as the dependent variable, using information available on school enrollment for individuals aged 6–18 at the time of the survey.[53] The regressions are estimated using TWFE

[52]The event study for the effect of 3G network coverage on school attendance is reported in Figure A20. The figure confirms that treatment and control observations followed parallel trends prior to the deployment of 3G networks.

[53]In DHS surveys, information on school enrollment is provided in the household roster for all individuals in the household regardless of their age.

and the estimation method for staggered difference-in-differences with a continuous treatment variable developed in Chaisemartin and D'Haultfœuille (2020) for the full sample, girls, and boys. The results of this exercise are reported in columns 3 and 4 of Table A10. The coefficients are small and, overall, largely statistically insignificant for both men and women.

Overall, these analyses suggest that 3G availability did not improve educational outcomes, making it unlikely that it reduced FGC via increases in maternal or paternal education.

9 What internet content is driving the change in sexual behavior?

Existing databases in Nigeria lack granular information on the specific internet content accessed, which prevents a comprehensive quantitative analysis of which particular content is driving the effects of 3G on FGC and sexual behavior. To explore this issue and gain a better understanding of norms change and its drivers in Nigeria, we implemented the following analyses.

First, we conducted a series of focus group discussions in 8 rural communities across Cross Rivers and Abuja states in Nigeria, including 68 participants from the Efok, Ekoi, Ibibio, Hausa, Yoruba, and Igbo ethnic groups. The goal of these discussions was to understand (1) how individuals used the internet and what kind of content they accessed; (2) the evolution of norms around sex in the community; and (3) the perceived effects of internet on social norms, particularly on sexual behavior and stigmas. Here we provide a brief summary of the main results. Further details about the design and the results of the qualitative analysis are reported in Appendix C.

Across groups, responses were remarkably consistent: internet was primarily used for communication, entertainment (especially movies, music, and—particularly among younger participants—social media), and accessing news. Participants across all communities identified both positive and negative transformations in their communities associated with internet access. On the positive side, improvements in access to entertainment, communication with family members living outside the community, and economic opportunities were frequently mentioned. On the negative side, participants expressed concerns about online fraud and moral decline. Foreign movies, social media, and pornography were seen as major drivers of cultural erosion. A common theme across all groups was that young people were increasingly imitating behaviors seen online—becoming more selfish, more prone to violence, and engaging in sexual relationships before marriage.

Regarding premarital sex, participants unanimously agreed that significant changes had occurred in recent years. What was once socially unacceptable has become widely normalized, especially among youth. In southern communities, traditional leaders appeared to have largely adapted to the shift, whereas in northern communities the issue is provoking notable intergenerational tension, with elders voicing strong concern. Across all focus groups, content depicting premarital sex as normal, as well as explicit depictions of nudity and sexual activity, was cited as the primary cause of the shift in sexual norms, with no dissenting voices on this point.

Second, we provide data from Google Trends on Google searches in Nigeria. Our results indicate that football, sports betting, social media, YouTube, websites that provide free access to films, as well as "sex" and various "pornographic" terms and websites, rank among the country's top search terms in Google, with several million searches each month.

Taken together, the results from Google Trends and the focus groups suggest that Nigerians regularly access content depicting premarital sex as normal and content displaying explicit sexual images. This exposure is perceived as driving changes in sexual behaviors and reducing the stigma surrounding premarital sex. While we cannot empirically test whether these contents are indeed triggering the observed changes, previous evidence showed that cultural content portraying Western lifestyles can shift beliefs and behaviors toward more progressive views (Jensen and Oster, 2009; La Ferrara et al., 2012), and that exposure to sexually explicit content can change sexual behaviors (Brown et al., 2006; Peter and Valkenburg, 2008).

While access to sexually explicit content is perceived by the local population as a key contributor to the normalization of premarital sex, with potential implications for FGC, we are not making normative judgments about the desirability of promoting such content, as this could not only raise ethical concerns but also have unintended negative effects on mental health and aggressive behavior (Waterman et al., 2022; Wright et al., 2016; Zhou et al., 2021; Setyawati et al., 2020). Nonetheless, the results of this study are also valuable for policy: Beyond this specific case, they suggest that interventions aiming to challenge harmful norms should focus on reducing associated stigmas in order to diminish the value of these norms.

10 Conclusions

Harmful social norms such as FGC, breast ironing, or child marriage continue to affect millions of women worldwide. FGC alone threatens nearly four million girls each year and while the prevalence of these practices is declining in some areas, eradication is far from imminent.

What can be done to accelerate this process? Policy responses have often relied on advocacy campaigns that stress the health risks of these practices or on education programs. Yet, evidence shows that these approaches have limited effects—suggesting also that parents are not necessarily unaware of the harms involved. In some cases, harmful norms are coordination norms and deviating from them would be costly. However, in many settings harmful norms are not coordination norms (Novak, 2020; Efferson et al., 2015). In such cases, they persist because they serve an important function that, for some households, makes the perceived benefits of harmful norms outweigh the costs.

In the case of Nigeria, our study shows that FGC is believed to discourage women from engaging in premarital or extramarital relations, a function that becomes particularly salient in contexts where such practices are highly stigmatized. We then examine the impact of one of the most significant cultural shocks in recent decades in sub-Saharan Africa: the expansion of fast internet. This technological shift introduced new cultural content and alternative models of women's behavior to communities previously less exposed to such influences. We find that exposure to 3G networks leads to both a decline in the prevalence of FGC and diminished support for the practice. Our results also suggest that this reduction in FGC is driven by 3G fostering more progressive sexual norms and reducing premarital sex stigma, thereby diminishing the value of FGC as a mechanism of controlling sexuality.

While fast internet may also entail adverse effects, such as cultural convergence and other unintended outcomes, our findings highlight that harmful practices can decline when the value of the function they serve is eroded. Beyond 3G, our results suggest that interventions targeting the underlying stigmas and beliefs that sustain harmful norms — rather than the practices themselves — may be more effective, particularly in contexts where individuals are already aware of the negative health consequences involved.

Table 1: Descriptive statistics

PANEL A: Sample of females used in the FGC analysis					
	N	Mean	SD	Min	Max
FGC (0/1)	64,018	0.169		0	1
3G at time of birth (0/1)	64,018	0.105		0	1
Age at survey	64,018	4.900	3.493	0	14
Year of birth	64,018	2011.815	3.177	2007	2018

PANEL B: Sample of men and women used in the analysis of support for FGC, sexual behavior, and other outcomes	(1)	(2)	(3)	(4)	(5)
	N	Mean	SD	Mean men	Mean women
Support for FGC analysis					
Support for FGC (1-3)	83,043	1.542	0.847	1.564	1.534
1.No (0/1)	83,043	0.693		0.69	0.694
2. Depends (0/1)	83,043	0.072		0.057	0.078
3. Yes (0/1)	83,043	0.235		0.254	0.228
Support for FGC (0/1)	83,043	0.307		0.310	0.306
Age	83,043	30.757	9.936	32.753	30.037
Female (0/1)	83,043	0.735			
Share pop with 3G available	83,043	0.090	0.231	0.037	0.110
Sexual behavior, LFP and wealth analyses					
Age at 1st marriage	117,792	19.634	5.944	25.287	17.938
Age at 1st intercourse	131,673	17.744	4.069	20.324	16.822
Lifetime sexual partners	156,611	1.961	4.681	3.174	1.480
Lifetime sexual partners (excluding spouses)	153,740	1.105	4.583	2.409	0.621
Sexual partners excluding spouse (last 12 m.)	168,531	0.147	0.524	0.256	0.104
Used condom last relation (0/1)	124,647	0.094		0.177	0.064
Labor force partic. (0/1)	168,568	0.672		0.811	0.616
Hh wealth index	169,172	0	1	0.044	-0.018
Female (0/1)	169,172	0.715			
Age	169,172	29.458	10.186	30.984	28.851
Share pop with 3G available	169,172	0.115	0.255	0.107	0.119
Internet access analysis					
Internet access (0/1)	52,759	0.154		0.196	0.116
Share pop with 3G available	54,335	0.184	0.387	0.187	0.181

Note: Panel A reports descriptive statistics for the main analytical sample used to study the effect of 3G availability at birth on FGC. The sample consists of girls born between 2007 and 2018 (years for which 3G data are available), whose mothers were interviewed in the 2013 and 2018 DHS rounds and the 2016–17 and 2021 MICS rounds. FGC status for these daughters is reported by their mothers as they are younger than 15 at the time of the survey. Panel B reports descriptive statistics for the analysis of 3G at the time of the survey on support for FGC, sexual behavior, and other outcomes. This sample includes women aged 15–49 and men aged 15–59 interviewed in the 2003, 2008, 2013, and 2018 DHS rounds. Differences in the number of observations across variables, and between this table and the estimation tables, are due to missing values, the fact that the FGC module is not applied in all surveyed households, the lack of information on some outcomes in certain DHS rounds, and the exclusion of singleton observations in the estimations.

Table 2: Effect of 3G network availability at the time of birth on the probability of FGC

Dep var: FGC (0/1)	(1)	(2)	(3)	(4)
3G available	-0.023***	-0.021**	-0.021**	-0.021
	(0.005)	(0.009)	(0.009)	(0.013)
N	63,760	63,760	64,018	25,775
Mean dep var.	0.169	0.169	0.169	0.169
Estimation method	TWFE	Sun & Abraham	Callaway & Sant'Anna	Chaisemartin & D'Haultfoeuille

Note: Columns 1–4 estimate the effect of 3G availability at birth in the cluster of residence on the probability of undergoing FGC. Column 1 reports the results of a TWFE estimation. Column 2 reports the results of the method described in Sun & Abraham (2021). Column 3 reports the results of the method described in Callaway & Sant'Anna (2021). Columns 4 reports the results of the method described in Chaisemartin & D'Haultfoeuille (2020). TWFE and Sun & Abraham methods do not include all the observations in the main analytical sample presented in the descriptive statistics (64,018 observations) since singleton observations were automatically excluded. The N reported in the Chaisemartin & D'Haultfoeuille (2020) estimation includes only the effective observations used in the estimation, not the full sample of eligible observations (64,018). The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table 3: Heterogeneous effect of 3G availability on the probability of FGC

Dep var: FGC (0/1)	(1)	(2)	(3)	(4)	(5)
3G available	-0.019***	-0.005	-0.014**	-0.004	-0.032***
	(0.005)	(0.008)	(0.007)	(0.008)	(0.008)
3G available × FGC prevalence >50%	-0.013				
	(0.017)				
3G available × Rural		-0.030**			
		(0.012)			
3G available × Muslim			-0.014		
			(0.010)		
3G available × Main FGC benefit: avoids premarital sex				-0.139**	
				(0.057)	
3G available × FGC linked to religion					0.031
					(0.040)
N	63,726	63,759	63,664	63,710	37,205
Mean dep var.	0.169	0.169	0.169	0.170	0.162

Note: Column 1 reports the heterogeneous impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC by whether the prevalence of FGC among women aged 15-49 is higher or lower than 50%. Column 2 reports the heterogeneous impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC by whether the girl lives in a rural or urban area. The prevalence of FGC among rural and urban girls in the sample is 17.7% and 15.5%. Column 3 reports the heterogeneous impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC by whether the girl lives in a muslim family. The prevalence of FGC among girls from muslim and non-muslim families in the sample is 24.2% and 8.1%. Column 4 reports the heterogeneous impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC by the share of individuals in the state in 2008 that believe preserving virginity is the main advantage for FGC. Column 5 reports the heterogeneous impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC by whether the family believes FGC is linked to religion. The analytical sample is smaller in this analysis because the MICS data do not include information on whether families believe FGC is linked to religion. ***p<0.01;**p<0.05,*p<0.1.

Table 4: Robustness checks: Effect of 3G availability on the probability of FGC

Dep var: FGC (0/1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
3G available	-0.023***	-0.023***	-0.024***	-0.013***	-0.027***	-0.016**	0.121	-0.024***	-0.019***	-0.020***
	(0.005)	(0.005)	(0.005)	(0.004)	(0.006)	(0.007)	(0.091)	(0.007)	(0.006)	(0.006)
Spatial lag of X:										-0.002*
3G available										(0.001)
N	63,760	63,760	57,711	41,881	59,506	45,549	10,251	29,684	59,438	63,760
Mean dep var.	0.169	0.169	0.171	0.179	0.171	0.166	1.000	0.160	0.171	0.169
Analytical sample	All girls	All girls	All girls	All girls	All girls	Girls>2	All sample	Non-migrants	Parents married before 2012	All girls

Note: Columns 1-6 and 8 estimate the impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC. Column 1 reports the results of the main TWFE benchmark specification. Column 2 reports the results of the TWFE specification including age at survey fixed effects. Column 3 reports the results of the TWFE specification including age at survey fixed effects, and household access to electricity, TV and radio as control variables. Column 4 reports the results of the TWFE specification including household fixed effects. Column 5 reports the results of the TWFE specification excluding from the sample girls that were 1 year or 2 years old at the time of 3G arrival. These girls might be partially treated. Column 6 reports the results of the TWFE specification but excluding from the analytical sample girls younger than 3 years old at the time of the survey. More than 95% of the women cut are cut within the first 2 years of life. Column 7 reports the results of the TWFE specification on age at cutting including age at survey fixed effects. Column 8 reports the results of the analytical sample including only in the analytical sample those girls whose parents did not migrate in the pervious 10 years. Column 9 reports the results of the analytical sample including only in the analytical sample those girls whose parents marry before 2012. Column 10 reports the results of an spatial lag of X model where 3G network is allowed to affect nearby communities. ***p<0.01;**p<0.05,*p<0.1.

Table 5: Effect of 3G availability at the time of the survey on support for FGC

Panel A:	All		Women		Men	
Support for FGC (1-3)	(1)	(2)	(3)	(4)	(5)	(6)
Share pop with 3G available	-0.681***	-0.247***	-0.727***	-0.164***	0.319	0.190
	(0.146)	(0.049)	(0.177)	(0.046)	(0.333)	(0.174)
N	39,547	83,039	30,967	61,038	8,408	21,996
Mean dep var.	1.543	1.542	1.543	1.534	1.545	1.564
Parallel trends test	0.059	-0.025	0.076	-0.051	-0.138	-0.028
	(0.051)	(0.072)	(0.081)	(0.086)	(0.130)	(0.132)
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE

Panel B:	All		Women		Men	
Support for FGC (0/1)	(1)	(2)	(3)	(4)	(5)	(6)
Share pop with 3G available	-0.348***	-0.130***	-0.334***	-0.070***	0.124	0.028
	(0.080)	(0.025)	(0.098)	(0.024)	(0.171)	(0.090)
N	39,547	83,039	30,967	61,038	8,408	21,996
Mean dep var.	0.308	0.307	0.308	0.306	0.309	0.310
Parallel trends test	0.037	-0.006	0.040	-0.020	-0.073	-0.018
	(0.029)	(0.039)	(0.045)	(0.046)	(0.071)	(0.074)
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE

Note: Columns 1-6 estimate the impact of 3G availability at the time of survey on support for FGC for women aged 15-49 and men aged 15-59 surveyed in DHS rounds 2003, 2008, 2013 and 2018. In Panel A *Support for FGC* is a discrete variable that takes the value of 1 if individual does not want FGC to continue, 2 if depends, and 3 if respondent wants the practice to continue. In Panel B, *Support for FGC* is a dummy variable that takes the value of 0 if individual does not want FGC to continue, and 1 if individual responds depends or wants the practice to continue. Column 1, 3, and 5 report the results of the method described in Chaisemartin and D'Haultfœuille (2020). Columns 2, 4, and 6 report the results of a two-way fixed effect model (TWFE). The test for parallel trends in the TWFE estimations is a placebo test that measures the effect of the share of population covered by 3G in 2018 on the evolution of the outcome variable between 2003 and 2008, before the expansion of the 3G network in Nigeria. The parallel trends test in the Chaisemartin & D'Haultfoeuille estimations is the placebo analysis on the pre-trends developed in Chaisemartin and D'Haultfœuille (2020). TWFE estimations do not include all the observations in the main analytical sample presented in the descriptive statistics since singleton observations were automatically excluded. The N reported in the Chaisemartin & D'Haultfoeuille (2020) estimations include only the effective observations used in the estimations, not the full sample of eligible observations. The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table 6: Effect of 3G availability at the time of the survey on sexual behavior outcomes (Chaisemartin and D'Haultfœuille, 2020 estimation method)

	(1)	(2)	(3)	(4)	(5)	(6)
	Age at 1st marriage	Age at 1st intercourse	N lifetime sexual partners	N lifetime sexual partners excluding spouse	N sexual partners (last 12m excluding spouse)	Used condom last relation (0/1)
Panel A: Women						
Share pop with 3G available	0.520	-0.836***	1.028***	0.867***	0.046*	0.014
	(0.374)	(0.318)	(0.295)	(0.293)	(0.023)	(0.017)
N	46,719	50,454	62,254	62,254	62,582	47,406
Parallel trends test	-0.016	-0.079	-0.061	-0.111*	0.006	-0.002
	(0.184)	(0.155)	(0.057)	(0.063)	(0.010)	(0.008)
Mean dep var.	17.911	16.806	1.479	0.618	0.104	0.064
Panel B: Men						
Share pop with 3G available	1.224*	-0.828	0.053	-0.646	-0.130*	-0.053
	(0.726)	(0.647)	(0.653)	(0.646)	(0.074)	(0.044)
N	13,222	16,675	23,296	22,448	23,774	16,108
Parallel trends test	-0.361	-0.182	-0.267	-0.247	-0.069	-0.028
	(0.379)	(0.317)	(0.232)	(0.238)	(0.051)	(0.024)
Mean dep var.	25.270	20.324	3.160	2.395	0.256	0.176

Note: The table reports the estimates of the impact of 3G availability at time of survey on sexual behavior outcomes using the difference-in-differences method described in Chaisemartin and D'Haultfœuille (2020). Panel A reports the estimations for women and Panel B for men. The parallel trends test is the placebo analysis on the pre-trends developed in Chaisemartin and D'Haultfœuille (2020).The N includes only the effective observations used in the estimations, not the full sample of eligible observations. The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table 7: Effect of 3G availability on placebo samples

Dep var: FGC (0/1)	(1)	(2)	(3)	(4)
3G available	-0.006	-0.003	-0.007	0.012
	(0.025)	(0.014)	(0.008)	(0.010)
N	2,103	3,905	14,736	1,191
Mean dep var.	0.133	0.079	0.072	0.073
Sample	Placebo 1	Placebo 2	Placebo 3	Kanuri-Beriberi
FGM motive	Any except preserv. virginity	Any except preserv. virginity	Any	
Premarital sex common	No	Any	Yes	

Note: Column 1 reports the results of a placebo analysis estimating the impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC for girls that live in DHS clusters where FGC is existing (the prevalence of FGC is at least 5%) but where the preservation of virginity is not perceived as a benefit of FGC and where out-of-marriage sex is less stigmatized. In these states, the main benefits for FGC can be social acceptance, hygiene, religion, or a better marriage (the number of out-of-marriage lifetime sexual partners excluding spouses is at least 1). Column 2 reports the results of a placebo analysis estimating the impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC for girls that live in DHS clusters where FGC is existing (the prevalence of FGC is at least 5%) but where the preservation of virginity is not perceived as a benefit of FGC. In these states, the main benefits for FGC can be social acceptance, hygiene, religion, or a better marriage. Column 3 reports the results of a placebo analysis estimating the impact of 3G availability at time of birth on the cluster of residence on the probability of having experienced FGC for girls that live in regions where out-of-marriage sex is less stigmatized. We defined these regions as regions where the average number of lifetime sexual partners excluding husbands is at least 1.***p<0.01;**p<0.05,*p<0.1.

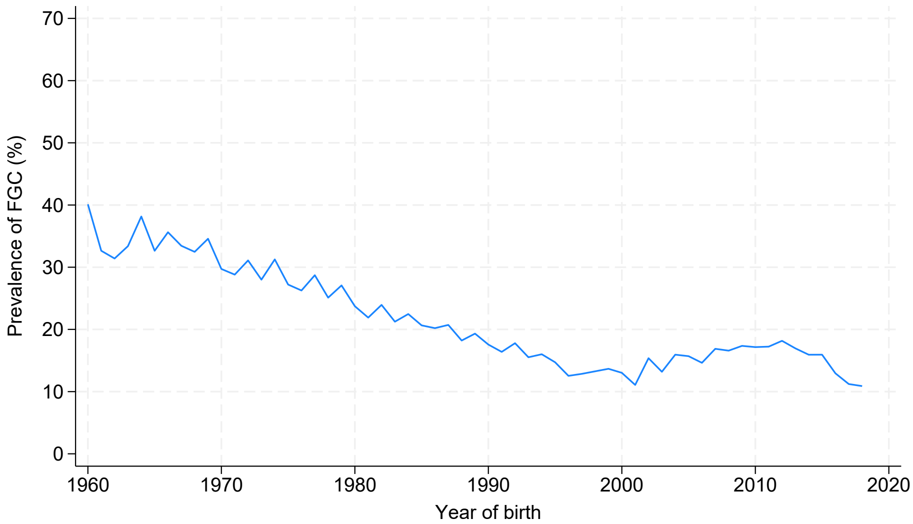
Table 8: Effects of the anti-FGC online campaign for the International Day of the Girl Child on support for FGC

Panel A: Support for FGC (1-3)	(1)	(2)	(3)	(4)	(5)	(6)
Post	-0.064	-0.034	0.018	0.166	0.058	0.129
	(0.089)	(0.024)	(0.067)	(0.172)	(0.040)	(0.085)
Estimation method	Non parametric	Parametric Linear fit	Parametric Quadratic fit	Non parametric	Parametric Linear fit	Parametric Quadratic fit
Cluster FE	No	Yes	Yes	No	Yes	Yes
Donut (1 week before)	No	No	No	Yes	Yes	Yes
Observations	6,484	6,482	6,482	6,106	6,102	6,102
Mean	1.392	1.392	1.392	1.384	1.384	1.384

Panel B: Support for FGC (0/1)	(1)	(2)	(3)	(4)	(5)	(6)
Post	-0.007	-0.024	0.027	-0.038	0.015	0.071
	(0.052)	(0.015)	(0.039)	(0.093)	(0.024)	(0.050)
Estimation method	Non parametric	Parametric Linear fit	Parametric Quadratic fit	Non parametric	Parametric Linear fit	Parametric Quadratic fit
Cluster FE	No	Yes	Yes	No	Yes	Yes
Donut (1 week before)	No	No	No	Yes	Yes	Yes
Observations	6,484	6,482	6,482	6,106	6,102	6,102
Mean	0.231	0.231	0.231	0.228	0.228	0.228

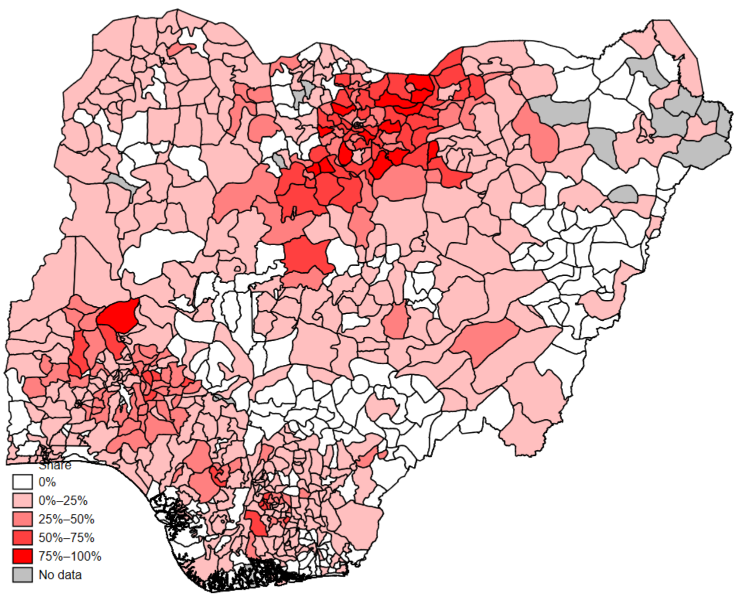
Note: Panel A reports the estimates of the short-term effects of the anti-FGC online campaign held for the International Day of the Girl Child on October 11th, 2018, on Support for FGC. The variable Support for FGC is a discrete measure that takes the value 1 if the respondent does not want FGC to continue, 2 if the answer is "it depends," and 3 if the respondent wants the practice to continue. In Panel B, *Support for FGC* is a dummy variable that takes the value of 0 if individual does not want FGC to continue, and 1 if individual responds depends or wants the practice to continue. Columns 1-3 report the RDD estimates for the subsample of individuals living in locations with 3G network available at the time of the campaign using the 2018 DHS data. We compute parametric estimations with polynomials of order 1 and 2 for the running variable and the non-parametric method following the procedure presented in Calonico et al. (2019). The parametric regressions include survey cluster fixed effects. Columns 4-6 reestimate the same regressions excluding respondents interviewed during the week before October 11th, which might be affected by the pre-campaign announcements.***p<0.01; **p<0.05; *p<0.1.

Figure 1: Proportion of women subjected to FGC in Nigeria by year of birth



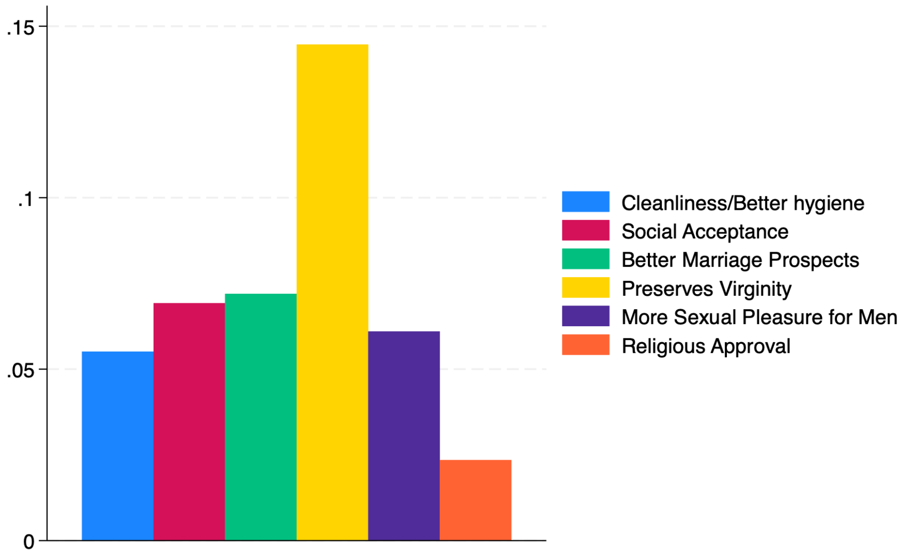
Note: The figure depicts the evolution of the share of women subjected to FGC in Nigeria by year of birth for girls and women older than 3. The figure is constructed using data from the Nigerian DHS, rounds 2003, 2008, 2013, and 2018, and MICS 2016, and 2021.

Figure 2: Prevalence of FGC in Nigeria by county (LGA) in the analytical sample (born between 2007 and 2018)



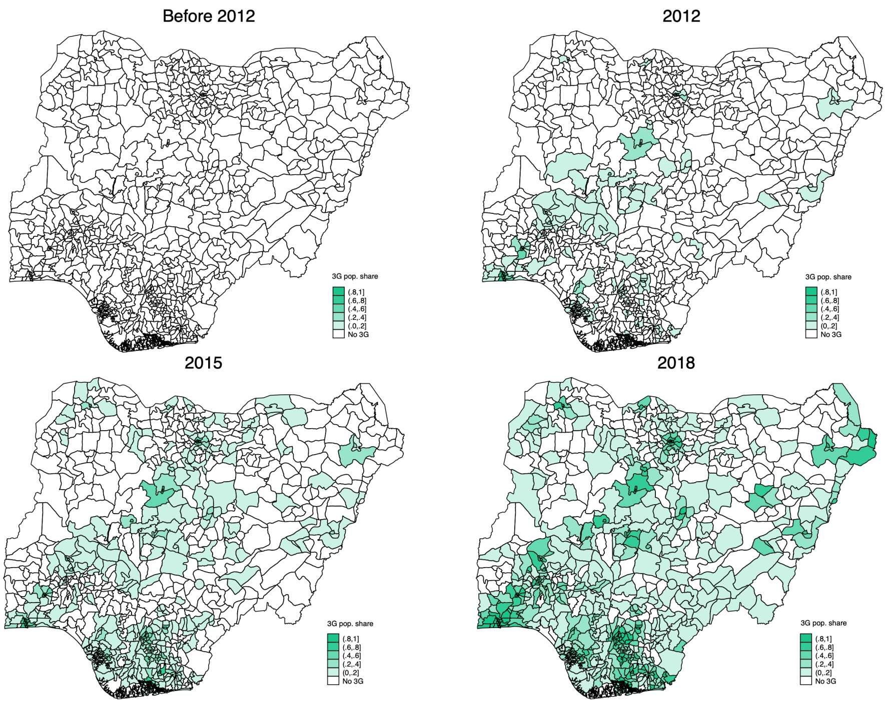
Note: The graph depicts the share of females undergoing FGC in the analytical sample by county (LGA). The figure is constructed using females born between 2007 and 2018 who are included in the 2013 and 2018 rounds of the Nigerian DHS and the 2016 and 2021 rounds of the Nigerian MICS. The prevalence of FGC by county among all women aged 0–49 in these databases is shown in Figure A3. The DHS and MICS data are not representative at the LGA level but at the state level. State-level prevalence for women aged 15–49 is shown in Figure A4.

Figure 3: Perceived benefits of FGC in Nigeria



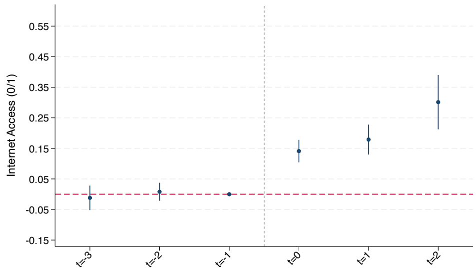
Note: The figure shows the share of individuals in Nigeria who perceive FGC to have each of the following benefits. The data are drawn from the 2008 Nigeria DHS, the most recent survey containing information on perceived benefits of FGC. Male participants were aged 15–59, and female participants were aged 15–49. Participants could indicate more than one perceived benefit of FGC, as responses were not mutually exclusive.

Figure 4: Share of individuals with 3G network available by county (LGA) and year

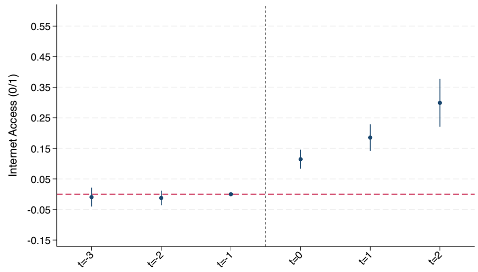


Note: The figure illustrates the expansion of the 3G network in Nigeria between 2012 and 2018, combining GSMA data with NASA population data to estimate the share of the population covered by 3G each year at the county level.

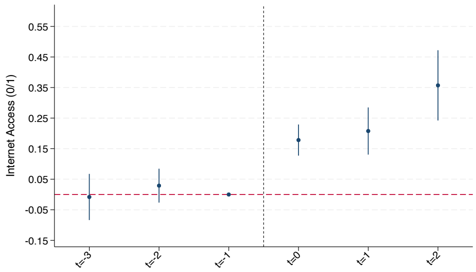
Figure 5: Effect of 3G network availability at the time of survey on internet access (Sun & Abraham)



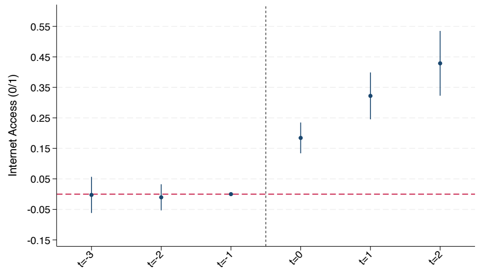
(a) Men



(b) Women



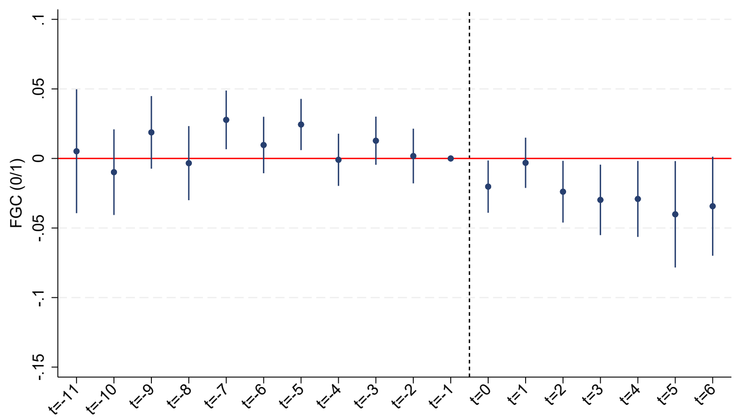
(c) Young Men



(d) Young Women

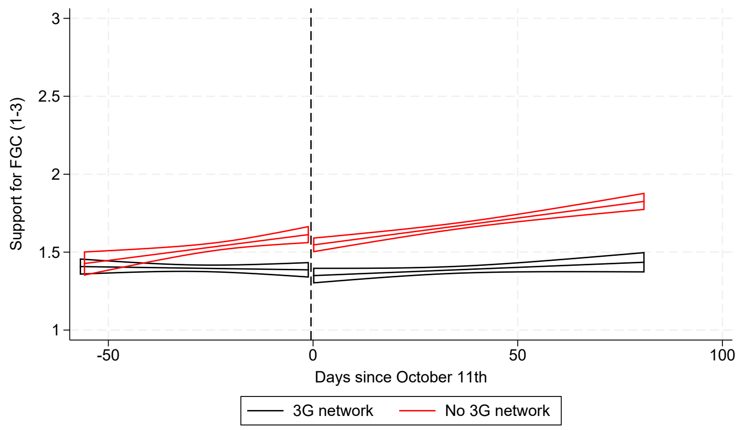
Note: This figure presents event studies estimating the dynamic effects of 3G network availability at the time of the survey on internet access, using the estimator developed by Sun and Abraham (2021). The bars represent 95% confidence intervals. 3G availability is defined at the village-year level. Top graphs refer to the entire sample while bottom graphs restrict the sample to people between 18 and 30 years old. The data used are the rounds 2010, 2012, 2015 and 2018 of the Nigerian General Household Survey that surveyed the same villages over time.

Figure 6: Event study: Effect of 3G network availability at the time of birth on the probability of FGC (OLS)



Note: The graph depicts the dynamic effects of 3G availability at the time of birth on the probability of FGC using OLS methods. The bars represent 95% confidence intervals.

Figure 7: The October 11th anti-FGC online campaign and the support for FGC (1-3)



Note: The figure displays the fitted linear polynomial from a regression discontinuity design estimating the short-term effect of the anti-FGC online campaign held on October 11th, 2018, for the International Day of the Girl Child, on support for FGC (1–3), using data from the 2018 Nigerian DHS round. The plot includes 95% confidence intervals and separate fits for individuals living in areas with and without 3G network coverage.

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Appendix A Additional robustness checks, tables and figures

This appendix reports additional robustness checks and provides supplementary tables and figures referenced in the main text.

First, while FGC typically occurs within the first year of life in Nigeria, a non-negligible share takes place up to the third year of life (around 15% of the cuts). One may therefore wonder whether girls aged 1 or 2 at the time 3G was deployed in their community might also have had their FGC status affected by 3G. In our analysis, however, these girls were categorized as controls ($g = -1$ and $g = -2$). To address this concern, we re-estimate the results excluding girls who were 1 or 2 years old at the time of deployment. The results, reported in column 5 of Table 4 in the main manuscript show slightly larger effects when these girls are excluded from the analytical sample.

Second, one may wonder whether the effects could be partially capturing a delay in the age at cutting rather than fully a reduction in the prevalence. While anecdotal evidence in the field points, if anything, in the opposite direction, we test this hypothesis as follows.[54] We first re-estimate the main results restricting the analytical sample to girls aged at least 3 at the time of the survey. In our sample of women aged 15–49, nearly 97% of girls who will be cut were already cut by age 3. The results of this analysis are reported in Column 6 of Table 4 in the main manuscript. While the sample size reduced substantially and the point estimate is smaller, the estimated coefficient remains meaningful and statistically significant at the 5% level. Second, we estimate the effect of 3G on age at cutting. The results of this test are reported in Column 7 in Table 4 in the main manuscript. While they should to be interpreted with caution because 3G might change the composition of the girls cut, the coefficient measuring the effect of 3G availability on age at cutting is small and largely insignificant.

Third, DHS and MICS data include the coordinates of the place of residence of survey respondents but not of the place of birth. For those households that migrate during the lifetime of the girl, the treatment variable (availability of 3G at the time of birth) might be measured with error. If this measurement error is random, it would merely bias the estimates downward, without altering the main conclusions of the analysis. The problem would however arise if fast internet affects migration (García-Hombrados et al., 2022; Adema et al., 2022), which could change the com-

[54] In a focus group in the Calabar area, an Ibibio woman highlighted that in her community, FGC is decreasing but is also being practiced earlier in life than it used to be.

position of villages receiving 3G. The latter may occur if the 3G network encourages the migration of more anti-FGC households into areas with fast internet, which would upwardly bias the estimated effect of interest or affect their peers. However, this is not the case in our sample: support for FGC among migrants and non-migrants in 3G-covered areas is, if anything, slightly higher among migrants than non-migrants.[55] As a complementary exercise, we exploit information on migration history—available only in the 2018 DHS and 2021 MICS rounds—and reestimate the main results restricting the analytical sample to daughters whose parents have never migrated during their lifetime. The results of this analysis are reported in column 8 of Table 4 in the main manuscript and show similar effects to those in the main analysis, suggesting that the main conclusions are not driven by a change in the composition of the individuals living in areas covered by 3G.

Fourth, we assess the extent to which spillovers may influence our results, potentially arising from the diffusion of norm changes in treated areas into control areas. We augment the baseline specification with a spatial lag of the treatment indicator, allowing internet coverage in nearby areas to affect FGC in a given DHS cluster, where weights are inversely proportional to distance. The results are reported in column 10 of Table 4 in the main manuscript. The spatial lag enters significantly, but its magnitude is small. More importantly, the main estimate of the effect of 3G on FGC is virtually unchanged.

Fifth, one may wonder whether other policies introduced around the same time, which could potentially have affected FGC, might be confounding the effect of 3G on FGC. Such confounding could arise only if a policy coincided in timing and location with the 3G rollout, or had differential effects across areas with and without 3G. While the granular nature of the 3G expansion and the effects observed from the first year help alleviate these concerns, we explicitly test the potential confounding effect of what is arguably the policy with the largest potential impact on FGC: the staggered introduction of anti-FGC legislation in some Nigerian regions from 2015. To explore whether these laws could confound the main results, we conduct two empirical tests. First, we re-estimate the main regression controlling for whether FGC was banned in the region at the time of birth. Second, we re-estimate the main specification excluding from the sample those states where FGC was banned during the study period. The results are reported in Table A11 in Appendix A. Column 1 shows the benchmark effect from the main estimation using the full sample. Column 2 indicates that adding a dummy variable for the existence of a ban at the time of birth has virtually no effect on the point estimate. Reassuringly, column 3 shows

[55] The difference is 2 percentage points with p-value = 0.190.

that the coefficient remains largely unchanged when regions with FGC bans are excluded.

Finally, the introduction of the 3G network not only provided fast internet but also facilitated communication among individuals through calls and short messages (SMS). To test whether these other smartphone functionalities could have driven the observed effects rather than internet access, we exploit the fact that 2G technology enabled calls and SMS-based communication but did not provide fast internet.[56] If calls or SMS were the mechanism behind the observed effects, exposure to 2G would be expected to produce similar effects on FGC. Using geolocated GSMA data on 2G coverage, we estimate the impact of the expansion of 2G mobile networks on FGC, which occurred mainly in the early 2000s. Overall, the results reported in Table A12 and Figure A21 in Appendix A show null effects that do not increase over time. Taken together, our results suggest that the observed effects of 3G are related to the internet rather than to other communication improvements already available through 2G coverage.

Table A1: Data sources

Outcome group	**Dataset**	**Rounds**	**Sample**	**3G Exposure**
FGC (0/1)	DHS & MICS	2013, 2016, 2018, 2021	Daughters module	Individual, at year of birth
Support for FGC	DHS	2003, 2008, 2013, 2018	Female & male modules	County-level share, at survey
Sexual behavior[a]	DHS	2003, 2008, 2013, 2018	Female & male modules	County-level share, at survey
Economic outcomes[b]	DHS	2003, 2008, 2013, 2018	Female & male modules	County-level share, at survey
Internet access	NGHS	2010, 2012, 2015, 2018	Female & male modules	Individual, at survey

Note: "County-level share, at survey" refers to the proportion of individuals in the county (LGA) exposed to 3G at the time of the survey. "Individual, at year of birth" refers to 3G availability in the village at the girl's year of birth. [a] Age at first intercourse, age at first marriage, lifetime sexual partners, sexual partners excluding spouse, and condom use at last relation. [b] Labor force participation and household wealth index.

[56]While 2G facilitated text-based communication through SMS, it only allowed limited and slow internet browsing and applications.

Table A2: Effect of 3G availability on state presence: Public schools openings, access to electricity, radio and TV

	(1) N schools opened	(2) N schools opened	(3) Access to electricity (0/1)	(4) Access to electricity (0/1)	(5) Radio (0/1)	(6) Radio (0/1)	(7) TV (0/1)	(8) TV (0/1)
Share pop with 3G available	-0.503	0.157	-0.115	0.015	0.057	0.068***	-0.038	-0.047*
	(0.399)	(0.171)	(0.095)	(0.029)	(0.054)	(0.021)	(0.063)	(0.025)
N	5,110	8,760	86,489	169,054	86,489	169,078	86,489	169,063
Mean dep var.	1.379	1.379	0.524	0.528	0.703	0.704	0.461	0.465
Parallel trends test	0.007	0.267	-0.029	0.109*	0.009	-0.029	-0.010	-0.025
	(0.116)	(0.258)	(0.044)	(0.056)	(0.020)	(0.030)	(0.029)	(0.056)
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE

Note: Columns 1–8 estimate the impact of 3G availability on different measures of state presence. Columns 1–2 show the effect of 3G availability in the LGA on the opening of public schools. Columns 3–4 show the effect of 3G availability at the time of the survey on access to electricity. Columns 5–6 show the effect of 3G availability at the time of the survey on having a radio. Columns 7–8 show the effect of 3G availability at the time of the survey on having a TV. Columns 1, 3, 5, and 7 report the results of the method described in Chaisemartin and D'Haultfœuille (2020), while Columns 2, 4, 6, and 8 report the results of a two-way fixed effects model (TWFE). The test for parallel trends in the TWFE estimations is a placebo test that measures the effect of the share of population covered by 3G in 2018 on the evolution of the outcome variable before the start of the deployment of 3G network in Nigeria. The parallel trends test in the Chaisemartin and D'Haultfœuille (2020) estimations is the placebo analysis on pre-trends proposed by the authors. In the Chaisemartin and D'Haultfœuille (2020) estimations, the mean of the dependent variable is calculated over the sample of available observations, rather than the effective sample, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table A3: Effect of 3G availability at the time of the survey on support for FGC (including the 2016 MICS round)

Panel A:	All		Women		Men	
Dep var: Support for FGC (1-3)	(1)	(2)	(3)	(4)	(5)	(6)
Share pop with 3G available	-0.540***	-0.183***	-0.522***	-0.086**	0.319	0.190
	(0.125)	(0.041)	(0.149)	(0.039)	(0.333)	(0.174)
N	52,845	100,181	44,237	78,181	8,408	21,996
Mean dep var.	1.533	1.535	1.533	1.527	1.545	1.564
Parallel trends test (p-value)	0.370	0.731	0.307	0.551	0.291	0.836
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE
Panel B:	**All**		**Women**		**Men**	
Dep var: Support for FGC (0/1)	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Share pop with 3G available	-0.258***	-0.098***	-0.215***	-0.034*	0.124	0.028
	(0.066)	(0.021)	(0.079)	(0.020)	(0.171)	(0.090)
N	52,845	100,181	44,237	78,181	8,408	21,996
Mean dep var.	0.302	0.303	0.302	0.301	0.309	0.310
Parallel trends test (p-value)	0.275	0.872	0.211	0.668	0.304	0.806
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE

Note: Columns 1-6 estimate the impact of 3G availability at the time of survey on support for FGC for women aged 15-49 and men aged 15-59 surveyed in DHS rounds 2003, 2008, 2013 and 2018, and MICS 2016. In Panel A *Support for FGC* is a discrete variable that takes the value of 1 if individual does not want FGC to continue, 2 if depends, and 3 if respondent wants the practice to continue. In Panel B, *Support for FGC* is a dummy variable that takes the value of 0 if individual does not want FGC to continue, and 1 if individual responds depends or wants the practice to continue. Column 1, 3, and 5 report the results of the method described in Chaisemartin and D'Haultfœuille (2020). Columns 2, 4, and 6 report the results of a two-way fixed effect model (TWFE). The test for parallel trends is a placebo test that measures the effect of the share of population covered by 3G in 2018 on the evolution of the outcome variable between 2003 and 2008, before the expansion of the 3G network in Nigeria. The parallel trends test in the Chaisemartin & D'Haultfoeuille estimations is the placebo analysis on the pre-trends developed in Chaisemartin and D'Haultfœuille (2020). TWFE estimations do not include all the observations in the main analytical sample presented in the descriptive statistics since singleton observations were automatically excluded. The N reported in the Chaisemartin & D'Haultfoeuille (2020) estimations include only the effective observations used in the estimations, not the full sample of eligible observations. The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table A4: Effect of 3G availability at the time of the survey on sexual behavior outcomes (TWFE estimation method)

	(1)	(2)	(3)	(4)	(5)	(6)
	Age at 1st marriage	Age at 1st intercourse	N lifetime sexual partners	N lifetime sexual partners excluding spouses	N sexual partners (last 12m excluding spouses)	Used condom last relation (0/1)
Panel A: Women						
Share pop with 3G available	0.564***	-0.105	0.577**	0.515*	0.015	-0.015
	(0.156)	(0.138)	(0.262)	(0.267)	(0.012)	(0.009)
N	90,609	97,002	112,213	112,106	120,587	91,717
Parallel trends test	0.054	0.167	NA	NA	0.001	0.039**
	(0.329)	(0.200)			(0.019)	(0.016)
Mean dep var.	17.938	16.822	1.480	0.621	0.104	0.064
Panel B: Men						
Share pop with 3G available	0.140	-0.164	-0.273	-0.444	-0.077***	-0.081***
	(0.273)	(0.304)	(0.301)	(0.299)	(0.026)	(0.020)
N	27,181	34,670	44,397	41,633	47,943	32,929
Parallel trends test	0.160	0.153	NA	NA	0.233**	0.006
	(0.653)	(0.467)			(0.116)	(0.042)
Mean dep var.	25.286	20.323	3.174	2.409	0.256	0.177

Note: The table reports the estimates of the impact of 3G availability at time of survey on sexual behavior outcomes using TWFE. Panel A reports the estimations for women and Panel B for men. TWFE estimations do not include all the observations in the main analytical sample presented in the descriptive statistics since singleton observations were automatically excluded. The test for parallel trends in the TWFE estimations is a placebo test that measures the effect of the share of population covered by 3G in 2018 on the evolution of the outcome variable between 2003 and 2008, before the expansion of the 3G network in Nigeria. Since information on the number of lifetime sexual partners is not included in the 2003 DHS round, the pre-trends test in the TWFE specification cannot be estimated for these variables.***p<0.01; **p<0.05; *p<0.1.

Table A5: Effect of 3G availability at the time of the survey on sexual behavior outcomes for individuals aged 30 or older (Chaisemartin and D'Haultfœuille, 2020 estimation method)

	(1)	(2)	(3)	(4)	(5)	(6)
	Age at 1st marriage	Age at 1st intercourse	N lifetime sexual partners	N lifetime sexual partners excluding spouse	N sexual partners (last 12m excluding spouse)	Used condom last relation (0/1)
Panel A: Women						
Share pop with 3G available	0.642	-0.878**	1.305***	1.231***	0.075***	0.019
	(0.464)	(0.388)	(0.406)	(0.405)	(0.023)	(0.014)
N	27,211	26,530	27,961	27,961	28,221	24,677
Parallel trends test	-0.076	-0.076	-0.079		-0.131 -0.012	0.002
	(0.240)	(0.223)	(0.076)	(0.086)	(0.010)	(0.010)
Mean dep var.	18.670	17.077	1.844	0.706	0.050	0.034
Panel B: Men						
Share pop with 3G available	0.762	-1.637**	-1.036	-1.562	-0.093	-0.003
	(0.788)	(0.768)	(1.030)	(1.115)	(0.076)	(0.036)
N	11,047	11,345	11,696	10,874	12,116	11,362
Parallel trends test	-0.411	-0.185	-0.143	-0.226	-0.018	-0.015
	(0.451)	(0.426)	(0.464)	(0.539)	(0.044)	(0.019)
Mean dep var.	26.037	21.264	4.491	3.321	0.171	0.099

Note: The table reports the estimates of the impact of 3G availability at time of survey on sexual behavior outcomes for individuals aged 30 or older using the difference-in-differences method described in Chaisemartin and D'Haultfœuille (2020). Panel A reports the estimations for women and Panel B for men. The N includes only the effective observations used in the estimations, not the full sample of eligible observations. The parallel trends test is the placebo analysis on the pre-trends developed in Chaisemartin and D'Haultfœuille (2020). The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table A6: Effect of 3G availability on sexual behavior outcomes in placebo settings

	(1) Age at 1st marriage	(2) Age at 1st intercourse	(3) N lifetime sexual partners	(4) N lifetime sexual partners excluding spouse	(5) N sexual partners (last 12m excluding spouse)	(6) Used condom last relation (0/1)
Panel A: Regions where FGC is not grounded on sexual control and premarital sex is stigmatized						
Share pop with 3G available	-2.253	-4.687***	1.865**	1.534**	0.107	0.008
	(1.461)	(1.632)	(0.812)	(0.627)	(0.069)	(0.098)
N	2,421	2,503	2,992	2,992	2,994	2,421
Parallel trends test	0.062	-0.206	0.381	0.374	0.002	0.013
	(0.411)	(0.382)	(0.413)	(0.353)	(0.022)	(0.016)
Mean dep var.	16.332	15.621	1.314	0.362	0.085	0.048
Panel B: Regions where FGC is not grounded on sexual control						
Share pop with 3G available	-2.593*	-2.678***	1.831**	1.571**	0.029	-0.042
	(1.350)	(0.989)	(0.786)	(0.747)	(0.075)	(0.085)
N	4,205	4,861	5,795	5,795	5,893	4,635
Parallel trends test	0.434	-0.353	0.347	0.370	0.035	0.003
	(0.415)	(0.294)	(0.301)	(0.261)	(0.033)	(0.021)
Mean dep var.	17.441	15.928	1.715	0.892	0.179	0.076
Panel C: Regions where premarital sex is less stigmatized						
Share pop with 3G available	1.082	0.077	0.657**	0.661**	0.028	-0.032
	(0.746)	(0.369)	(0.305)	(0.304)	(0.049)	(0.031)
N	10,903	13,239	16,235	16,235	16,457	12,265
Parallel trends test	0.374	-0.086	0.076	0.107	0.019	-0.009
	(0.435)	(0.312)	(0.121)	(0.131)	(0.027)	(0.017)
Mean dep var.	19.792	17.398	1.886	1.156	0.205	0.116
Panel D: Kanuri-Beriberi people						
Share pop with 3G available	2.778	2.454	-0.653	-0.513**	-0.029	0.004
	(1.786)	(1.788)	(0.435)	(0.203)	(0.034)	(0.017)
N	675	650	843	843	843	636
Parallel trends test	1.652	0.585	-0.150	-0.055	0.000	-0.001
	(1.362)	(0.371)	(0.300)	(0.075)	(0.000)	(0.010)
Mean dep var.	16.400	16.023	1.358	0.400	0.044	0.027

Note: The table reports the estimates of the impact of 3G availability at time of survey on sexual behavior outcomes of women using the difference-in-differences method described in Chaisemartin and D'Haultfœuille (2020). The analytical sample in Panel A includes only women aged 15-49 that live in areas where the FGC is existent (at least 5%), but where the preservation of virginity is not mentioned as a benefit of FGC (less than 3%), and where premarital sex is stigmatized (the mean number of out-of-marriage sexual relations is less than 1). The analytical sample in Panel B includes only women aged 15-49 that live in areas where the FGC is existent (at least 5%), but where the preservation of virginity is not mentioned as a benefit of FGC (less than 3%). The analytical sample in Panel C includes only women aged 15-49 that live in regions where premarital sex is less stigmatized (the mean number of out-of-marriage sexual relations is at least 1). The analytical sample in Panel D includes only women aged 15-49 from the Kanuri-Beriberi ethnic group. The N includes only the effective observations used in the estimations, not the full sample of eligible observations. The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01;**p<0.05,*p<0.1.

Table A7: Effect of 3G availability at the time of the survey on wealth and labor force participation

	(1) HH wealth index	(2) HH wealth index	(3) Labor force participation	(4) Labor force participation
Panel A: All indiv.				
Share pop with 3G availability	-0.041	0.000	0.022	0.006
	(0.143)	(0.049)	(0.048)	(0.016)
N	86,489	169,172	86,257	168,568
Parallel trends test	-0.028	0.007	-0.018	0.032
	(0.064)	(0.099)	(0.021)	(0.034)
Mean dep var.	0.000	0.000	0.672	0.672
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE
Panel B: Women				
Share pop with 3G availability	-0.053	-0.002	-0.027	-0.010
	(0.144)	(0.049)	(0.063)	(0.020)
N	62,651	120,998	62,485	120,516
Parallel trends test	-0.023	0.014	-0.031	0.070
	(0.064)	(0.098)	(0.026)	(0.043)
Mean dep var.	-0.018	-0.018	0.616	0.616
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE
Panel C: Men				
Share pop with 3G availability	-0.017	0.001	0.114**	0.038*
	(0.150)	(0.051)	(0.046)	(0.021)
N	23,838	48,173	23,772	48,051
Parallel trends test	-0.023	0.001	-0.031	-0.037
	(0.064)	(0.121)	(0.026)	(0.039)
Mean dep var.	0.044	0.044	0.811	0.811
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE

Note: Columns 1-4 report the estimates of the impact of 3G availability at the time of the survey on household wealth index and on labor force participation. The wealth index varies between -284155 and 315067 but for estimation purposes the variable has been normalized. TWFE estimations do not include all the observations in the main analytical sample presented in the descriptive statistics since singleton observations were automatically excluded. The N reported in the Chaisemartin & D'Haultfoeuille (2020) estimations include only the effective observations used in the estimations, not the full sample of eligible observations. The test for parallel trends in the TWFE estimations is a placebo test that measures the effect of the share of population covered by 3G in 2018 on the evolution of the outcome variable between 2003 and 2008, before the expansion of the 3G network in Nigeria. The parallel trends test in the Chaisemartin & D'Haultfoeuille estimations is the placebo analysis on the pre-trends developed in Chaisemartin and D'Haultfœuille (2020). The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table A8: Effect of 3G availability at the time of the survey on bargaining power of women within the household

	(1)	(2)	(3)	(4)	(5)
Respondent	Women	Women	Women	Women	Men
Final say on	Health care	Large HH purchases	Visits family relatives	Manage women money	Large HH purchases
Panel A: Chaisemartin & D'Haultfoeuille					
Share pop with 3G available	0.171*	0.135	0.044	0.081	-0.237
	(0.088)	(0.083)	(0.102)	(0.075)	(0.149)
N	43,445	43,423	43,448	42,846	12,841
Parallel trends test	0.044	0.003	-0.015	-0.005	0.017
	(0.046)	(0.036)	(0.044)	(0.052)	(0.049)
Mean dep var.	1.497	1.440	1.640	1.342	2.571
Panel B: TWFE					
Share pop with 3G available	0.153***	0.117***	0.089**	-0.023	-0.284***
	(0.038)	(0.034)	(0.039)	(0.037)	(0.063)
N	84,930	84,860	84,912	78,326	26,652
Parallel trends test	-0.105	-0.147***	0.059	0.000	0.011
	(0.088)	(0.053)	(0.075)	(0.000)	(0.049)
Mean dep var.	1.502	1.446	1.648	1.344	2.507

Note: The table reports the estimates of the impact of 3G availability at the time of the survey on bargaining power within the household for men and women. The variables indicate the final say of the respondent on different household decisions for married individuals. The variable takes the value 3 if individual takes the decision alone, 2 if individuals participate in the decision, and 1 if the decision is taken by another person. Columns (1) to (4) report the results for women and column (5) reports the results for men. Panel A reports the estimations of the difference-in-differences method described in Chaisemartin and D'Haultfœuille (2020). Panel B reports the results of a two-way fixed effects model. The test for parallel trends in the TWFE estimations is a placebo test that measures the effect of the share of population covered by 3G in 2018 on the evolution of the outcome variable between 2003 and 2008, before the expansion of the 3G network in Nigeria. The parallel trends test in the Chaisemartin & D'Haultfoeuille estimations is the placebo analysis on the pre-trends developed in Chaisemartin and D'Haultfœuille (2020). The event study is reported in Figure A22. TWFE methods do not include all the observations in the main analytical sample presented in the descriptive statistics since singleton observations were automatically excluded. The N reported in the Chaisemartin & D'Haultfoeuille (2020) estimations include only the effective observations used in the estimations, not the full sample of eligible observations. The mean of the dependent variable is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01; **p<0.05; *p<0.1.

Table A9: Effect of 3G availability on interethnic marriages and marrying outside the community

	(1) Interethnic marriage	(2) Interethnic marriage	(3) Marrying outside community	(4) Marrying outside community
Panel A: All women				
Share pop with 3G available	-0.061	-0.020	-0.040	-0.039
	(0.064)	(0.021)	(0.177)	(0.070)
N	12,944	26,395	2,701	7,301
Parallel trends test	-0.023	-0.026	-0.085	0.131
	(0.030)	(0.042)	(0.139)	(0.133)
Mean dep var.	0.131	0.131	0.313	0.215
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE
Panel B: Women younger than 25				
Share pop with 3G available	-0.023	0.010	0.258	-0.166
	(0.183)	(0.053)	(0.314)	(0.167)
N	3,157	6,830	482	1,659
Parallel trends test	-0.001	-0.140	-0.160	0.315
	(0.054)	(0.127)	(0.256)	(0.251)
Mean dep var.	0.132	0.142	0.247	0.156
Estimation method	Chaisemartin & D'Haultfoeuille	TWFE	Chaisemartin & D'Haultfoeuille	TWFE

Note: The table reports the estimates of the impact of 3G availability at time of survey on inter-ethnic marriages and on the probability of marrying someone outside the community using the difference-in-differences method described in Chaisemartin and D'Haultfœuille (2020) and TWFE. The N in the Chaisemartin and D'Haultfœuille (2020) estimations includes only the effective observations used in the estimations, not the full sample of eligible observations. The mean of the dependent variable in Chaisemartin and D'Haultfœuille (2020) is calculated over the sample of available observations, rather than the effective observations, because the command does not retain which observations were actually used in the estimation.***p<0.01;**p<0.05,*p<0.1.

Table A10: Effect of 3G availability on schooling outcomes

	(1) Educ. Attainment (0-4)	(2) Secondary educ (0/1)	(3) School enrollment (0/1)	(4) School enrollment (0/1)
Panel A: All indiv.				
N years exposed to 3G	-0.020***	-0.004*		
during schooling years (0-13)	(0.004)	(0.002)		
Share pop with 3G available			-0.122	-0.022
			(0.078)	(0.023)
N	88,226	88,226	93,832	181,980
Parallel trends test			-0.005	0.108***
			(0.038)	(0.036)
Mean dep var.	1.374	0.534	0.680	0.680
Estimation method	OLS	OLS	Chaisemartin & D'Haultfoeuille	TWFE
Panel B: Women				
N years exposed to 3G	-0.018***	-0.002		
during schooling years (0-13)	(0.005)	(0.002)		
Share pop with 3G available			-0.138*	-0.036
			(0.082)	(0.024)
N	64,629	64,629	46,361	90,025
Parallel trends test			0.009	0.091**
			(0.038)	(0.037)
Mean dep var.	1.268	0.490	0.651	0.651
Estimation method	OLS	OLS	Chaisemartin & D'Haultfoeuille	TWFE
Panel C: Men				
N years exposed to 3G	-0.024***	-0.006*		
during schooling years (0-13)	(0.007)	(0.003)		
Share pop with 3G available			-0.109	-0.007
			(0.081)	(0.024)
N	23,575	23,575	47,466	91,945
Parallel trends test			-0.018	0.128***
			(0.041)	(0.041)
Mean dep var.	1.661	0.653	0.709	0.709
Estimation method	OLS	OLS	Chaisemartin & D'Haultfoeuille	TWFE

Note: Columns 1-4 report the estimates of the effect of exposure to 3G on different schooling outcomes. Column 1 reports the OLS estimates of the number of years of exposure to 3G during the school years (ages 6 to 18) on educational attainment for individuals aged 18 or older. Educational attainment is a discrete variable that takes the value 0 if the individual has no education, 1 if primary education, 2 if secondary education, and 3 if higher education. Column 2 reports the OLS estimates of the number of years of exposure to 3G during the school years (ages 6 to 18) on the probability of having secondary education for individuals aged 18 or older. Columns 3 and 4 report the difference-in-differences estimates (see equation 2) of exposure to 3G at the time of the survey on school enrollment at the time of the survey for individuals aged 6 to 18. Column 3 reports estimates using the procedure developed by Chaisemartin and D'Haultfoeuille, and Column 4 reports results from the canonical TWFE. The test for parallel trends in the TWFE estimations in column 3 is a placebo test that measures the effect of the share of population covered by 3G in 2018 on the evolution of the outcome variable between 2003 and 2008, before the expansion of the 3G network in Nigeria. The parallel trends test in the Chaisemartin & D'Haultfoeuille estimations in column 4 is the placebo analysis on the pre-trends developed in Chaisemartin and D'Haultfœuille (2020).***p<0.01; **p<0.05; *p<0.1.

Table A11: Robustness check: Anti-FGC legislation

Dep. var.: FGC (0/1)	(1)	(2)	(3)
3G available	-0.023***	-0.024***	-0.024***
	(0.005)	(0.005)	(0.006)
N	63,760	63,760	51,171
Mean dep. var.	0.169	0.169	0.176
Estimation method	TWFE	TWFE	TWFE
Control variable: FGC ban at birth	No	Yes	No
Analytical sample	All girls	All girls	Excluding regions with anti-FGC laws

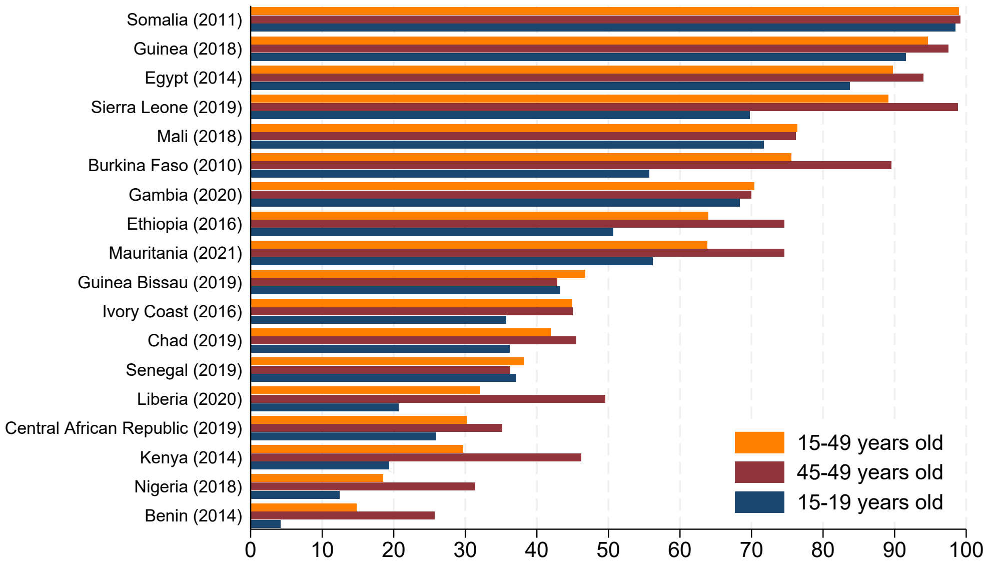
Note: Columns 1–3 estimate the impact of 3G availability at the time of birth in the cluster of residence on the probability of having experienced FGC. All columns use TWFE estimation. Column 1 reports the benchmark result from column (1) of Table 2. Column 2 adds a control for whether a law banning FGC was in place in the region at the time of the girl's birth. Column 3 excludes girls living in regions that had already adopted legislation banning FGC by 2018, the last year for which we have information on 3G availability.***p<0.01; **p<0.05; *p<0.1.

Table A12: Placebo test: Effect of 2G availability at the time of birth on the probability of FGC

Dep var: FGC (0/1)	(1)	(2)	(3)	(4)
2G available	0.010*	0.005	0.023	-0.005
	(0.005)	(0.008)	(0.020)	(0.018)
N	39,929	39,929	26,502	18,998
Mean dep var.	0.181	0.181	0.176	0.175
Estimation method	TWFE	Sun & Abraham	Callaway & Sant'Anna	Chaisemartin & D'Haultfoeuille

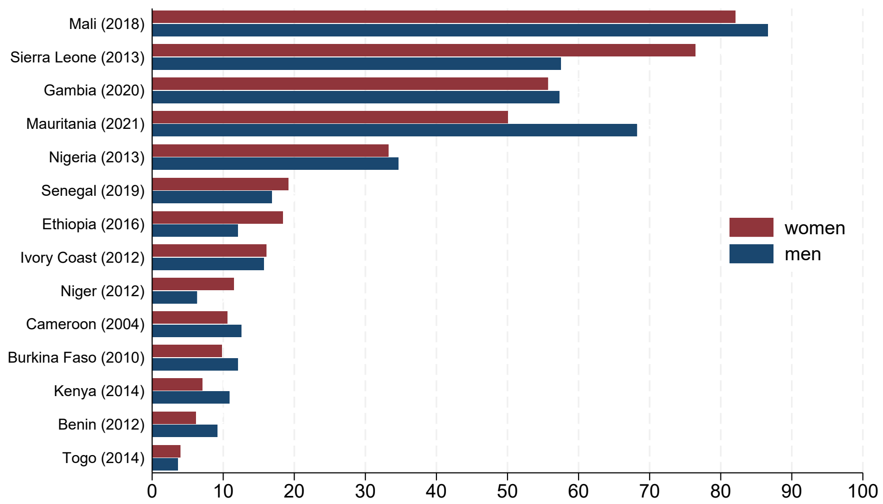
Note: Columns 1–4 estimate the effect of 2G availability at birth in the cluster of residence on the probability of undergoing FGC. Column 1 reports the results of a TWFE estimation. Column 2 reports the results of the method described in Sun & Abraham (2021). Column 3 reports the results of the method described in Callaway & Sant'Anna (2021). Columns 4 reports the results of the method described in Chaisemartin & D'Haultfoeuille (2020).***p<0.01; **p<0.05; *p<0.1.

Figure A1: Prevalence of FGC by country and age group



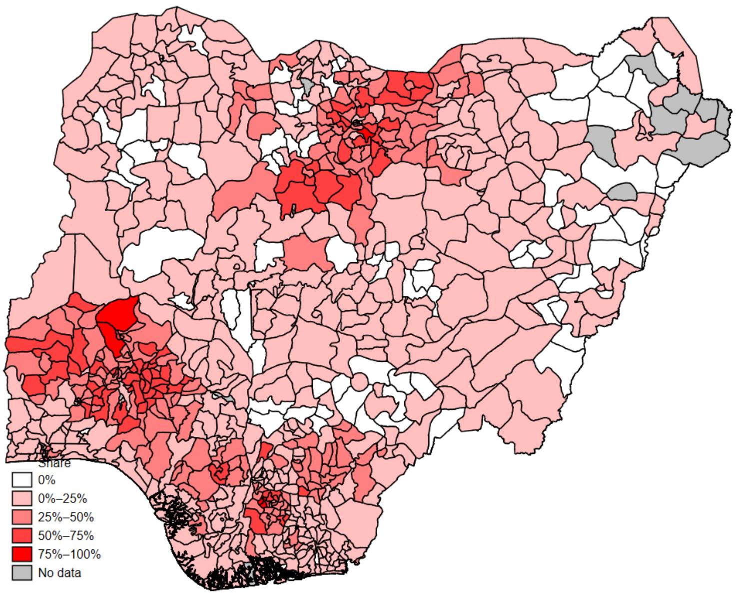
Note: The figure reports average FGC prevalence among women aged 15–19, 15–49, and 45–49 for countries in which the average prevalence among women aged 15–49 is above 10%. Because the vast majority of FGC occurs by the age of 15, the differences in the prevalence of FGC across generations captures the variation in the practice over time. To build the figure, we use data from the last round of DHS and MICS surveys with information on FGC in every African country. An exception to this is Nigeria. While a MICS survey was conducted in 2021, we use the 2018 DHS because it is the last year for which information on 3G coverage is available and thus the last year in the studied period.

Figure A2: Support for FGC by country and sex



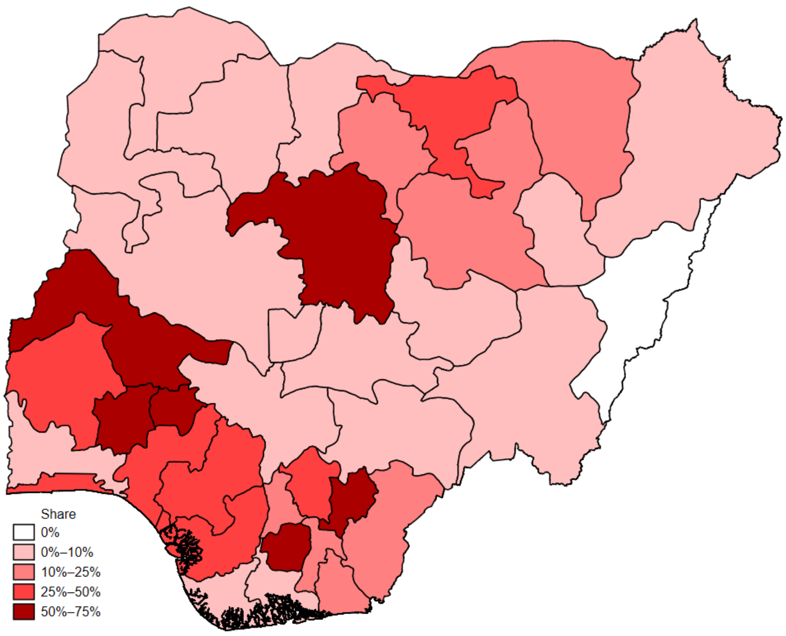
Note: The figure shows the average support for FGC by sex across different countries, focusing on men and women aged 15–49. Surveys typically include nationally representative samples of men aged 15–59 and women aged 15–49. Since our interest is in comparing support across genders, we restrict the male sample to ages 15–49, excluding men aged 50–59. Support for FGC is defined as the percentage of respondents who answer "yes" or "depends" to the question of whether the practice should continue. The data are drawn from the most recent DHS or MICS survey available for each country that includes information on support for FGC by sex.

Figure A3: Prevalence of FGC among women aged 0-49 by county (LGA)



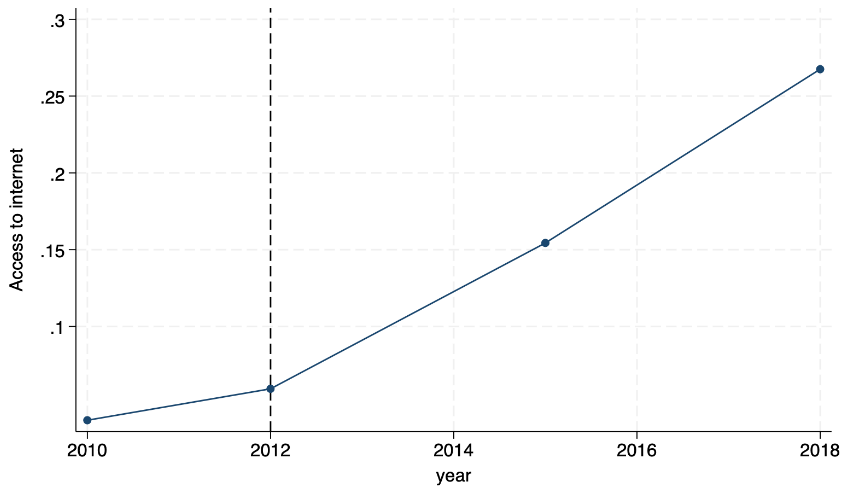
Note: The graph depicts the proportion of females aged 0–49 undergoing FGC in the analytical sample by county (LGA). The figure is constructed using all females for whom information is available in the 2013 and 2018 rounds of the Nigerian DHS and the 2016 and 2021 rounds of the Nigerian MICS. The DHS and MICS data are not representative at the LGA level but at the state level. State-level prevalence for women aged 15–49 is shown in Figure A4.

Figure A4: Prevalence of FGC in Nigeria by region (age 15-49) (DHS 2018)



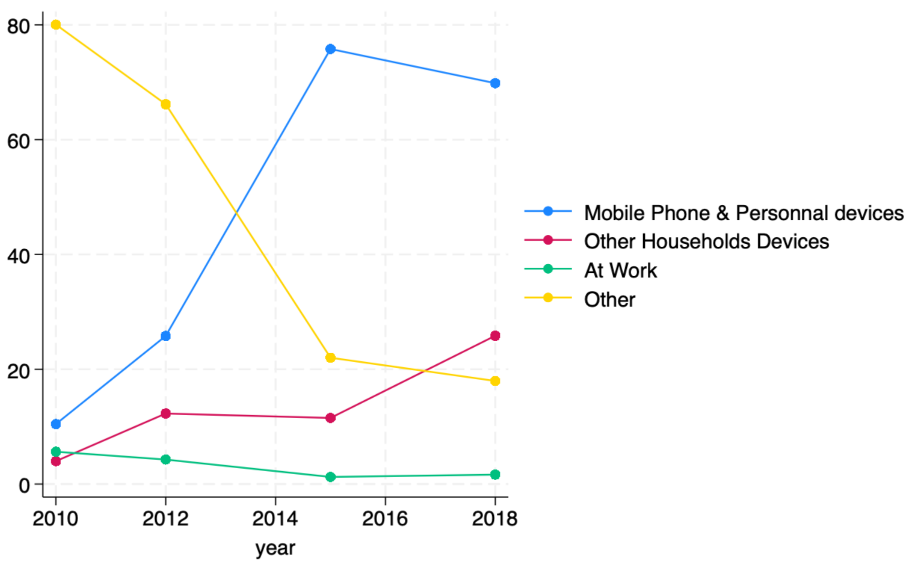
Note: The graphs depict the proportion of females aged 15-49 subjected to FGC in Nigeria by state. The figure is constructed using the 2018 Nigerian DHS round. This survey is representative at the regional level for women aged 15-49 in 2018. Since FGC typically occurs in the first years of life and fast internet only arrived in Nigerian cities in 2012, it is unlikely to affect the prevalence of FGC among women in the age group used in the construction of the map.

Figure A5: Internet access in Nigeria



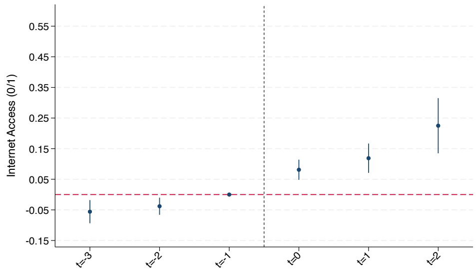
Note: The graph shows the evolution of the proportion of the population that report having access to internet in Nigeria. The proportions are calculated using the Nigerian General Household Survey rounds 2010, 2012, 2015, and 2018.

Figure A6: Main form of internet access in Nigeria over time

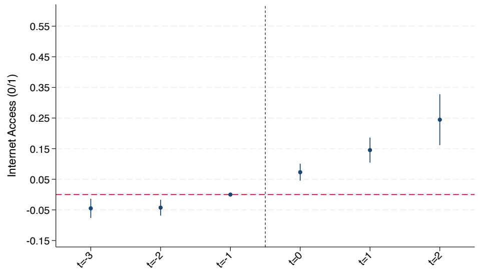


Note: The figure shows the evolution of the main sources of internet access in Nigeria. The share for each source is calculated over the sample of individuals with internet access. The data come from the 2010, 2012, 2015, and 2018 rounds of the Nigerian General Household Survey.

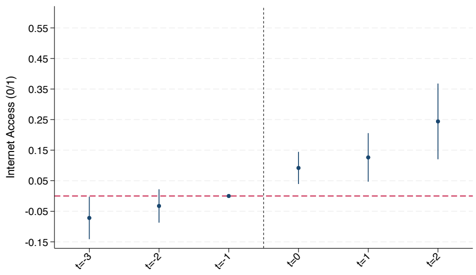
Figure A7: Effect of 3G availability at the time of the survey on internet access (OLS)



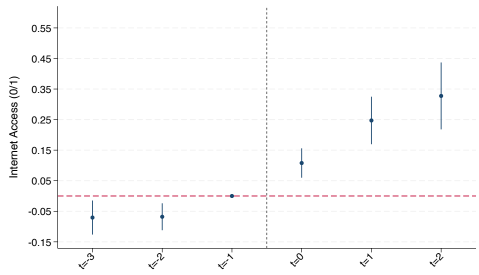
(a) Men



(b) Women



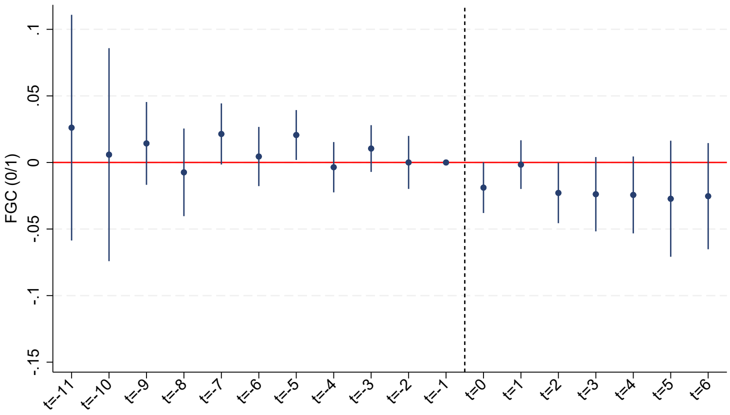
(c) Young Men



(d) Young Women

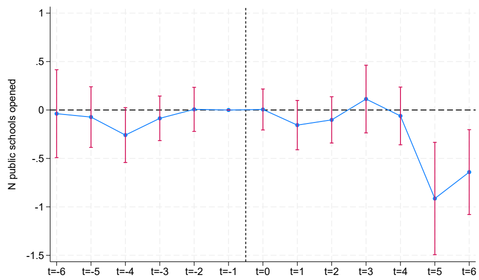
Note: This figure presents event studies estimating the dynamic effects of 3G availability at the time of the survey on internet access using OLS. The bars represent 95% confidence intervals. 3G availability is defined at the village-year level. Top graphs refer to the entire sample while bottom graphs restrict the sample to people between 18 and 30 years old. The data used are the rounds 2010, 2012, 2015 and 2018 of the Nigerian General Household Survey that surveyed the same villages over time.

Figure A8: Event study: Effect of 3G availability at the time of birth on the probability of FGC (Sun & Abraham)

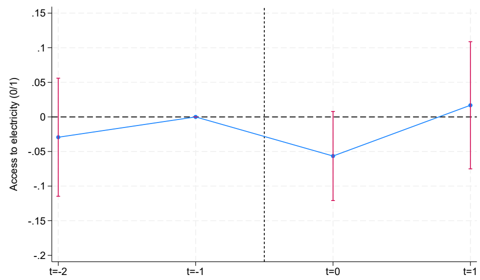


Note: The figure depicts the dynamic effects of 3G availability at the time of birth on the probability of FGC using the Sun & Abraham event study. The bars represent 95% confidence intervals.

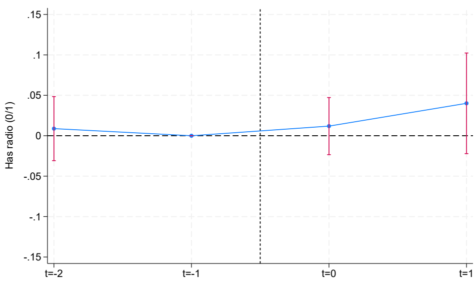
Figure A9: Effect of 3G availability at the time of the survey on different measures of state presence



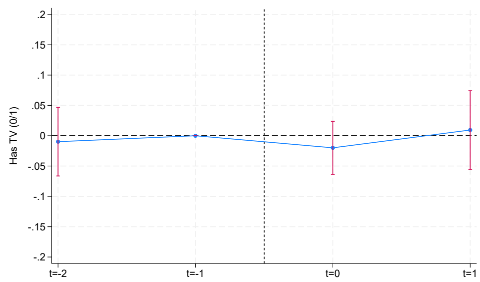
(a) N of schools opened



(b) Access to electricity



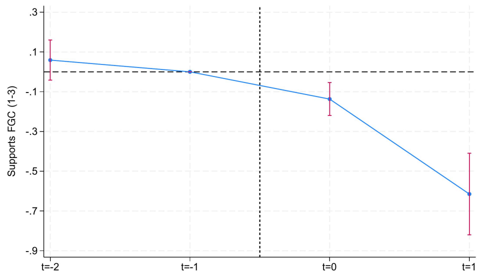
(c) Has a radio



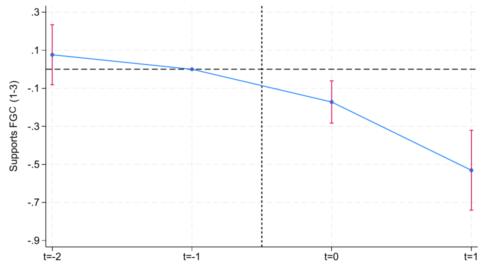
(d) Has a TV

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on different measures of state presence using the event study estimator developed in Chaisemartin and D'Haultfœuille (2020). The bars represent 95% confidence intervals. For the analysis of electricity, radio, and TV, we use data from the 2010, 2012, 2015, and 2018 rounds of the DHS. For the analysis of public school openings, we construct a yearly panel of school openings at the county level between 2007 and 2018.

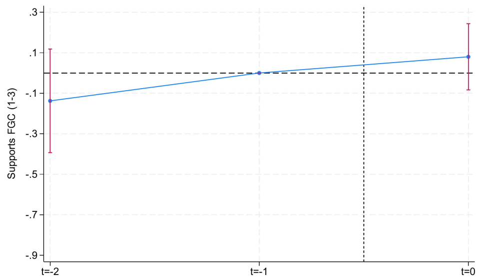
Figure A10: Effect of 3G network availability at the time of the survey on the support for FGC (1-3)



(a) All individuals



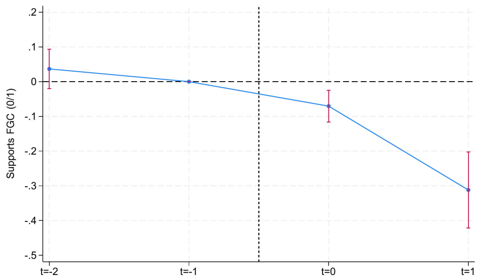
(b) Women



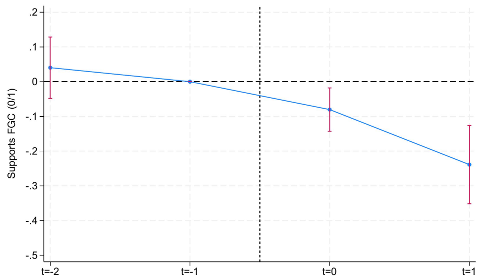
(c) Men

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on the support for FGC using the event study estimator developed in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include rounds 2003, 2008, 2013, and 2018 of the Nigerian DHS. Information on support for FGC is not included for men in DHS 2018. The bars represent 95% confidence intervals.

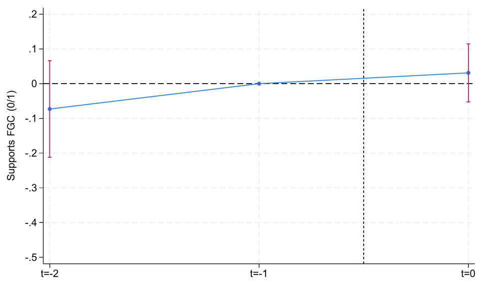
Figure A11: Effect of 3G network availability at the time of the survey on the support for FGC (0/1)



(a) All individuals



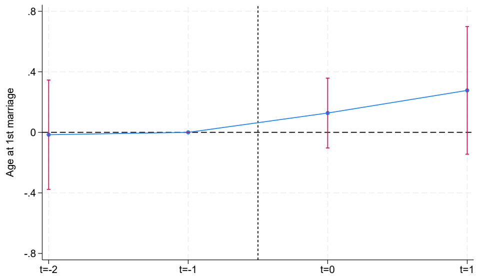
(b) Women



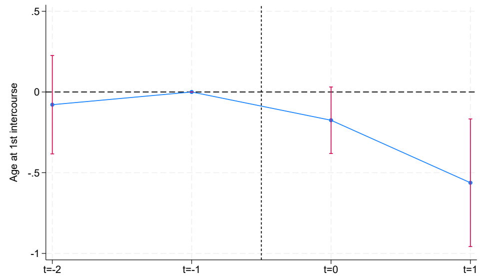
(c) Men

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on the support for FGC (0/1) using the event study estimator developed in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include rounds 2003, 2008, 2013, and 2018 of the Nigerian DHS. Information on support for FGC is not included for men in DHS 2018. The bars represent 95% confidence intervals.

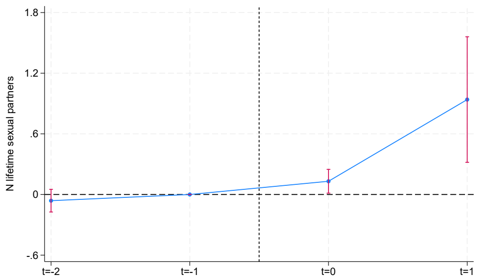
Figure A12: Effect of 3G network availability at the time of the survey on sexual behavior outcomes for women



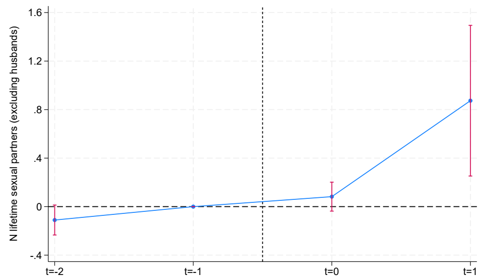
(a) Age at 1st marriage



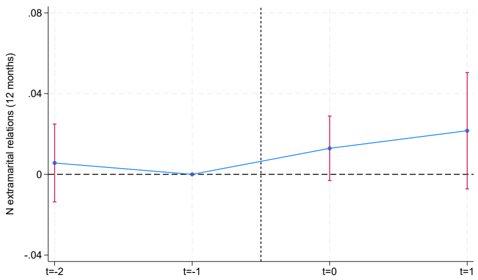
(b) Age at 1st intercourse



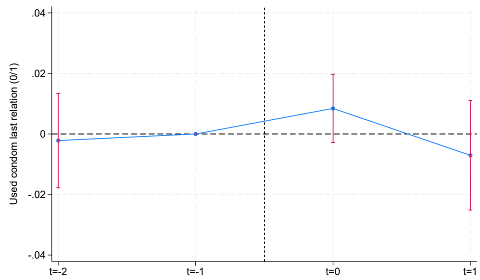
(c) N lifetime sexual partners



(d) N lifetime sexual partners (excluding spouses)



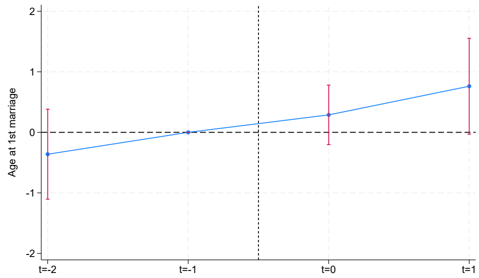
(e) N extramarital partners last 12 months



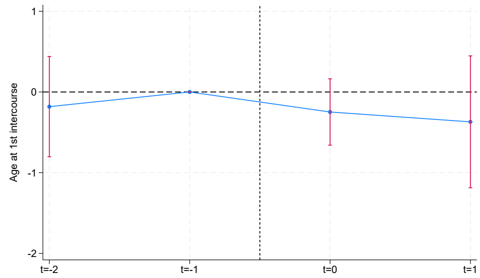
(f) Used condom in last relation

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on sexual behavior outcomes for women using the estimator presented in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include the Nigerian DHS, rounds 2003, 2008, 2013, and 2018. The bars represent 95% confidence intervals.

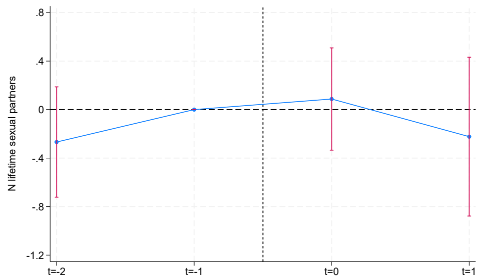
Figure A13: Effect of 3G network availability at the time of the survey on sexual behavior outcomes for men



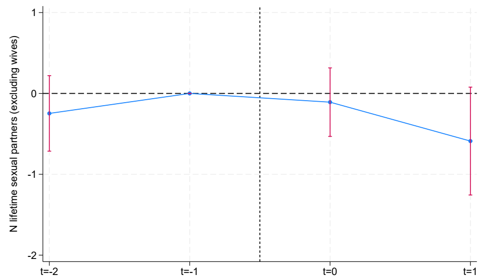
(a) Age at 1st marriage



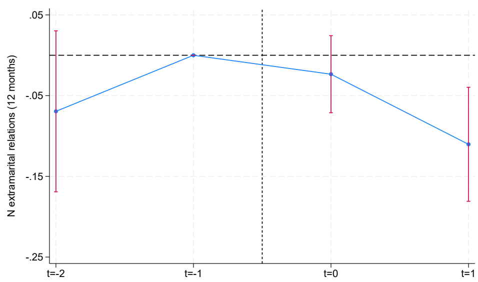
(b) Age at 1st intercourse



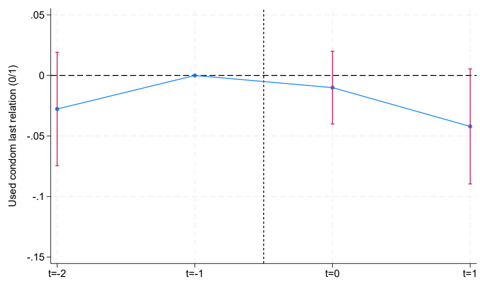
(c) N lifetime sexual partners



(d) N lifetime sexual partners (excluding spouses)



(e) N extramarital partners last 12 months



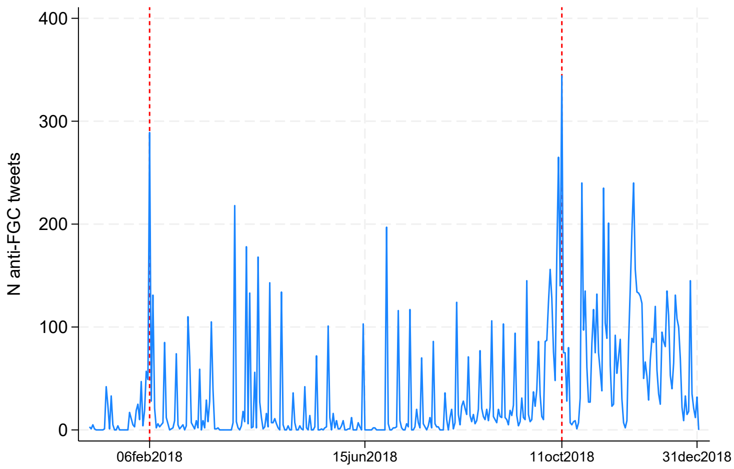
(f) Used condom in last relation

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on sexual behavior outcomes for men using the estimator presented in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include the Nigerian Demographic and Health Surveys, rounds 2003, 2008, 2013, and 2018. The bars represent 95% confidence intervals.

Figure A14: Examples of anti-FGC tweets

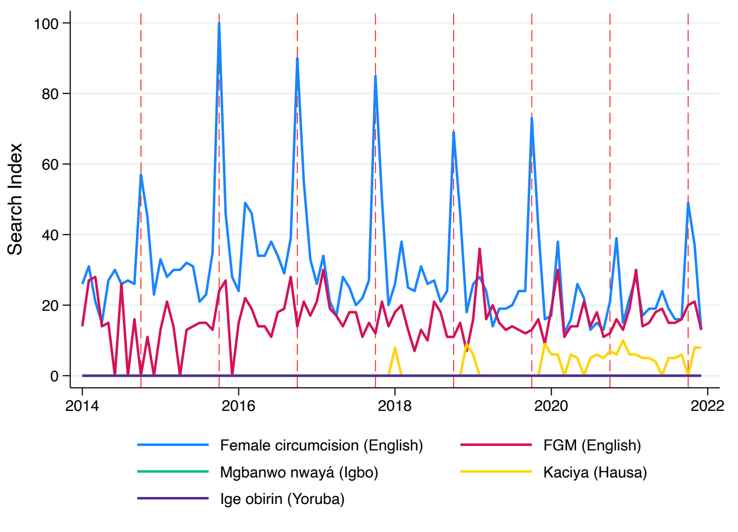
Note: The figure displays various examples of anti-FGC tweets in Nigeria. The tweets were issued on October 11th, 2018, during the International Day of the Girl Child.

Figure A15: Daily Number of anti-FGC tweets in 2018



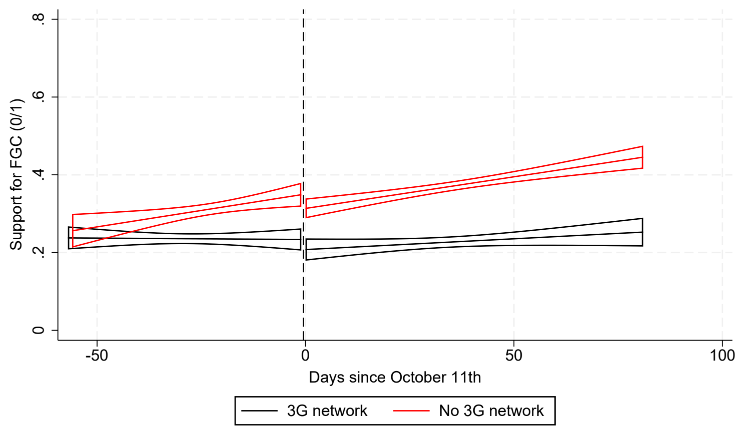
Note: The figure depicts the daily number of tweets in Nigeria that used one or more of the following anti-FGC hashtags: #endFGM, #endcuttinggirls, or #nofgm. The two vertical lines on February 6th and October 11th indicate the International Day of Zero Tolerance for FGC and the International Day of the Girl Child, respectively. No survey fieldwork was conducted in 2018, nor in any other year during the days immediately before or after the International Day of Zero Tolerance for FGC (Feb 6th).

Figure A16: Google searches for FGC in Nigeria



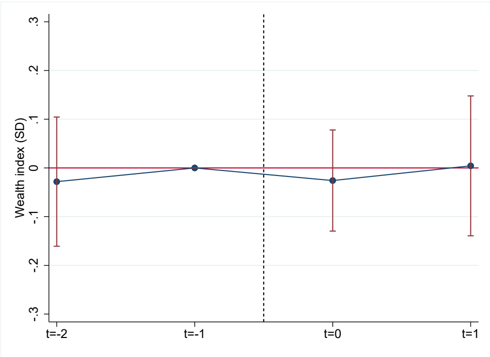
Note: Google trends data. The figure depicts Google searches between 2014 and 2021 for the main words used to refer to FGC in Nigeria in English, Yoruba, Igbo, and Hausa, the main languages spoken in Nigeria. The data do not provide the number of Google searches over time for each term, but rather the evolution of a search index normalized to the time and term with the highest search volume. Red dashed lines mark October, the month of the International Day of the Girl Child.

Figure A17: The October 11th anti-FGC online campaign and the support for FGC (0/1)

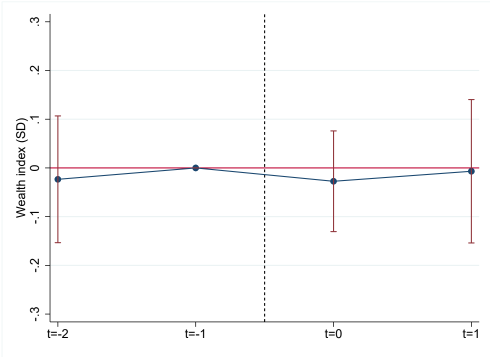


The figure displays the fitted linear polynomial from a regression discontinuity design estimating the short-term effect of the anti-FGC online campaign held on October 11th, 2018, for the International Day of the Girl Child, on support for FGC (0/1), using data from the 2018 Nigerian DHS round. The plot includes 95% confidence intervals and separate fits for individuals living in areas with and without 3G network coverage.

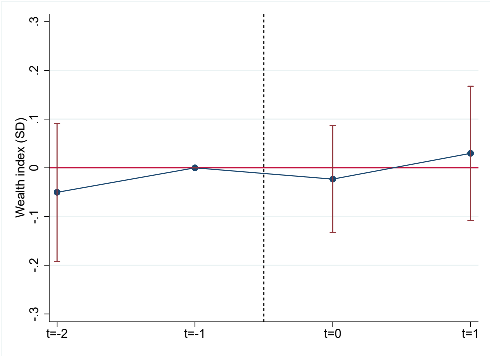
Figure A18: Effect of 3G network availability at the time of the survey on household wealth



(a) All



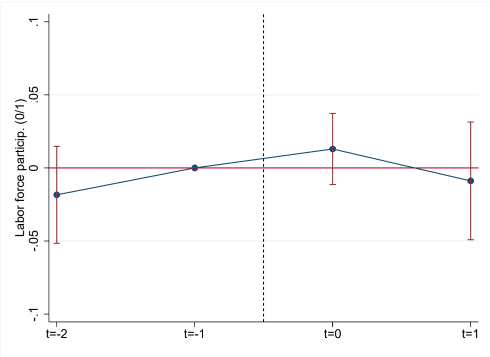
(b) Women



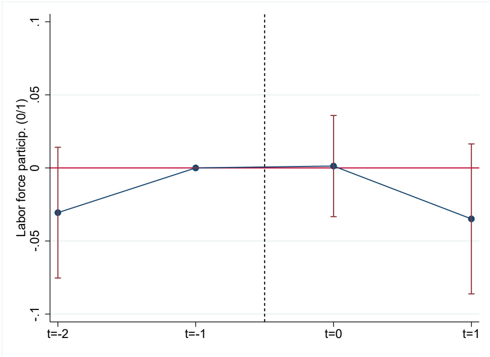
(c) Men

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on household wealth using the estimator presented in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include the Nigerian Demographic and Health Surveys, rounds 2003, 2008, 2013, and 2018. The bars represent 95% confidence intervals.

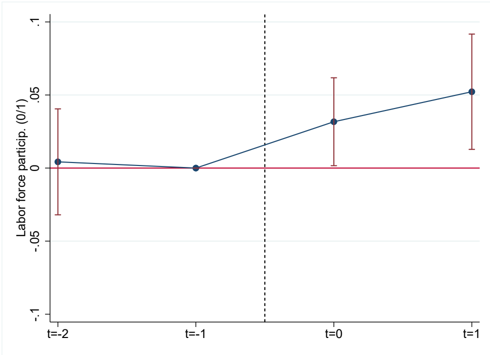
Figure A19: Effect of 3G network availability at the time of the survey on labor force participation



(a) All



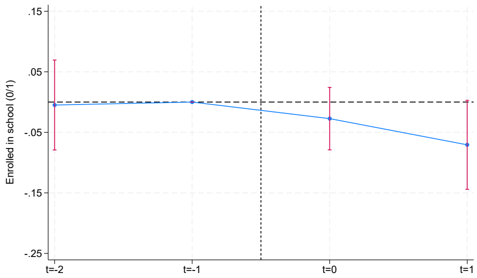
(b) Women



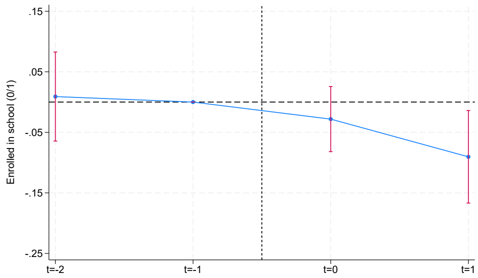
(c) Men

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on labor fore participation using the estimator presented in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include the Nigerian Demographic and Health Surveys, rounds 2003, 2008, 2013, and 2018. The bars represent 95% confidence intervals.

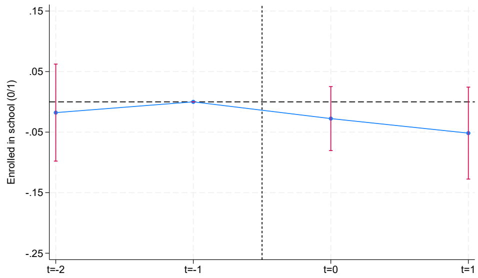
Figure A20: Effect of 3G availability at the time of the survey on school enrollment (individuals aged 6-18)



(a) All individuals



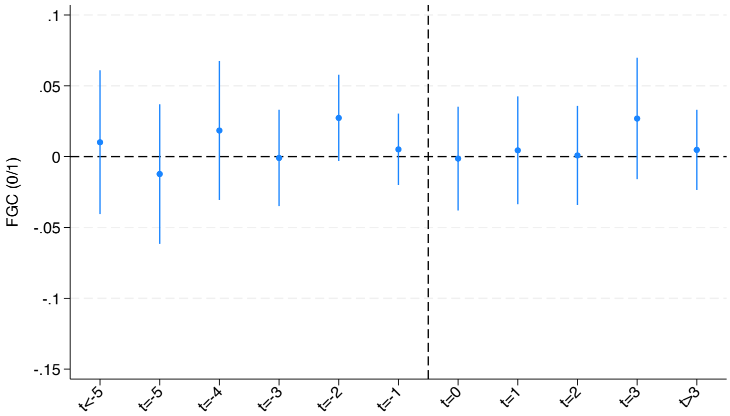
(b) Women



(c) Men

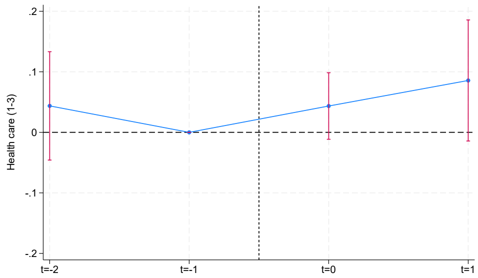
Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on school enrollment for individuals aged 6-18 using the event study estimator developed in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include rounds 2003, 2008, 2013, and 2018 of the Nigerian Demographic and Health Surveys. The bars represent 95% confidence intervals.

Figure A21: Effect of 2G network availability at the time of birth on the probability of FGC

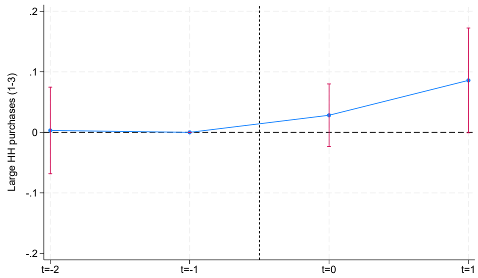


Note: The figure shows the dynamic effects of 2G network availability at the time of birth on the probability of FGC using the event study estimator presented in Sun and Abraham (2021). The bars represent 95% confidence intervals.

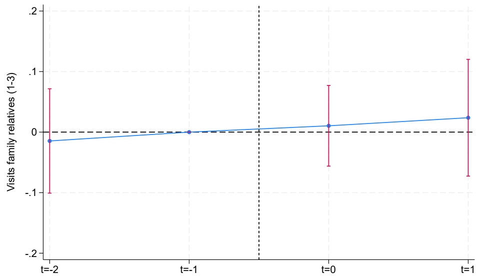
Figure A22: Effect of 3G network availability at the time of the survey on final say on...



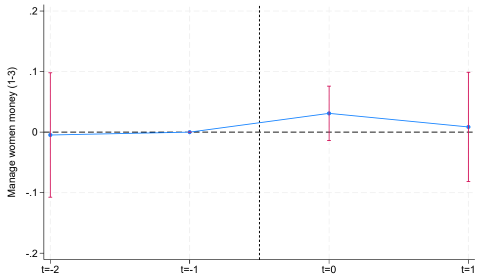
(a) Health care - Women



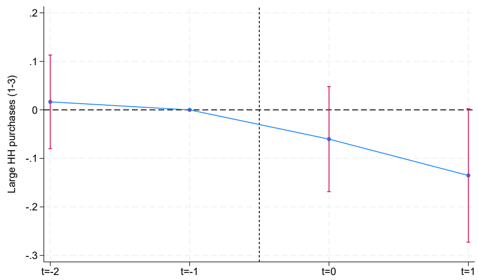
(b) Large HH purchases - Women



(c) Visits family relatives - Women



(d) Manage women money - Women



(e) Large HH purchases - Men

Note: The figure shows the dynamic effects of 3G network availability at the time of the survey on bargaining power within the household for women and men using the estimator presented in Chaisemartin and D'Haultfœuille (2020). 3G availability is defined as the share of the population in a county (LGA) covered by 3G. Data used include the Nigerian Demographic and Health Surveys, rounds 2003, 2008, 2013, and 2018. The bars represent 95% confidence intervals.

Appendix B 3G network availability, support for FGC, and sexual behavior: 3G availability defined at the individual level

In this appendix, we explore the association between 3G network availability, support for FGC, sexual behavior and other outcomes using an alternative empirical approach. Rather than using the share of individuals in the county (LGA) with 3G network available at the time of the survey, we define an alternative measure of treatment exposure based on whether the individual lives in a village with 3G network available at the time of the survey. Specifically, we estimate the following regression:

$$\begin{aligned} Outcome_{ilt} =& \delta_0 + \delta_1 3G\ network\ available_{it} + \delta_2 Never\ received\ 3G\ network_i \\ &+ Year\ of\ interview_t + \nu_l + u_{ilt} \end{aligned} \tag{5}$$

where $Outcome_{it}$ indicates the outcome of interest for individual i, living in county (LGA) l and interviewed in year t. *3G network available*$_{it}$ is a dummy variable that indicates whether individual i interviewed in year t has 3G network available. *Never received 3G network* is a dummy variable equal to 1 if individual i lives in a location that never received 3G during the study period. *Year of interview*$_{it}$ and ν_l are year-of-interview (survey) and county fixed effects. u is the error term. Standard errors are clustered by county. The main parameter of interest is δ_1, which measures the association between the availability of 3G network and the outcome of interest.

Unlike in the main analysis, where exposure to 3G is measured as the share of individuals in the county with 3G network availability, exposure to 3G networks in this analysis is defined at the individual level based on the geocoded location of villages or neighborhoods. However, this approach is problematic because individuals and villages in the sample are only interviewed once during the study period. Thus, the empirical framework used is not a difference-in-differences and the causal interpretation of the analysis does not rely on the parallel trends assumption. Rather, the interpretation of δ_1 as the causal effect of 3G network availability on the outcome of interest mainly relies on no unobservable variables correlated with both timing of 3G network expansion and the outcome of interest. To limit endogeneity concerns, we introduced a variable indicating whether individual i lives in a location unexposed during the study period, which implies that the variation used for the identification of the parameter of interest δ_1 comes from individuals living in locations that at some point during the study period received 3G network, but that were interviewed either before or after the arrival of the network.

The results of these estimations broadly support the main conclusions of the study. The estimates for FGC support are reported in Table B1, showing negative associations between availability of 3G networks and both measures of the support for FGC, which are mainly driven by women.

Also in line with the evidence provided above, the results reported in Table B2 show that the availability of 3G networks is associated with a higher age at marriage and a higher number of lifetime sexual partners for women, and a lower age at first intercourse for men. Like in the main analysis, there is no association between 3G availability and wealth or labor force participation for both men or women.

Table B1: 3G network availability at the time of the survey and support for FGC: Individual level exposure to 3G network

	All		Women		Men	
	Support for FGC (1-3)	Support for FGC (0/1)	Support for FGC (1-3)	Support for FGC (0/1)	Support for FGC (1-3)	Support for FGC (0/1)
	(1)	(2)	(3)	(4)	(5)	(6)
3G available	-0.095***	-0.051***	-0.057**	-0.024	0.020	-0.010
	(0.029)	(0.015)	(0.027)	(0.014)	(0.090)	(0.048)
N	83,039	83,039	61,038	61,038	21,996	21,996
Mean dep var.	1.542	0.307	1.534	0.306	1.564	0.310

Note: Columns 1-6 estimate the association using OLS between 3G network availability at the time of the survey measured at the individual level and the support for FGC among women aged 15-49 and men aged 15-59 surveyed in DHS rounds 2003, 2008, 2013 and 2018. In Panel A *Support for FGC* is a discrete variable that takes the value of 1 if individual does not want FGC to continue, 2 if depends, and 3 if respondent wants the practice to continue. In Panel B, *Support for FGC* is a dummy variable that takes the value of 0 if individual does not want FGC to continue, and 1 if individual responds depends or wants the practice to continue. The regressions estimated include LGA fixed effects, year of interview fixed effects, and a dummy variable indicating whether the village of residence did not receive 3G during the study period. Thus, the variation used in the estimations arises from locations that at some point receive 3G network during the study period but were interviewed either before or after the arrival of 3G network. Columns 1 and 2 report the results using the full sample, Columns 3 and 4 report the results using the sample of women, and Columns 5 and 6 report the results using the male sample. Standard errors are clustered at the LGA level. ***p<0.01; **p<0.05; *p<0.1.

Table B2: 3G network availability at the time of the survey and sexual behavior outcomes, labor force participation, and household wealth: Individual level exposure to 3G network

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Age at 1st marriage	Age at 1st intercourse	N lifetime sexual partners	N lifetime sexual partners (excluding husb.)	N sexual partners (last 12m excluding husb.)	Used condom last relation (0/1)	Labor force participation	HH wealth
Panel A: Women								
3G available	0.262**	-0.000	0.244*	0.205	-0.000	-0.011**	0.001	0.009
	(0.103)	(0.082)	(0.133)	(0.136)	(0.008)	(0.005)	(0.012)	(0.033)
N	90,609	97,002	112,213	112,106	120,587	91,717	120,516	120,998
Mean dep var.	17.938	16.822	1.480	0.621	0.104	0.064	0.616	-0.018
Panel B: Men								
3G available	-0.101	-0.285*	-0.062	-0.149	-0.028	-0.048***	0.016	-0.009
	(0.192)	(0.166)	(0.180)	(0.178)	(0.019)	(0.014)	(0.013)	(0.037)
N	27,181	34,670	44,397	41,633	47,943	32,929	48,051	48,173
Mean dep var.	25.286	20.323	3.174	2.409	0.256	0.177	0.811	0.044

Note: Columns 1-8 estimate the association using OLS between 3G network availability at time of survey measured at the individual level and sexual behavioral outcomes, household wealth, and labor force participation for women aged 15-49 and men aged 15-59 surveyed in DHS rounds 2003, 2008, 2013 and 2018. The regressions estimated include LGA fixed effect, year of interview fixed effects, and a dummy variable indicating whether the village of residence did not receive internet during the study period. Thus, the variation used in the estimations arises from locations that at some point receive 3G network during the study period but were interviewed either before or after the arrival of 3G network. Panel A reports the results using the sample of women, and Panel B reports the results using the male sample. Standard errors are clustered at the LGA level.***p<0.01; **p<0.05; *p<0.1.

Appendix C What internet content is normalizing premarital sex?

This appendix explores which specific types of internet content may be driving the change in sexual behavior and contributing to the erosion of premarital sex stigma. To address this question, we conduct the following analyses. First, we conduct focus groups in 8 rural communities in the areas of Calabar and Abuja. Second, to shed further light on the results of the qualitative research, we use Google searches to provide a broader picture about internet content consumed in Nigeria. Finally, we revisit the existing literature on the effects of internet content on sexual behavior and discuss the feasibility of the qualitative findings.

C.1 Qualitative research

In December 2024, we conducted 10 focus groups throughout 8 rural communities, gathering the views from 65 Nigerian women and 3 men in rural areas of Abuja and Calabar. Additionally, we conducted in-depth interviews with 6 Christian and Muslim religious and traditional leaders. The communities surveyed in the area of Calabar were Christian, predominantly from Efok, Ekoi, and Ibibio ethnicities. In the area of Abuja, we visited Igbo, Yoruba and Hausa rural communities. Individuals living in these rural communities near Abuja were eminently internal migrants that moved from Igboland (east), Yorubaland (south west), and the North of the country in search for better economic opportunities and security in the last few years.

Each focus group lasted for approximately 1 hour and a half, and while fluent English was spoken by most of the participants, the research team —two of the study authors— was supported by a local translator that also facilitated the focus groups. The discussions were mainly focused on internet use and their perceived effects of internet on social norms, particularly on sexual behaviors and stigmas.

Participants in the focus groups emphasized three main internet uses. First, communication with friends and family living outside the community. Second, they reported using internet for entertainment such as films, music, and social media. While the specific content varied across age groups, both younger and older women appeared to use the internet for similar purposes, though the consumption of Western cultural content was more prevalent among the younger participants. Third, most participants also use internet to access updated information, particularly news media and weather forecasts. Finally, some focus groups also highlighted educational and business-related uses of the internet among some participants.

And what were the perceived effects of internet on sexual behavior? Despite coming from a wide range of ethnic groups throughout the country, the women interviewed offered remarkably similar accounts about how the expansion of internet access—mostly through smartphones since the early 2010s—has reshaped social norms, particularly around premarital sex. Once widely stigmatized and associated with shame or a loss of family honor, premarital sex is now increasingly seen as a normal part of youth life, especially among younger generations. In Christian communities, it was consistently described as "the new normal," noting that young people face little, if any, social sanction from families or traditional leaders. This stands in sharp contrast to a few years ago, when such behavior could damage a girl's marriage prospects or trigger strong parental discipline. In Muslim communities, while premarital sex is reportedly on the rise among young people as well, it remains a sensitive and taboo topic for religious leaders. This rapid change is generating tensions in some Muslim communities, particularly with traditional and religious leaders who continue to strongly oppose such practices.

When asked what specific online content was triggering the shift in sexual norms and behaviors, the women interviewed highlighted two types of content. The first includes films, music, and social media posts depicting Western cultural content in which premarital sex is portrayed as normal. The second consists of films and other content that depict nudity or explicit sexual acts. Many emphasized that "young people do everything they see online"—not just in terms of sexual behavior, but also in how they dress, the music they listen to, and how they interact with others. Respondents described this exposure as a key factor triggering the observed changes in behavior, by introducing new role models and reshaping perceptions of what is normal or acceptable. While television was occasionally mentioned, it was consistently described as less influential due to shared viewing spaces and greater family oversight. In contrast, mobile phones provide private, unregulated access to global content, which respondents identified as central to the speed and depth of these transformations—even in communities that, until recently, were relatively isolated.

Additionally, although religious and traditional leaders continue to denounce premarital sex—particularly in Muslim communities—their influence appears to have weakened. In some cases, interviewees pointed to inconsistencies between leaders' messages and their own behavior. As a result, religious discourse remains present but is perceived as less effective in regulating sexual behavior.

Beyond sexual norms, internet access has brought both opportunities and concerns. On the positive side, it facilitates communication—especially with migrants—, access to information, and educational or commercial activities. Some respondents praised its value for business, learning, and staying connected with the wider world. At the same time, internet use is frequently associated with moral decline. Terms like "corruption" or "copying bad behavior" appeared in nearly all discussions, typically referring to sexual content, fraudulent schemes, and a general departure from local customs and values.

In multiple interviews, internet access was also linked to rising rates of teenage pregnancy and out-of-marriage pregnancies. While poverty and parental neglect were also cited as contributing factors, many participants stressed that exposure to sexual content online encourages early sexual activity. Interestingly, a few women in Christian communities noted that among educated young women, internet access could also have protective effects by increasing knowledge about contraception.

C.2 Google trends analysis

While the results of the qualitative research presented above emphasized the powerful influence of both Western cultural content and sexually explicit content in shaping young people's behavior, it remains important to ask whether access to such content is, in fact, widespread in Nigeria. To explore this question, we examined the

200 most searched terms on Google in Nigeria.[57] Among these we identified some expected terms related to news, social media, films, popular national media, and UK and Spanish football. We also found several terms that may help understand how Nigerians are exposed to Western cultural content, such as YouTube, Instagram, Facebook, and websites providing pirated access to films. Moreover, among the 200 most cited terms, we identified 11 pornographic websites, which together account for more than 14.6 million searches per month. This figure refers only to Google searches—actual traffic to websites is likely to be significantly higher, as many users access them directly or through other platforms.

Figure C1: 20 most searched terms in Google

KEYWORD	VOLUME
livescore	9,140,000
sportybet	7,480,000
translate	6,120,000
flashscores	6,120,000
bet9ja shop	5,000,000
bet9ja	5,000,000
bbc hausa	5,000,000
facebook	4,090,000
flashscore mobi	4,090,000
xnxx	4,090,000
livescore cz	3,350,000
betking	3,350,000
whether	2,740,000
weather	2,740,000
porn	2,240,000
youtube	2,240,000
man united	1,830,000

Note: The figure depicts the most 20 searched terms and the approximate volume of monthly searches in Nigeria in 2024.

C.3 Discussion and previous evidence on the effects of exposure to Western cultural content and sexually explicit content

The vast majority of women interviewed identified two important triggers of the normalization of premarital sex: (1) Western cultural content in which premarital sex is portrayed as normal, and (2) sexually explicit content. While we cannot test the specific effects of these types of content in our setting, is there any evidence on the effects of exposure to these contents?

Regarding the effect of exposure to Western cultural content, a few studies show that exposure to Western media can transform beliefs and behaviors, bringing them more in line with the values portrayed in these media. Jensen and Oster (2009)

[57] Figure C1 shows the 20 most searched terms and the approximate volume of monthly searches in Nigeria.

shows that access to cable TV in India reduced the acceptability of wife beating, lowered the reported preference for sons, increased female school enrollment, and decreased fertility. La Ferrara et al. (2012) shows that soap operas portraying small families led to lower fertility. However, media can also backfire: Blumenstock et al. (2022) shows that, in Pakistan, exposure to Western media increased voting for religious parties and enrollment in religious schools.

A growing body of literature indicates that exposure to sexually explicit content is associated with shifts in sexual norms and behaviors, including a greater acceptance of premarital sex and earlier sexual initiation. A systematic review by Pathmendra et al. (2023) synthesizes the existing evidence and concludes that higher levels of pornography exposure are consistently associated with a younger age at first sexual intercourse. Supporting this pattern, Brown et al. (2006) find that exposure to sexual content accelerates adolescents' sexual activity and increases their risk of engaging in early sexual intercourse. Beyond behavioral outcomes, Peter and Valkenburg (2008) show that pornography consumption has been linked to heightened sexual preoccupation and Vandenbosch and Eggermont (2015) document that exposure to pornographic websites is directly associated with the internalization of appearance ideals, self-objectification, and increased body surveillance, highlighting the broader influence of pornography on adolescents' sexual self-concept and body image.

But why exposure to sexually explicit content might affect sexual behaviors? Different mechanisms have been proposed in the literature. First, pornography often serves as a form of informal sex education, shaping young people's beliefs about what is typical or acceptable sexual behavior. Second, sexually explicit content may encourage behavioral imitation (or copy-cutting), as adolescents replicate the sexual acts, roles, or dynamics they observe, assuming these portrayals reflect real-life expectations. Third, exposure to sexually explicit content can lower perceived social and psychological barriers to engaging in sex by framing it as casual, risk-free, and universally practiced. Fourth, repeated exposure may lead to desensitization, weakening internalized moral or cultural norms and shifting perceptions of peer behavior. Finally, sexually explicit content can elicit sexual arousal, which may heighten short-term motivation to initiate sexual activity, particularly in contexts where opportunities are available.

While our qualitative results show that exposure to sexually explicit content is perceived by the local population as a key contributor to the normalization and destigmatization of premarital sex—with implications for practices such as female genital cutting—our aim is to explain observed patterns, not to make normative judgments about this content. We neither endorse its use nor propose it as a policy tool, and we do not overlook the potential harms associated with it. A substantial body of research has documented associations between pornography consumption and a range of adverse outcomes, including increased sexual aggression (Waterman et al., 2022; Wright et al., 2016), aggressive attitudes and behaviors (Zhou et al., 2021), and poorer mental health indicators (Setyawati et al., 2020). Although causality remains difficult to establish due to methodological constraints, these findings highlight legitimate concerns about the possible negative consequences of exposure to sexually explicit content, particularly during adolescence.

Appendix D The effect of rainfall shocks on FGC in Nigeria

One potential mechanism driving the effect of 3G network on FGC is an increase in income. If 3G networks increase household income (Bahia et al., 2024) and FGC increases a daughter's value in marriage (i.e., leading to a higher bride price) (Khalifa, 2022; García-Hombrados and Salgado, 2022), parents at the margin of cutting their daughters might decide to stop the practice because the additional income from 3G compensates for the loss of income associated with not having their daughter subjected to FGC. The latter mechanism implies that 3G might decrease the prevalence of FGC even if it does not reduce the support for this practice.

To test this hypothesis, we examine in this appendix the effect of a pure income shock on FGC, specifically rainfall shocks. If a pure income shock does not affect the prevalence of FGC, it is unlikely that the effect of 3G on FGC is solely driven by a rise in economic welfare. To this end, we replicate the analysis conducted by McGavock and Novak (2023), focusing on Nigeria. The latter paper assesses the effect of rainfall shocks during the age of risk of FGC on the prevalence of this practice in sub-Saharan Africa. Following McGavock and Novak (2023), we estimate the following equation using Nigerian data:

$$FGC_{ibv} = \delta_0 + \delta_1 Rainfall\ shock_{bv} + \theta_b + \gamma_v + u_{ibv} \tag{6}$$

where *Rainfall shock* is equal to 1 if the annual precipitation in cluster v during the year of birth b was below a certain percentile of the gamma distribution of the historical rainfall in the cluster.[58] Because the typical age at cutting varies across sub-Saharan African countries, McGavock and Novak (2023) focuses on rainfall shocks during the year the girl reached the first percentile of the distribution of age at FGC. Given that in Nigeria, more than 80% of the cuts occur within the first year of life, we focus on rainfall shocks during the year of birth. θ_b and γ_v are survey cluster and year of birth fixed effects. u is the error term.

The results of this analysis are reported in columns 1–4 of Table D1, using different percentiles of the historical rainfall distribution within the village to define negative economic shocks. Our findings show that the estimated coefficients of rainfall shocks across these different definitions are negative and mostly not statistically different from zero. These results suggest that, if anything, negative economic

[58]The rainfall information was provided by Lindsey Novak and Tamara McGavock, who constructed a database on annual precipitation in DHS clusters between 1900 and 2017 using monthly precipitation information gathered by the University of Delaware at the 0.5 x 0.5 degree grid.

shocks reduce the prevalence of FGC, supporting the hypothesis that positive economic shocks are unlikely to be a major driver of the effects of 3G on FGC. Our results align with those of McGavock and Novak (2023), who find that, in some settings, negative economic shocks increase FGC prevalence, but observe no effect for ethnic groups where cutting occurs early in life, as in the case of Nigeria.

As an additional empirical exercise, we re-estimate equation 1 including rainfall shocks as an additional control variable to assess whether meteorological shocks could confound the effect of 3G availability. Column 5 in Table D1 shows the benchmark estimation of the effect of 3G availability at the time of birth reported in Table 2, while column 6 reports the same estimation including rainfall shocks as a control variable. The estimates are virtually identical, reassuring that rainfall shocks are not confounding the main results of the study.

Table D1: Effect of adverse rainfall shocks at the time of birth on the probability of FGC in Nigeria

Dep var: FGC (0/1)	(1)	(2)	(3)	(4)	(5)	(6)
Adverse rainfall shock	-0.002	-0.011	-0.012*	-0.003		
	(0.012)	(0.007)	(0.006)	(0.006)		
3G available					-0.023***	-0.023***
					(0.005)	(0.005)
Rainfall percentile defining drought	Lowest 5%	Lowest 10%	Lowest 15%	Lowest 20%		
Rainfall shock control					No	Yes
N	63,760	63760	63,760	63,760	63,760	63,760
Mean dep. var	0.169	0.169	0.169	0.169	0.169	0.169

Note: Columns 1–4 report the estimated impact of rainfall shocks at the time of birth on the probability of undergoing FGC. Rainfall shocks are defined as years in which rainfall falls within the lowest 5%, 10%, 15%, and 20% of the historical distribution of rainfall within a cluster, corresponding to columns 1 through 4 respectively. Column 5 reports the benchmark estimation of the effect of 3G availability at the time of birth on FGC. Column 6 reports the main estimation of the effect of 3G availability at the time of birth on the probability of FGC, including rainfall shocks as a control variable. Rainfall shocks in this specification are defined as years in which rainfall falls within the lowest 15% of the historical distribution of rainfall within each cluster. ***p<0.01; **p<0.05; *p<0.1.