Economic Shocks and Risky Sexual Behaviours

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Abstract

HIV prevention remains critical in tackling HIV as a public health threat. Vast gender inequalities in acquiring new infections across Africa mean young women face a disproportionately higher risk of acquiring HIV than their male counterparts. This thesis aims to improve understanding and generate new evidence on the link between economic vulnerability and HIV transmission among women in Africa. It applies economic theory to empirically explore how incentive structures surrounding risky sex can be leveraged to smooth consumption for women and their families during economic shocks.

This thesis comprises four original research papers. The first research chapter is a systematic literature review investigating the role of economic shocks on risky sexual behaviours, revealing that persistent negative economic shocks consistently lead to behaviours that increase HIV risk; however, positive shocks, mainly unconditional cash transfers, typically lack the size and targeting required to elicit a protective response. The three empirical papers are preceded by a conceptual framework chapter that conceptualises the use of risky sexual behaviours, including transactional and commercial sex, for consumption smoothing. The second research paper is an empirical investigation of the impact of Tabaski, a religious festival celebrated in West Africa, upon risky sexual behaviours using primary data from an observational study of female sex workers in Dakar, Senegal. It finds condomless sex, measured robustly using the list experiment, falls by between 27.3 percentage points (65.5%) and 43.1 percentage points (22.7%) in the nine days before Tabaski, or a maximum of 49.5 percentage points (76%) in the week preceding Tabaski. The third paper studies the impact of out-of-pocket health expenditure shocks on condomless sex again within the same sample of female sex workers in Dakar. This uses the same dataset as the previous research paper finding that female sex workers utilise increased sex work as their primary form of coping with out-of-pocket health expenses and that these health shocks lead to between a 62% and 70% decrease in condom use during their last sex act. The final research chapter utilises Demographic Health Surveys to investigate the impact of drought on the prevalence of transactional sex and its role in HIV in Africa. It finds increases in the prevalence of transactional sex for women by around 35%, rising to 50% for those in rural areas suffering droughts. It also provides evidence that increases in transactional sex account for a small but meaningful proportion of the increase in reported STI symptoms and HIV. The thesis demonstrates that economic marginalisation in the absence of formal safety nets leaves many women in Africa at risk of engaging in commercial and transactional relationships, plus the incentive for condomless sex, significantly increasing their exposure to and risk of HIV.

The main lesson from this thesis is that policy should focus on smoothing the economic variability faced by women in Africa to avoid the need to use risky behaviours to support themselves. Policy to protect women needs to increase their economic resilience to cope with income fluctuations but also target support around specific shocks such as Tabaski, health expense shocks and consequences of climate change. The findings suggest that women engaged in transactional sex are at high risk of HIV and should be considered a key population to reduce the disproportionate HIV infections among young women and continue the ongoing fight against HIV.

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List of abbreviations

ART	Antiretroviral Therapy
CCT	Conditional Cash Transfer
CNERS	National Ethics Committee for Health Research in Senegal
DHS	Demographic Health Survey
FSW	Female Sex worker
GDP	Gross Domestic Product
GPCC	Global Precipitation Climate Centre
HIV	Human Immunodeficiency Virus
IPV	Intimate Partner Violence
MSM	Men who have Sex with Men
PrEP	Pre-exposure prophylaxis
SSA	sub-Saharan Africa
LMIC	Low- and middle-income country
LSHTM	London School of Hygiene and Tropical Medicine
NGO	Non-governmental organisation
OLS	Ordinary least squares
OPP	Out-of-pocket payments
SPI	Standardised Precipitation Index
STI	Sexually Transmitted Infection / Disease
UCL	University College London
UDEL	University of Delaware

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Chapter 1 - Introduction

1.1 Introduction

This thesis sets out to improve our knowledge and understanding of the role of economic shocks in the transmission of HIV and other sexually transmitted diseases in low- and middle-income countries (LMICs), focussing on sub-Saharan Africa (SSA). It explores if and how economic incentives, facilitated by economic and structural gender inequalities, cause economically vulnerable women to engage in risky sexual behaviours to cope with economic shocks, putting themselves and their sexual partners at risk of HIV. It seeks to identify the impacts of economic vulnerability through the realisation of economic shocks as exogenous changes in net income, driving risky sexual behaviours of primarily female sex workers (FSWs) in Senegal and women and men across SSA.

1.1.1 A brief history of HIV in sub-Saharan Africa

The earliest confirmed case of HIV was found in the Democratic Republic of Congo in 1959. By 2002 71% (28.5 million) of people living with HIV were in SSA, becoming the largest cause of death in the region (UNAIDS 2002). Prevalence in SSA peaked around 5-6%, with southern and eastern regions of Africa the worst affected. Botswana, Lesotho, Eswatini, and Zimbabwe's highest prevalence were estimated at almost 30%. By 1996 antiretroviral therapy (ART) was found to be highly effective in treating HIV and reduced death and hospitalisation by up to 80% in high-income countries. However, approximately ten years later, less than 5% of those requiring ART in SSA have adequate access. Up to the early 2000s, the economic and political costs to subsidise life-saving drugs for SSA were too great for pharmaceutical companies and high-income governments, restricting supplies reaching Africa and worsening the HIV crisis and leading to millions of preventable deaths on the continent (Bendavid et al. 2010; Menzies, Berruti, and Blandford 2012; McNeil 2019; Walensky et al. 2013). As well as improving the quality of life of HIV patients, ART and other treatments were more recently found to prevent ongoing transmission but only when coverage and adherence are high (Cohen et al. 2016; Muessig and Cohen 2014; Anglemyer et al. 2013). Due to the vast costs, achieving wide enough coverage in SSA was impossible, despite strong warnings of the potential damage of inaction (Whiteside

2001). Action, therefore, focussed on prevention rather than treatment (Canning 2006). Over time, changing perceptions, increased competition from smaller pharmaceutical companies and greater accountability[1] (McNeil 2019) led to ART becoming economically available in Africa and other LMICs. Between 2005 and 2007, coverage increased rapidly for those needing treatment (World Bank 2020). Between these dates, coverage rose rapidly from 2% to 10% leading to today, where it is estimated that 87% of those living with HIV know their HIV status, 76% to 83% were on ART, and 90% of those are virally suppressed (Cornell et al. 2021; World Bank 2020). However, this means that around 5 million African people still cannot access ART drugs and remain at great risk of transmission. In Africa, UNAIDS warns that gains on HIV, health and development have overlooked many groups in greatest need. Key populations, namely FSWs, men who have sex with men (MSM), people who inject drugs, transgender women and prisoners, plus larger groups such as adolescent girls and young women and other marginalised groups have the highest risk of acquiring HIV and are at risk of being left behind.

HIV remains a main global health challenge in the early 21st century: 38.4 million [33.9 million–43.8 million] people globally were living with HIV in 2021 – 20.6 million living in eastern and southern Africa (53%) (UNAIDS 2021). Outside of SSA, 93% of new infections are among key populations and their sexual partners. Evidently, with better access to ART, other treatments for high-risk individuals such as pre-exposure prophylaxis (PrEP), and HIV activism promoting patient-driven care alongside funding for HIV research, the risk to the general population has fallen worldwide. However, SSA is lagging behind – it remains the region with the highest HIV prevalence among the general population, where an estimated 26 million people are living with HIV (2017 estimate). It is also responsible for around two-thirds of global HIV infections, but only 39% are among key populations (UNAIDS 2022).

1.1.2 HIV Within SSA today

Within SSA, 4,200 adolescent girls and women are infected with HIV each week, with women aged 15-24 twice as likely to be living with HIV than men of the same age. Figure 1 shows the ratio of HIV prevalence of women to men across Africa. Of all infections among adolescents aged 15-19, six in seven are among women (UNAIDS 2021). Risky sexual behaviours in heterosexual relationships are a crucial driver in the transmission of HIV, and women who have ever engaged in transactional sex are 50% more likely to be living with HIV than those who have not (UNAIDS

[1] Including projects such as https://accesstomedicinefoundation.org/

and Strive 2018). As a key population, FSWs today have 26 times the odds of acquiring HIV than their peers, up from 13 times in 2008, with prevalence among FSWs as high as 50% in some SSA countries (UNAIDS and Strive 2018; Baral et al. 2012; UNAIDS 2021).

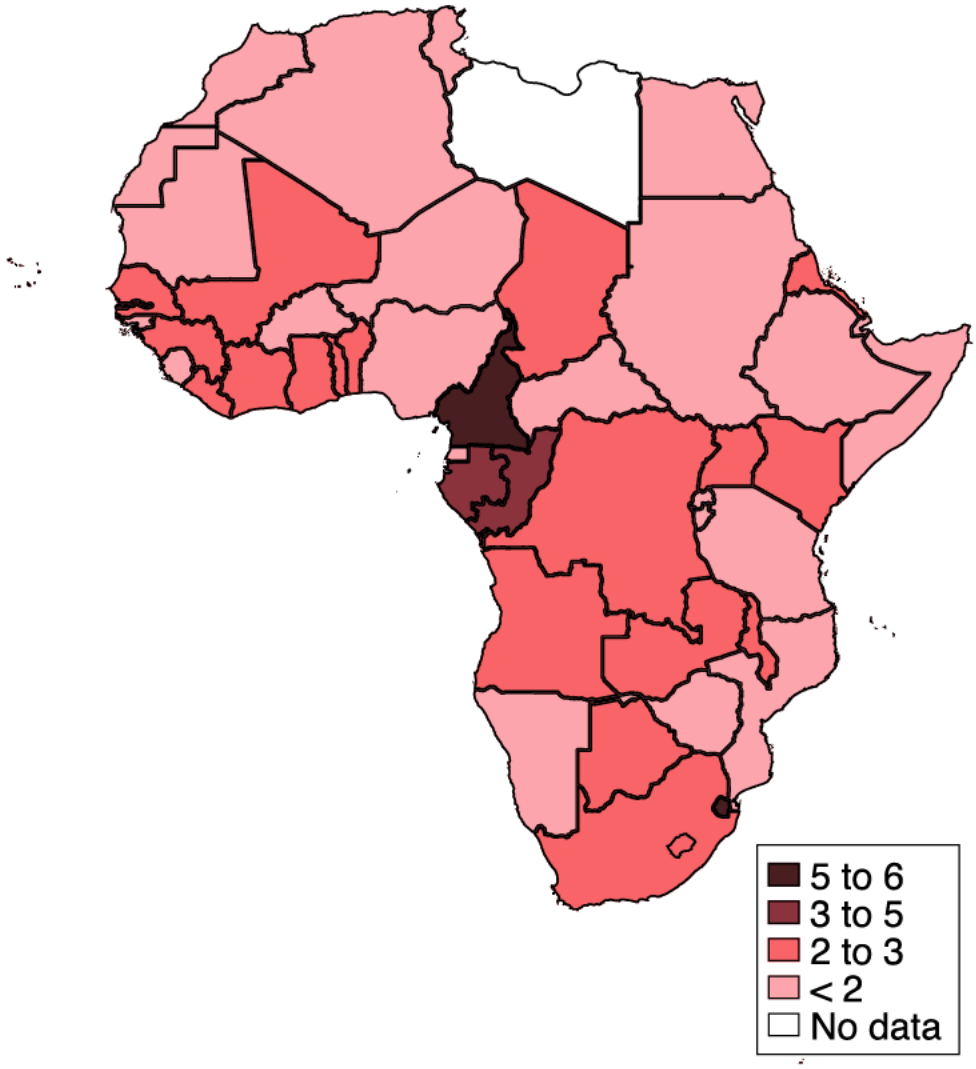

Figure 1.1: Female to male ratio of HIV prevalence (15-24 years) (Lépine 2019)

Adolescent girls and young women bear the brunt of new HIV infections. Not only does HIV affect the quality and length of life of those with the disease, but it also has negative externalities for all of society. Those immediately connected with HIV-positive people, such as sexual partners and unborn children, are at increased risk of HIV. Families feel the impacts of the economic costs of medications and reduced earning potential, and even HIV-related stigma. Further afield, communities are also put at increased risk of HIV, and countries must bear the collective cost of maintaining HIV-positive members of society, money that could be spent on other desperately needed public services. For young women, structural inequalities make the impacts of HIV even more acute.

In tackling HIV in SSA, UNAIDS (2022) recognises that improved access to treatment and reducing country-level viral load is essential. However, vast resources are required to maintain a large HIV-positive population and target PrEP when large chunks of the population are at risk, resources that SSA countries alone cannot dedicate. Support of external donors and non-governmental organisations (NGOs) is required to make up the difference, particularly in the wake of the COVID-19 pandemic and associated economic fallout. However, cuts in and withdrawal of funding threaten to put much of the gains against HIV at risk (Silhol et al. 2021). Therefore, in SSA, HIV prevention is recognised as a crucial element of tackling HIV. Prevention forgoes the vast costs of maintaining a growing population of HIV-positive individuals that would threaten the sustainability of Africa's already fragile health systems.

1.2 Outline of the Thesis

The thesis comprises the following nine chapters.

Chapter 1 – "Introduction", describes the current HIV epidemic focusing primarily on SSA and the disproportionate burden on young women and key vulnerable populations.

Chapter 2 - "Literature Review", starts by covering the existing literature on economic shocks covering key definitions, concepts, and methods of measurement, highlighting gaps in the literature surrounding types of economic shocks and missing causal pathways. It then covers key literature on the non-sexual impacts of economic shocks on vulnerable households.

Chapter 3 introduces the first research paper: "Economic shocks and Risky Sexual Behaviours: A Systematic Review of the Literature", published in the Journal of Development Effectiveness. This paper covers all literature examining the risky sexual behaviour impacts of economic shocks so far, considering the conceptual and empirical contributions to help inform the proceeding chapters. This chapter concludes with a post-script that addresses some key literature on behavioural interventions and protections that were excluded from the research paper but are highly relevant for this thesis.

Chapter 4 – "Conceptual Framework", details a conceptual framework to understand the relationships and incentives at work and helps frame what the empirical research intends to test. Each empirical chapter focuses on testing different implications of this framework.

Chapter 5 – "Methods", briefly introduces the quasi-experimental study designs to evaluate the causal impacts of economic shocks using natural experiments. Next, details of primary data collection in Senegal are discussed, followed by descriptions of the Demographic Health Survey (DHS) and precipitation datasets used. Statistical and empirical methods key to the empirical research are covered in additional detail than can be afforded in their respective research papers.

Chapter 6 – "Research Paper 2: Trading HIV for Sheep" is the second research paper and first empirical examining the effect of a religious festival, Tabaski, as an anticipated economic shock on condomless sex using a sample of FSWs in Dakar, Senegal.

Chapter 7 – "Economic shocks and condomless sex in FSWs in Senegal", is the second empirical results chapter. It includes a descriptive analysis of the range of economic shocks suffered by FSWs in an urban context, followed by an empirical analysis of their behavioural response to illness in the household as an unanticipated economic shock.

Chapter 8 – "Weather Shocks and Transactional Sex", is the third research paper and third empirical chapter examining drought as a cause of transactional sex in SSA. It utilises the DHS datasets from eight countries linked to precipitation data linking drought causally to transactional sex and HIV in men and women across the continent.

Chapter 9 – "Discussion and Conclusion", summarises the findings concerning the thesis objectives. It reflects upon the thesis's strengths and limitations before discussing implications for the literature, policy and future research.

The appendix includes an additional research paper written outside of the PhD but remains relevant to the contribution and conclusions of the thesis. Where relevant, this paper is referred to in the text directly.

1.3 Aims and Objectives

The aim of this thesis is to generate new evidence on the role of economic shocks in driving risky sexual behaviours and their contribution to unequal HIV transmission in Africa. Below are five research objectives investigated in this thesis, the final three of which involve generating empirical evidence.

1) To conduct a systematic literature review examining the effects of economic shocks on risky sexual behaviours, STIs and HIV in low- and middle-income countries.
2) To generate a conceptual framework that explains the role of the risk premium in creating an environment for women to use risky sexual behaviours within commercial and transactional sexual relationships to cope with economic shocks.
3) To empirically determine the effect of an anticipated economic shock on risky behaviours amongst FSWs in Senegal.
4) To empirically determine the association between an unanticipated illness shock and risky sexual behaviours amongst FSWs in Senegal.
5) To examine whether drought-induced economic shocks lead to greater transactional sex in sub-Saharan Africa.

This thesis contributes to understanding HIV transmission in Africa's most vulnerable groups to aid in efforts to end HIV as a public health threat by 2030. It builds on evidence that risky sexual behaviours are used as a consumption-smoothing mechanism in the face of economic shocks. By examining the impact of a religious festival and health expense shocks in Senegal and drought across SSA through the lens of economically vulnerable women, it generates conceptual and empirical evidence that policymakers can use to protect those most in need.

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Chapter 2 - Literature Review

This chapter reviews the theoretical and empirical literature on economic shocks and risky sexual behaviours. This chapter has five sections. The first section covers key concepts pertinent to this thesis. The second covers the economic drivers of HIV and how the question has been addressed in the past literature as the epidemic has evolved. The third section addresses the theoretical and applied literature on risky sexual behaviours concerning HIV. The fourth covers the theoretical underpinnings of consumption smoothing in response to economic shocks. Finally, the fifth section concludes with the empirical literature on non-sexual coping strategies.

The literature review extends our understanding of economic shocks with respect to HIV and risky sexual behaviours, an important public health issue, by explaining how they impact households in LMICs through their use of sexual and non-sexual coping strategies and how shocks contribute to perpetuating poverty. It also demonstrates how people value their health and the economic underpinnings of engaging in risky sexual behaviours. The concepts and evidence in this chapter are used throughout the thesis to inform the conceptual framework and the design and implementation of research papers. It is worth noting that the thesis also includes a systematic literature review on the effects of economic shocks on risky sexual behaviours, STIs and HIV in low- and middle-income countries, but this is presented in Chapter 3 as a stand-alone research paper.

2.1 Key concepts

2.1.1 Commercial and transactional sex

FSWs and women who engage in transactional sex are vital to understanding the role of economic variability and economic shocks in HIV transmission. Previous literature often overlooked and conflated transactional sex with commercial sex or sex work more generally, however, they are distinct. Recent literature has focussed on re-examining these definitions to provide a more nuanced understanding of transactional relationships. Stoebenau et al. (2016) define transactional sex as: *"non-commercial, non-marital sexual relationships motivated by the implicit assumption that sex will be exchanged for material support or other benefits"*. It has three paradigms: "*Sex for basic need*" positions girls as using transactional sex to meet the basic needs for themselves and their families, "*Sex for improved social status*" positions women as agents engaging in transactional sex aspirationally, and finally "*sex and material expressions of love*" highlights men as providers in sexual relationships. The implicit nature of transactional sexual relationships sets them apart from the explicit and formalised negotiation of payment in sex work and commercial relationships (Overs 2002; Crankshaw and Freedman 2023). There exists a fuzzy boundary between the two, with sex work sitting at the extreme of the "*sex for basic need"* and "*sex for improved social status"* paradigms. Indeed, where sex work becomes a primary income source, sex workers are highly likely to self-identify, refer to partners as clients, be paid explicitly and immediately for sex acts, and far less likely to share emotional intimacy with their sexual partners (UNAIDS and Strive 2018). Commercial sex workers may have transactional relationships, but those engaged in exclusively transactional relationships rarely consider themselves FSWs and would not engage in commercial relationships. Therefore the distinction can come at the relationship level. Throughout this thesis, FSWs are assumed to be those self-identifying as such who participate in both types of relationships generating a significant portion of their household income or support from these relationships. Those engaging in or vulnerable to engaging in transactional relationships only are termed as 'vulnerable women', but when using the more general terms: 'sex work', 'transactional sex' or 'sex markets' it includes both types of relationships. This is an attempt to recognise the differences in how women view themselves whilst appreciating their common vulnerabilities to HIV through their behaviours not evident in previous literature (Stoebenau et al., 2016).

Whilst commercial sex is almost universally stigmatised across SSA (Jewkes et al. 2021; 2023), attitudes to transactional sex are far more varied and nuanced across the continent (UNAIDS and Strive 2018; McMillan, Worth, and Rawstorne 2018). Since the payoff within transactional relationships is not explicitly tied to the sex act itself, relationships are often emotionally intimate, and prevailing attitudes suggest men are expected to provide for their partners (Mensah 2020; Poulin 2007; Crankshaw and Freedman 2023). Therefore, in general, social attitudes are sometimes more relaxed towards transactional relationships. However, for FSWs and women in stigmatised transactional relationships, this stigma can lead to marginalisation, exclusions from health services, and low self-esteem, all of which increase the risk of HIV.

Key to the research is that women engaging in such relationships have the agency to do so (Freedman, Rakotoarindrasata, and de Dieu Randrianasolorivo 2021). Women engaged in relationships due to sex trafficking, modern slavery or through direct intimidation make up a small part of the population engaged in sexual exchange and do not face the same economic incentives and are, therefore, beyond the scope of this thesis (UNAIDS 2009; UNODC 2022).

2.1.2 Risky sexual behaviours

Risky sexual behaviours risk the health of the individuals engaged in them. They are often associated with a series of sexual, physical and mental health problems that are difficult to quantify. Risky sexual behaviours are therefore studied to increase our understanding of these distal health outcomes. With respect to HIV, direct risky sexual behaviours, such as unprotected sex and unprotected anal sex, increase the risk of contracting HIV from a seropositive person. There are several indirect risky sexual behaviours and other risk factors that are strongly associated with HIV and other direct risky behaviours but do not themselves lead to HIV. Examples include intimate partner violence (IPV) (Campbell et al. 2008), transactional sex (Kilburn et al. 2018; Jewkes and Dunkle 2012; Wamoyi et al. 2016), child marriage (Clark 2004; Isiugo-Abanihe 2006; Nour 2006), age-disparate relationships (Luke 2003; Schaefer et al. 2017), multiple and concurrent sexual partners (Halperin and Epstein 2004; Mah and Halperin 2010). Typically these behaviours increase the chance of unprotected sex with a seropositive man through expanding sexual networks and less control over protection decisions. Child marriage and age-disparate relationships mean women are with older men who have likely had more lifetime sexual partners and longer to have acquired HIV. IPV acts through several causal channels, including genital injury that increase transmission risk and diminished condom negotiating power, among others (Vetten and Bhana 2001; M Quaife 2018). Risky sexual behaviours acting as a proxy to biological measures that are more difficult to collect and analyse have become commonplace in the HIV literature and drive HIV policy in SSA.

Empirically, HIV prevalence appears in many datasets but is problematic to use in causal studies aiming to find reasons for infection, such as this thesis, since survivability confounds many studies. E.g. those who live the longest after contracting HIV and are more likely to appear in datasets are more likely to be wealthier, painting a biased picture of HIV being associated with wealth. In addition, there is bias resulting from non-random refusals to take HIV tests or report HIV status given the historic stigma in many countries against HIV, as seen in DHS surveys (Mishra et al. 2006). The ideal measure to study prevention is HIV incidence, but since HIV has a relatively low incidence rate, long periods of time and/or large samples are required for statistical strength. Risky sexual behaviours remain a solid indicator of HIV transmission, often used in conjunction with and instead of biomarkers.

In this thesis, outcomes relating to HIV across direct and indirect behaviour and health outcomes, either self-reported or from bio-markers, are considered. Typical behaviour outcomes are evaluated in the literature across the *extensive* margin, the extent to which a behaviour exists in a group or population; the *intensive* margin, how frequently an individual or group of individuals engage in certain behaviours. Not typical in the literature is the evaluation of *riskiness*, the risk level of sex acts within relationships. For example, the change from protected to unprotected sex. Whilst such outcomes are covered in the literature, see Chapter 3, this thesis treats the group of outcomes as a separate margin of understanding HIV risk because all three can be affected separately. It is plausible that the riskiness of behaviours increases, thus increasing HIV risk, without being observed on the *extensive* and *intensive* margins. For example, observing a greater proportion of unprotected to protected sex acts without observing an increase in the number of FSWs engaging in unprotected sex, nor an increase in the number of sex acts.

An issue using survey data with self-reported risky sexual behaviours is the threat of social desirability bias, a subset of sensitivity bias. These groups of biases mean researchers are worried about the answers to sensitive questions being inaccurate, and there is evidence since the 60s that misreporting is distorting the prevalence of sensitive topics (Maccoby and Maccoby 1954; A. Campbell et al. 1980). Social desirability bias covers the bias that leads respondents to report behaviours or traits that they believe are desirable to "avoid embarrassment and project a favourable image to others" (R. J. Fisher 1993)—differentiating between what is "social desirability bias" and what, more broadly ", sensitivity bias" is not clear cut. Any misreporting driven by wishing to appear more favourable would be the former and other motivations the latter. For example, the most common manifestation of social desirability bias is through managing others' impressions, i.e. reporting desirable behaviours to appear more favourable to interviewers or others who might learn their answers. Self-deception is more likely categorised as sensitivity bias, i.e., respondents misreport because they do not want to admit, even to themselves, that they participate in sensitive behaviours due to how they view themselves. Importantly, social desirability bias does not include bias beyond that of conformity to social norms, such as personal safety or because of perceived financial consequences (Blair, Coppock, and Moor 2020).

In SSA, where HIV and stigma are high, social desirability bias is also likely to be high, particularly in women who feel social pressures to conform more than men (Dalton and Ortegren 2011). Statistically, social desirability bias reduces the variability in outcome measures and risks underestimating effects through attenuation bias or bias estimates due to confounding. Indirect elicitation methods, such as the list experiment utilised in this thesis, improve prevalence estimates but have limitations and are unable to control for all forms of bias.

2.1.3 Economic shocks

Economic shock events are the realisation of economic uncertainty, and much public policy in high-income countries is focused on alleviating this variability at the individual- and economy-levels. This is because the consequences of the income shock and incurred expenditure on livelihoods damage economic growth and well-being of those suffering (Loayza et al. 2007). On one level, citizens of SSA suffer more from economic shocks because the governments do not have the fiscal capacity and social safety nets to protect them, and where protection does exist is not distributed equally or equitably. On the other hand, people living in many LMICs, particularly SSA, are increasingly subject to economic shocks from climate change (Haile et al. 2020). This thesis defines economic shocks across four dimensions pertinent to how women who engage in commercial or transactional sex cope with them. Previous literature typically focused on three dimensions, the *direction*, *magnitude* of the impact and *scale* of shocks. However, this thesis considers the *expectation* of the time a shock affects someone. The dimensions defining shocks are:

- Direction: If the shock has a positive or negative effect on household consumption,
- Scale: who is affected?
    - *Idiosyncratic* shocks affect individuals or households within a community,
    - *Covariate* shocks affect entire communities, villages, or sub-national units,
    - *Aggregate* shocks affect countries or regions, having macroeconomic implications,
- Magnitude: the size of the shock,
- Expectation: upon realisation of a shock, how long is it expected to last?
    - *Temporary*: Short periods with reduced net income,
    - *Persistent*: Medium-term periods of reduced net income, i.e. several months to a couple of years,
    - *Permanent*: net income expected to be permanently reduced.

Further discussion and analysis using this categorisation is found in Research Paper 1 found in Chapter 3.

2.2 Economic drivers of HIV

Previous studies examining the link between poverty, wealth and HIV infection have shown mixed results (Gillespie, Kadiyala, and Greener 2007; Hajizadeh et al. 2014). Wealth is positively associated with HIV in some countries and contexts (Shelton, Cassell, and Adetunji 2005; Fox 2010) but this does not tell the whole story. These studies use HIV prevalence, not HIV incidence, a relationship with wealth that is confounded by survivability and risk factors positively associated with wealth. Heterogeneous analyses shed more light; Magadi (2013) describe a negative relationship between wealth and HIV within urban areas, i.e. urban poor are at greater risk than non-poor urban people, but the positive relationship is maintained in rural areas that host the majority of SSA populations and are generally poorer than urban areas. Studies of mechanisms associated with wealth support these findings showing high-risk and well-paid workers, such as miners and military personnel, are associated with increased risky behaviour and attract higher-risk populations such as FSWs (Clift et al. 2003; Meekers 2000; Brodeur, Lekfuangfu, and Zylberberg 2018; Nwokoji and Ajuwon 2004). Mobility and transitory populations were studied through proximity to roads and found to be an important element to HIV risk. Roads are associated with higher economic activity, greater mixing of people and increased risk of HIV (Oster 2012a; K. S. Rao et al. 1999; Orubuloye, Caldwell, and Caldwell 1993; Lippman et al. 2007; Lagarde et al. 2003; Isdory, Mureithi, and Sumpter 2015). However, more recent work has shown that the positive link between HIV and wealth is weakening (Andrus et al. 2021). Some studies have pointed to economic inequality and poverty as more significant risk factors than wealth itself (Fox 2012; Fenton 2004), all of which point to a highly complex relationship that wealth alone inadequately describes.

Whilst economic activity and wealth play important roles in attracting vulnerable young women into activities like commercial and transactional sex, there is growing evidence that income variability, economic shocks, and poverty are more significant in driving HIV through unsafe sexual behaviours. The nexus of structural gender inequalities and economic shocks are likely the primary driver of transactional and commercial relationships and risky behaviours within them. African societies are largely patriarchal, meaning the economic and social odds are stacked against women. Many women lack comparable education and access to formal, well-paid, secure jobs and productive assets and therefore do not have the same ability to earn a secure income as men. Women who sit outside the typical husband-wife family structures, such as divorced, abandoned or simply those without a committed partner or parental support, are particularly vulnerable. The lack of economic opportunity is compounded by a lack of safety nets, characteristic of SSA (Banerjee and Duflo 2007; Dercon 2002), but particularly for marginalised communities such as FSWs (Nyabeze et al. 2021; UNAIDS 2018). Without alternatives, vulnerable women engage in transactional or commercial sex to satisfy their basic needs and support themselves and their families in times of economic shocks.

Many studies show that entry into sex work is driven by economic insecurity (McClarty et al. 2014; Scorgie et al. 2012; Gichane et al. 2020). Estimates for the number of young women engaged in transactional sex in Africa collated by UNAIDS and Strive (2018) range from 2.1% (Steffenson et al. 2011) to 52% (Juma et al. 2013). For young women and girls between 14-19 with more than one sexual partner, the prevalence was estimated to be as high as 81% in Malawi (Moore, Biddlecom, and Zulu 2007). Whilst definitions have more recently become more precise, variations in methods of collecting data and estimating transactional sex mean there is no definitive estimate for it's prevalence (Stoebenau et al. 2016).

The effect of transactional sex on risk women's health and well-being is less straightforward. Epidemiological evidence suggests that transactional sex is associated with HIV risk behaviours such as alcohol use, sexual or physical violence, inconsistent condom use and multiple partners (Stoebenau et al. 2016). Economic incentives drive these behaviours within transactional relationships, and poor protections for women mean these behaviours are compensated for by men (Cunningham and Shah 2011; Gertler, Shah, and Bertozzi 2005; Mac and Smith 2018; UNAIDS and Strive 2018). Indeed, female sex workers are observed to obtain a premium for unprotected sex acts across the world (Gertler, Shah, and Bertozzi 2005; V. Rao et al. 2003) that can be up to 81% more for condomless sex acts compared to protected sex acts (Islam and Smyth 2012). Risky sexual behaviours within transactional relationships present a way for women to earn additional money or protection, build economic resilience, and cope with economic adversity (Cust et al. 2021; Robinson and Yeh 2012). This risk premium is crucial in understanding why economic shocks are so important to HIV risk in young women.

2.3 Economics of Health and Risky Sexual Behaviours

2.3.1 Economic Theory of HIV and Risky Sexual Behaviours

The theoretical literature of HIV in SSA has focussed on attempts to model the differences in HIV prevalence between continents and within Africa itself through biological, structural and risky behaviours, paying particular attention to the stage of the epidemic that the continent was suffering at the time. Oster (2005) presents a theory and simulation model to explain the differences in HIV between the United States and SSA. She models the epidemic in terms of demographics, marital status, sexual behaviours (pre-marital, extra-marital sex and condom use), prevalence starting points and most importantly, transmission rate, the likelihood HIV spreads from one sexual partner to another. She postures that the critical difference between continents is the transmission rate driven by untreated STIs in SSA but that differences within Africa are due to epidemic timing and less so sexual behaviours. She argues that the most cost-effective approach to preventing infection is the treatment of these untreated STIs rather than costly ART. This work suggests that differences in risky sexual behaviours are not very significant in explaining differences in HIV prevalence at a time when there was little available treatment, low HIV awareness and high transmission rates.

Later Oster (2012b) details a theory of the response of risky behaviours to HIV prevalence through a theory of the relationships between risky sexual behaviours, life expectancy and HIV awareness to understand their contribution to the ongoing epidemic. The first of these relationships posits that risky behaviours fall as HIV prevalence increases; second, risky behaviours fall dependent on the length of non-HIV life expectancy; and third, risky behaviours fall given more accurate information on HIV and its transmission. To test this theory, she uses an instrumental variable approach to eliminate reverse causality that hampered prior literature. Her paper explains why risky sexual behaviours are so important in HIV differences across Africa as the epidemic moved forward and HIV prevalence diverges between African countries. Since this work, as predicted in the paper, many countries have reached their steady states of HIV infection and the link to education has faded with widespread HIV awareness and condom distribution. Education does remain relevant in promoting adherence to safe sex and treatment.

Later, as inequalities in HIV infection appeared, Duflo, Dupas, and Kremer (2015) presented a model of risky behaviour in response to subsidies for schooling and increased education (or information on HIV) through encouraging abstinence before marriage and safe sex. The model shows how STIs and pregnancy are influenced by unprotected sex but that the type of relationship influences them differently. *Committed* relationships sought by adolescent girls will increase the chance of pregnancy and lower the chance of STIs compared to girls who seek *casual* relationships. They test this theory using data from a long-running education subsidy programme in Kenya. As the epidemic has progressed, on average new HIV infections fall around this time, but inequalities against young women and girls persist. Understanding the interaction between risky behaviours and the type of relationships is crucial in understanding these inequalities and how transactional relationships contribute to HIV transmission today.

2.3.2 Theory of commercial sex

The most notable theoretical work focussing on entry to and markets for female sex workers in LMICs is from Edlund and Korn (2002). It argues that sex workers earn a relatively high wage for their skill level and describes sex work as deciding between marriage and being in the sex market.

This paper provides the first formal model describing the choice to engage in sex work but relinquishing the money they had received through marriage since sex workers cannot marry due to stigma and taboo (R. Arunachalam and Shah 2008). Key implications for the thesis are that the physical attractiveness and characteristics of the male population, or the pool of potential partners, are vital in maintaining commercial sex worker populations. For example, a high transitory male population implies a high wage can be earned with little prospect for marriage and explains why sex work is prevalent among transitory male populations. This theoretical advancement helps lay the foundation for much of the work on high-risk populations and their contribution to SSA, which Oster (2012a) expanded by linking economic activity to congregations of high-risk individuals. As previously mentioned, FSW populations have been found in numerous areas that attract high-risk but low marriage potential men (Clift et al. 2003; Meekers 2000; Brodeur, Lekfuangfu, and Zylberberg 2018; Nwokoji and Ajuwon 2004). Formal economic theory on transactional sex is missing from the literature, but more work does exist in health and HIV literature (Stoebenau et al. 2016; UNAIDS and Strive 2018). Chapter 4 attempts to address this gap in the literature for this thesis.

2.3.3 The criminalisation of sex work in Africa

Senegal is the only SSA country with a legalised system of commercial sex if women register as sex workers with the authorities. Ito, Lépine, and Treibich (2018) show that registered FSWs have better health but reduced mental well-being, social support networks, engage in riskier sex acts and are more likely to be subject to violence than their unregistered peers. Cameron, Seager, and Shah (2020) studied the criminalisation of sex work in Indonesia using its sudden outlawing in a single district to show increases in STIs from reduced access to and use of condoms. In the US, there are causal estimates that decriminalisation reduced the realisation of sexual violence and STI prevalence (Cunningham and Shah 2018). Previous research conducted in Senegal showed that although FSWs have a good knowledge of HIV risks and good access to HIV prevention services, 22% did not use a condom during their last sex act (Treibich and Lépine 2019; Bradley et al. 2010). This evidence supports the idea that social marginalisation and stigma through the law, both prevalent in SSA, are important in setting the environment where vulnerable women use risky behaviours and persist the spread of HIV among commercial sex populations.

2.3.4 The premium for risky sex

This thesis hinges on the mechanism of the risk premium, the positive relationship between risky behaviours and sex act price. i.e., those in transactional relationships can trade behaviours that increase health risks for relatively more money or value but also that simply engaging in transactional or commercial sex yields income higher than a women's next best alternative. Economic theory has identified the compensating wage differential (Rosen 1986) starting as early as Adam Smith's (1776) seminal work that introduced the idea of 'net advantages', i.e. those in riskier occupations could earn higher wages. Risk compensating wage differentials are now an accepted economic theory and key to understanding voluntary risky behaviours of women engaging in sex markets. Theoretical models describe sex as a normal good and revolve around the overlap of a higher willingness to pay for higher utility and riskier sex because they prefer it (Randolph et al. 2007) and the willingness of women to accept supplying unprotected sex (V. Rao et al. 2003; Gertler, Shah, and Bertozzi 2005; Cunningham and Shah 2016). In these models, bargaining power and underlying risk, i.e. STI prevalence, influence the clearing and price in risky sex markets (Arunachalam and Shah 2013). Theoretical and empirical literature focuses on commercial sex and condomless sex acts because of the explicit nature of those relationships, the measurement and analysis advantages of comparing protected to unprotected sex acts using price and the higher probability of truthful answers to price and condom use questions.

It follows that women will minimise their own risk, not necessarily only minimising the risk of HIV but the risk of physical violence or robbery; therefore, anything that is risk-increasing can be compensated for. For example, anal sex increases the transmissibility of HIV and has a higher premium than unprotected vaginal sex (Robinson and Yeh 2011). The risk can take the form of different elements of a transaction, such as location, alcohol consumption, and whether FSWs / clients stay the night. There is no reason this compensating differential does not exist within transactional relationships except that quantitatively testing it is more difficult, given that implicit value transfers are difficult to measure. There is some quantitative evidence (Luke et al. 2011; Robinson and Yeh 2012; 2011), although whether such relationships are exactly transactional as we now understand them is unlikely. There is evidence of associations between poverty and inconsistent condom use in girls at risk of engaging in transactional relationships (Davidoff-Gore, Luke, and Wawire 2011). It is logical that transactional sexual relationships under the paradigms of 'improving social status' and 'meeting basic needs' are more likely to be influenced by risk premiums since the objective is material gains (Stoebenau et al. 2016).

2.3.5 Behaviour Change and PrEP

A parallel topic but one that helps us understand how people respond to risk is looking at PrEP which protects against just HIV but not other harms of unprotected and commercial sex. PrEP is a tool for women to empower themselves to protect against HIV by protecting themselves before entering risky sexual situations. In high-income countries, PrEP is widely available to key populations but less so in Africa, only being available in Kenya, Nigeria, South Africa, Uganda, Zambia, and early trials in Senegal. However, behavioural changes might limit the impact PrEP can have. Whilst PrEP's safety and effectiveness – a function of efficacy and adherence - is proven in clinical trials (Fonner et al. 2016). Efficacy demands adherence to daily oral tablets for women, but among FSWs, adherence has been observed to be as low as 23% after one year, reducing the effectiveness (Karim and Baxter 2021). On the other hand, for those that even partially adhere, there are other benefits, such as increased contact with health systems for more regular testing and treatment of STIs, a particular problem with stigmatised groups who often avoid contact with health services.

Economic models suggest that if PrEP reduces the risk of HIV for condomless sex, then FSWs will increase such behaviour, termed behavioural disinhibition (Quaife et al. 2021). In other words, if an FSW's risk tolerance is unchanged, reducing the riskiness of a sex act will mean they can engage in more of it and maintain the same cumulative amount of risk, or engage in unprotected sex, increasing STIs and increasing HIV susceptibility. There are concerns that risk disinhibition will negate the impact of PrEP interventions (Cassell et al. 2006; Eaton and Kalichman 2007), particularly when considering the negative externalities of STIs (Quaife et al. 2021).

Whilst there is evidence of risk disinhibition in MSM (not sex workers) following PrEP uptake (V.-K. Nguyen et al. 2018; Kojima, Davey, and Klausner 2016), there is minimal evidence of behavioural change in either direction for FSWs. Whilst men and women will respond to changes in risk in broadly similar ways, women must keep a stricter PrEP regime to ensure efficacy, and FSWs are using sex for an income and therefore exposed to economic incentives too. Modelling studies have shown that economic conditions and competition between PrEP-treated FSWs and non-PrEP FSWs might cancel each other out regarding HIV and lead to net increases in commercial sexual activity without changing net HIV risks (Quaife et al. 2021). Some qualitative evidence suggests there is little change in behaviours (Guest et al. 2008), and forthcoming evidence from a trial of FSWs in Senegal shows risk behaviours fall for those taking PrEP, indicating the benefits of increased contact with health services outweigh any temptation for increased risk behaviours (Toh, Lépine, and Treibich 2022). Toh et al.'s (2022) study is somewhat limited by two-sided non-compliance and self-reported risk behaviours, which could be related to increased health service contact.

2.4 Theory of Coping with Economic Shocks

Consumption and utility theory is fundamental to understanding the motivation for the consumption of goods and services, how one deals with consumption over time, and how to deal with the uncertainty generated by economic shocks. After the theoretical section comes a brief review of empirical and applied studies surrounding shocks and coping strategies. This provides a baseline in understanding the typical non-sexual coping strategies available, which are expanded upon in Chapter 4.

2.4.1 Consumption theory

Consumption theory describes the relationship between the consumption of goods, income and utility, explaining what goods and services we consume and why. Neoclassical theory, including Keynes (1937), proposed the first consumption functions and coined the "absolute income hypothesis", describing how short-run real income drives consumption. Intertemporal consumption describes how it is distributed over time. Some early work, namely Fisher (1930), proposed a basic model where consumption in a given year was determined by current income and savings (plus interest) from previous years, implying a simple relationship where interest rates influence consumption. Friedman's (1957) "permanent income hypothesis" build on these ideas by splitting income into permanent and transitory income, the former now the driver of current consumption, with transitory income spread over future consumption. These models can now help predict the effects of economic shocks and understand basic consumption smoothing behaviours.

Deaton (1991) and Zeldes (1989) developed more sophisticated consumption smoothing models using "buffer-stock" concepts in the late '80s. These state that households without access to borrowing accumulate assets via savings as a buffer used to dissave when income falls to preserve consumption. Deaton's (1989) theory is particularly relevant to understanding consumption smoothing in developing countries where the poor still have little access to formal credit services. He describes the study of savings and consumption smoothing of the poor as distinct from those in developed countries because the poor face increased uncertainty in income and consumption without developed countries' financial instruments and welfare systems. Therefore economic shocks and uncertainty contribute to the poverty cycle in LMICs by changing household allocation decisions away from assets that might encourage growth such as girls education, towards more tangibly valuable assets such as livestock. Whilst the latter might still be productive, the cycle of economic uncertainty means households often have to sell them for less than their initial outlay preventing sustained quality-of-life improvements (Whitehead and Kabeer 2003).

2.4.2 Utility functions

Utility functions describe how consumption is transformed into utility. Lancaster's (1966) key contribution was the characteristics of goods, services, and their combinations produced utility. Whilst this appears a straightforward assumption, it allowed for interactions and more complex ideas of substitution and complementarity to be modelled. Expected utility theory describes how we derive utility under uncertainty accepting the tendency of risk-aversion but relying on fixed probabilities. In reality, the data does not conform to these simplistic intertemporal consumption and utility theory models.

Behavioural economics has sought to explain these data better using psychology to justify irrational human bias. For example, 'Knightian risk' differentiates between risk as a known probability and uncertainty as unknown risk (Knight 1921). Whilst Knight introduced this idea to focus on the behaviour of markets, Ellsberg (1961) showed that decision-makers would overwhelmingly favour choices with a known and quantifiable level of risk compared to those with unknown risks coining the term "ambiguity aversion". Ambiguity aversion helps us to understand why women might risk their health in the face of the ambiguous consequences of economic shocks. For example, an FSW with a sick child would be more willing to risk their own health, for which they grasp the risks, rather than face the unknown consequences of letting their child go without medical care.

From prospect theory, loss aversion states that an individual will avoid losses moreso than equivalent gains (Kahneman and Tversky 2013). Behavioural economists Shefrin and Thaler (2004) introduced 'mental accounting' to better explain consumption smoothing. Mental accounting compartmentalises the different income streams of households into 'current income', 'future income' and 'savings' (including assets), each of which has a different marginal propensity for consumption. They hypothesise that 'current income' has a marginal propensity of spending close to one, future income close to zero and savings between the two. These behavioural economic contributions help align the economic theory with the observed behaviours. These ideas are relevant because they help us to understand why women are willing to take risks to increase their current income at the potential cost of future income rather than use savings.

2.4.3 Demand for health

Health economics aims to link health and healthcare services with utility. Critical in this was Grossman (1972), who built on Arrow's (1963) work showing that healthcare is a derived demand, meaning individuals do not obtain utility from consuming health but from enjoying the benefits of a stock of health. This idea allows economists to understand why people demand health services despite few generating utility directly. How health status translates into utility over a lifetime has been discussed and theorised at great length focusing primarily on the consequences of ill health to utility (Mark R. Rosenzweig and Schultz 2015; Viscusi and Evans 1990). In this thesis, health status serves two roles, first as a utility-generating input as discussed in these theories, but also as an asset that can be used as collateral to generate income through transactional sex acts. The insights help illustrate the painful trade-off women engaging in transactional sexual relationships have to make between enjoying their stock of health and generating a living. It also helps us to realise the economic importance of affordable and accessible healthcare services. Stigma and other barriers to healthcare are so important to not only generating utility but also to the economic potential of the women and their ability to earn an income without taking increasing risks with their health.

2.5 Empirical Evidence of Coping with Economic Shocks

An important next step in understanding the decisions women make in the face of economic shocks is to examine the typical (non-sexual) coping strategies used in LMICs. Whilst sexual coping strategies are not available or used by large portions of households, non-sexual coping strategies are available to those household where women engage in transactional sexual relationships. The literature focussing on non-sexual coping strategies is discussed here with a view to understanding what alternatives might be available to women outside of sexual coping strategies, important for the empirical and conceptual chapters to follow, but also their impacts on poverty and economic development more generally.

2.5.1 Economic uncertainty

LMICs suffer around a third more economic uncertainty than high-income countries (Bloom 2014). This economic vulnerability is key to the perpetuation of poverty in the lives of the poor. Literature on poverty began with static definitions, progressing to appreciate the dynamic nature of poverty (Foster, Greer, and Thorbecke 1984; Sen 1976; 1979). More recent literature appreciates these dynamics and presents theories on assets as savings, investment, and consumption smoothing instruments. For example, Rosenzweig and Wolpin (1993) theorise one element to the poverty cycle is driven by the sale of productive assets to deal with weather shocks, leading to long-run productivity losses. Carter and Barrett (2006) present a similar asset-based poverty measure that argues the importance of shocks on poverty is the state the shock leaves a household ex-post, not its capabilities ex-ante. The results of these theories appear throughout the applied literature. Explaining the link between HIV and income requires analysis through this same lens. i.e. HIV transmission is a by-product of a sub-set of consumption smoothing behaviours used in response to economic shocks.

Extensive data of households across time in large geographic areas with multiple shock, consumption and coping strategy survey modules are required to test these theoretical contributions. Until recently, these were difficult to conduct in LMICs due to the considerable time and financial resources needed. Therefore, literature tends to focus on partial models of specific shocks with a growing literature of multi-shock analyses over time. The applied literature divides into two streams – the first is assessing the economic vulnerability of a population, and the second is evaluating the response and consequences to households of coping with economic shocks.

2.5.1.1 Health shocks

Health shocks are characterised as idiosyncratic, striking individuals or households somewhat randomly in LMICs, making it popular for study since the effect of the shock can be estimated whilst minimising confounding. Health shocks vary in magnitude and affect consumption through increased expenses and lost income.

Wagstaff et al. (2018) show that economic vulnerability is rising through increased catastrophic health payments in Africa and Asia, both nominally and relative (to themselves). A lack of wealth and poor financial access prevents the use of formal coping strategies, such as health insurance or savings, and are key factors in maintaining poverty in Africa following health shocks (Atake 2018; Dupas and Robinson 2013). As a response to economic vulnerability, on a micro-level, Gertler and Gruber (2002) show that the severity of illness in Indonesia is an important factor in consumption smoothing. Households could smooth consumption in response to minor illnesses and injuries but cannot adequately smooth consumption following a major illness. They found lost income to be more significant than health expenses; however, the relative impact depends largely on country-level risk pooling, insurance and sick pay policies.

Alam and Mahal (2014) conducted a review that builds on the findings of Gertler and Gruber (2002), showing that households fail to insure against health costs in LMICs adequately. Their review synthesises the evidence of coping strategies noting that immediate responses to health shocks - meeting OOP expenses - come from current income and savings. More severe health shocks elicit borrowing and sale of assets, including productive assets. Furthermore, poorer households utilise informal borrowing and are more likely to use it for minor health shocks. Non-medical expenses such as lost income are smoothed using community and extended family transfers. The sale of productive assets is particularly problematic for long-run economic resilience and persistent poverty, but there is evidence that micro-credit and access to formal financial institutions reduce the sale of these assets by improving savings and borrowing rates (DeLoach and Smith-Lin 2018; Islam and Maitra 2012). Research since Alam and Mahal (2014) broadly reflects these findings, adding that those more vulnerable, such as female-headed households, are less able to protect consumption (Genoni 2015; Mitra et al. 2016). However, informal safety nets are not always adequate at smoothing consumption in response to idiosyncratic shocks (Morduch 1999) and lead to real quality-of-life impacts such as food insecurity.

2.5.1.2 Agricultural shocks

Agricultural and climate shocks differ from health shocks because many are covariate affecting whole communities or economies but remain common and widely studied. Significant literature studies the mechanisms that drive poverty through the magnitude and long-run consequences of agricultural shocks (Carter and Barrett 2006; Hoddinott 2006; M. R. Rosenzweig and Wolpin 1993). Climate and price shocks are the most common types of economic shock in Africa, according to Christiaensen and Demery (2018), but there are studies of idiosyncratic types of agricultural shocks, such as crop or livestock disease and losses. By definition, agricultural shocks affect those in rural areas, who are likely to be poor and more vulnerable without access to formal financial services. Such shocks are predicted to become more common and severe with the changing climate (Devereux and Edwards 2004; Jones and Olken 2010).

Covariate agriculture shocks are inadequately coped with for several reasons (Hoddinott 2006):

i) Households lack assets used to consumption smooth. Agricultural savings through assets is complicated because of lumpy pricing,

ii) Reduced terms of trade and productive potential mean households are unwilling to liquidate assets during times of economic strife, i.e. covariate shocks lower the price of assets in the local economy when most needed meaning households lose out by selling below the buying cost,

iii) Entry constraints and increased competition for alternative work mean income substitution methods are limited,

iv) Lack of access to formal financial services, including credit and savings accounts from banks,

v) Other private coping strategies, such as remittances or liquid savings, are insufficient.

Coping strategies utilised include internal migration (Dillon, Mueller, and Salau 2011; Gröger et al. 2016; Mehar, Mittal, and Prasad 2016), microinsurance (Janzen and Carter 2019), remittances (Yang and Choi 2007), mobile money (Abiona et al. 2022; Jack and Suri 2014; Riley 2018). A theme of these studies is a call for increased public support and safety nets in LMICs to protect the most vulnerable households (Dercon 2002; Skoufias 2003). However, evidence that credit as a coping strategy for covariate agricultural shocks is slim (Khandker and Koolwal 2016; Shimamura and Lastarria-Cornhiel 2014).

The key to coping strategies utilised in covariate shocks such as most agricultural shocks, is that they affect whole communities. This means the choice of coping strategy is endogenous to the shock that takes place. The value of community coping strategies, e.g. support from those also affected, and strategies that are influenced by the local economy, e.g. sale of assets, are relatively less valuable in these circumstances compared to strategies that are unaffected by the shock, e.g. liquid savings or remittances. The evidence presented in this sub-section suggests a reliance on strategies unaffected by the shock where possible. Furthermore, evidence suggests crop disease shocks (not affecting the wider community or local economy) labour substitution becomes one of the primary responses, a coping strategy not utilised when the wider community is also affected (Berloffa and Modena 2013; Kochar 1999).

2.5.1.3 Aggregate shocks

Most economy- or region-wide aggregate shocks studied are financial crises and conflict. Dual causality of aggregate shocks makes learning the cause and consequences problematic (Blattman and Miguel 2010; Miguel, Satyanath, and Sergenti 2015); thus, many studies focus on associative impacts rather than causal. Appropriate data exist from Indonesia to address these questions and is used to study the impact of the Asian crisis. Studies find income diversification, personal savings and durable and productive assets were primarily relied upon (Frankenberg, Smith, and Thomas 2003; J. Friedman and Thomas 2009). These responses differ from the conflict literature coming from a broader range of countries. Studies on conflict from Colombia (Ibáñez and Moya 2010; Pena, Urrego, and Villa 2017), Palestine (Brück, d'Errico, and Pietrelli 2019) and Afghanistan (D'Souza and Jolliffe 2013) and political unrest in Kenya (Dupas and Robinson 2010) show the extreme impact of such shocks on society and institutions leading to a breakdown of typical coping strategies, particularly for those displaced. Destruction of income-generating and diversification opportunities, coupled with increased food insecurity and prices, lead to destitution (Brück, d'Errico, and Pietrelli 2019; D'Souza and Jolliffe 2013) and the use of atypical strategies are relied upon, such as child labour and sexual coping strategies (Dupas and Robinson 2010; Pena, Urrego, and Villa 2017).

2.5.2 Multiple shocks

Whilst single-shock studies are beneficial in studying the response to a single shock, they are unable to compare the impact and response of different shocks within the same population. Multi-shock studies address these limitations and allow better information for policymakers to prioritise and support the most vulnerable. Like single-shock literature, multi-shock studies describe the consequences of comparative income variability and analyse coping strategies. Over two waves of data collection, Jack and Suri (2014) found that over 50% of their respondents suffered a negative shock in the previous 12 months – less than 10% benefited from a positive shock. They found geographically broader financial networks (enabled through mobile money adoption) were beneficial in coping with negative shocks. Nguyen et al. (2020) find differences in coping with different covariate shocks for rural households in Cambodia. Floods led to reductions in consumption, whereas livestock disease (more idiosyncratic), decreased education expenditure and forced sale of durable assets. However, droughts did not affect consumption but required the same coping strategies plus child labour to smooth consumption. Health shocks were found to be well-coped using networks and borrowing (Nguyen and Grote 2020).

On the other hand, in Laos, Wagstaff and Lindelow (2014) found that health shocks were more likely than droughts to lead to consumption cuts but concluded that there are long-run consequences for households due to borrowing and asset sales that resulted. Yilma et al. (2014)

found natural shocks more frequent than health shocks, contrary to other studies (Heltberg and Lund 2009; Wagstaff and Lindelow 2014). However, they found health shocks are more likely to lead to borrowing and asset sales, but non-health shocks have a larger effect on consumption (Yilma et al. 2014). Kurosaki (2015) finds a greater impact of floods and health shocks than droughts in terms of consumption effects in Pakistan.

The results from the multi-shock literature are mixed and do not follow the conclusions found within single-shock studies. For example, drought has differing effects both within the multi-shock literature and single-shock literature which challenges the conclusions from the single-shock literature. These results can be explained by:

i) Differences in the social and economic context – the country's context where the shock takes place determines the impact and response to shocks. Factors such as the level of OOP expenditure or financial inclusion, shock coping strategy availability and efficiency, and household characteristics differ between countries (Arouri, Nguyen, and Youssef 2015). For example, Kurosaki's (2015) finding of a lack of effect for drought in Pakistan might be due to the >50% irrigation of agricultural land[2] (World Bank n.d.) compared to locations of studies that do find an effect (Yilma et al. 2014).

ii) Methodological issues:
   a. Endogeneity concerns – different shocks affect the terms of trade and the value of coping strategies differently. For example, farmers are likely to own several productive assets that they could use for consumption smoothing, whereas an urban professional is less likely to. Therefore, results claiming droughts lead to asset sales are biased because farmers are more likely to have the assets available in the first place.
   b. Self-reported data – self-reported surveys are common in the multi-shock literature and potentially bias the results. Typically, surveys ask which of the shocks have been suffered over a long recall period, where answers to such questions are likely to correlate with the consequence or impact (Kahnman 1994). For example, a hill farmer and a floodplain farmer both suffer drought, and both recognise a mild and severe drought similarly. Both are equally likely to report the drought, but the hill farmer is less likely to report the flood because it might only affect a small portion of their land compared to the floodplain farmer. In addition, single-shock studies are more likely to use a shock as external to the dataset used

[2] However, it is acknowledged lack of water is not the only factor leading to reduced crop yields and economic shocks associated with droughts

and assume impact based on other sample characteristics, e.g. Burke, Gong, and Jones (2015), assume those in rural locations are impacted by lack of rainfall but do not confirm this within the household level data.

c. Publication bias - Single shock studies are more prone to publication bias because they include only one shock, so finding an effect of that particular shock is more important for the authors and its publication. Also, aggregate and some covariate single-shock studies are undertaken because certain shocks occurred. Taking a cautious, perhaps cynical view that multi-shock studies suffer the same biases, they have more shocks in which to find a publishable effect and are, therefore, more likely to report null effects for the other shocks.

A small subset of the multi-shock literature focuses on the cumulative and interactive impact of shocks and their effects on coping strategies (Ansah, Gardebroek, and Ihle 2021; Harriss-White et al. 2013). Ansah et al. (2021) investigate multiple shocks to determine if the number of, or type of shock, affects the coping strategy utilised using a recursive bivariate probit model to address endogeneity between coping strategy and shocks suffered. They find savings are used for all shocks, but the chances of asset depletion increase with the number of shocks suffered, reflecting findings of more severe health shocks.

2.6 Conclusion

This chapter reviewed the foundational theoretical and applied literature surrounding how economists understand health and consumption under uncertainty. There is a wealth of literature surrounding the economics of the HIV epidemic with strong contributions but shortcomings make the relationship between wealth, income and HIV far from complete. This thesis aims to fill some of these shortcomings by presenting economic variability as a significant contributor in the evolution of HIV as a public health issue. Next, Chapter 3, builds on this chapter by critically appraising literature that studies sexual coping strategies as a response to economic shocks. Chapter 4 then draws on the literature in these two literature review chapters to build a conceptual framework explaining the trade-off between health and wealth women face in transactional relationships.

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Chapter 3 - Research Paper 1: Systematic Review

3.1 Overview of the research paper

Economic uncertainty through realised economic shocks is thought to play a vital role in explaining risky sexual behaviours and the disproportionate share of HIV infections among women. This first Research Paper systematically reviews the literature addressing the empirical link between economic shocks, both positive and negative, and risky sexual behaviours of women and men. It synthesises a vast and heterogeneous literature, summarising the findings graphically using innovative evidence maps. It provides evidence of a consistent relationship between negative economic shocks and risky behaviours but a weaker reverse link when positive shocks occur.

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3.1.1 Implications for the thesis

The most substantive implications for the thesis are the theoretical and conceptual approaches taken in the literature to explain the link between economic shocks and risky sexual behaviours, in addition to identifying the gaps in the literature. There exists no theoretical or conceptual understanding that can be applied to women engaging in both transactional and commercial to cope with economic shocks. It also identifies gaps in the literature with respect to anticipated economic shocks and the investigation of transactional sex as a driver of HIV in young women. The gaps found in the literature helped inform the other research papers in this thesis.

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Surname/Family Name	Cust		
Thesis Title	Economic Shocks and Risky Sexual Behaviours		
Primary Supervisor	Timothy Powell-Jackson		

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Economic shocks and risky sexual behaviours in low- and middle-income countries: a systematic review of the literature

Henry Cust, Harriet Jones, Tim Powell-Jackson, Aurélia Lépine & Rosalba Radice

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Economic shocks and risky sexual behaviours in low- and middle-income countries: a systematic review of the literature

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ABSTRACT

We document the extent to which economic shocks through economic incentives explain HIV transmission through risky sexual behaviours in LMICs. We include 35 papers containing 31 unique negative and 11 unique positive economic shocks combined with over 320 health and risky sex outcomes. We find a diverse literature with varying empirical approaches showing increases in risky sexual behaviours are more sensitive to negative shocks than decreases are to positive shocks. Those already at risk of engaging in transactional sex are particularly vulnerable to increasing risky behaviours. Protecting against negative shocks is likely to most effective in preventing HIV transmission.

ARTICLE HISTORY

1 May 2021

KEYWORDS

Economic shocks; risky sexual behaviours; HIV; transactional sex; systematic review; literature review

Introduction

In sub-Saharan Africa, five in six new HIV infections among adolescents aged 15–19, are among young women. Women, aged 15–24, are twice as likely to be living with HIV than men of the same age (UNAIDS 2020). Risky sexual behaviours.[1] are a primary contributor in the transmission of HIV to women across low- and middle-income countries (LMICs). A lack of formal insurance and safety nets coupled with economic gender inequalities, prevalent throughout LMICs, leaves women highly vulnerable to economic shocks. Women often rely on informal coping strategies to maintain basic living standards for themselves and their dependents. These can be economic strategies, such as informal networks of extended family and friends, sale of household assets or withdrawal of children from school (De Weerdt and Dercon 2006). Transactional sex.[2] is an alternative coping strategy that provides women a means to receive support, money, or gifts quickly to alleviate sudden drops in consumption power. Ex-ante, transactional sex is used to build networks, which can be relied upon once a shock hits (Robinson and Yeh 2012), or ex-post to directly receive money or gifts whilst suffering from the shock. Within commercial sex.,[3] unprotected sex acts carry a premium of up to 81 per cent in comparison to protected sex acts (Islam and Smyth 2012), encouraging those who need additional income to accept additional risk of HIV (Gertler, Shah, and Bertozzi 2005; Quaife et al. 2019; Rao et al. 2003). Luke (2006) presents convincing evidence that there is a market for risky sex in informal relationships more akin to transactional sex as we define it.

The only previous literature review in the Oxford Handbook of the Economics of Prostitution reviews the economic literature on incentives which influence the decision to supply risky sex. We

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build on this review by including a broader range of literature to examine the link between shocks and risky sexual behaviours through transactional sex as a consumption smoothing mechanism. There are three objectives of the paper. First, to describe the range of risky sexual behaviours and shocks in this literature. Second, to evaluate the extent to which shocks, positive and negative, influence the risky sexual behaviours of women as 'suppliers' of sex and men as 'users' or 'purchasers' of sex. Third, we examine how the characteristics and context of economic shocks affecting both men and women influence the type of risky sexual behaviours that occur in response.

In the 35 studies included in this review, we find 31 unique negative shocks, 30 of which are naturally occurring, and 11 positive shocks, only one of which is naturally occurring. The remaining are interventions. We find that negative shocks lead to increases in risky sexual behaviour and HIV acquisition and that risky sexual behaviours appear more responsive to negative shocks than positive. Much larger positive shocks are required to reverse increases in risky sexual behaviours, implying protection for women against downside risk is likely more effective and feasible than expecting behaviour change through positive shocks such as cash transfers.

Below, we present our methods, including an organising analytical framework, summary of studies included, followed by a narrative presentation of estimated effects of shocks on risky sexual behaviours, finishing with a discussion and concluding remarks.

Methods

Search strategy & definitions

We searched social science and health databases and websites using terms intended to identify papers that examine the relationship between an economic shock and risky sexual behaviours of men and women in LMICs. Papers identified using search terms relating to 'economic shocks' and terms relating to a broad set of risky sexual behaviours and health outcomes from LMICs in any language were taken for abstract screening. Only quantitative studies were included with no exclusions based on study design. For the purposes of screening, we defined economic shocks as: 'An unexpected, sudden and significant change in income or expenditure of a household, which if unaddressed would have meaningful impacts on household consumption'. For a risky sexual behaviour outcome to be included it must satisfy the following:

(1) The behaviour is expected to increase risk of exposure to HIV or is a direct measure of exposure to HIV;
(2) The behaviour is expected to generate an economic return such that it can be used to smooth consumption in the study population.

A paper is included if at least one outcome satisfies the two criteria above and it contains a valid economic shock. Notable exclusions include any homosexual relationships and outcomes of violence or forced sex. Further details of the method and discussion of inclusion or exclusion of certain shocks and outcomes are available in Appendix A. Full inclusions and exclusion criteria are available in Appendix B with a full list of search terms in Appendix C.

Abstract screening

All papers found in the database and website searches were blind screened (title and abstract) by two reviewers before 12 March 2020. There were 28 papers included by only one reviewer after the screening. These discrepancies were discussed, and final exclusion or inclusion agreed upon. No papers required an independent third reviewer for a decision. Finally, all reference lists of papers included for full-text review were sifted for additional papers by the lead author. Figure 1 summarises the studies included.

Full-text review and data extraction

Full-text review to determine the final inclusion and data extraction was done by the lead author. Data were inputted into predefined data extraction form. Additional fields that were deemed pertinent during full-text review were added. Information extracted include details of the study's aims, data used, sample information, study design and quality, detailed characteristics of all shocks used in the analysis, details of study outcomes, main and secondary model estimates.[4] (where reported), estimates separated by gender (where reported), authors' interpretations of results and conclusions.[5]

Quality appraisal

Given the nature of economic shocks, there is a wide range of study designs, data sources, samples and methods employed to analyse their effects on HIV and risky behaviours, from randomised controlled trials (RCTs) to quasi-experimental methods based on natural experiments. In our case, the most important feature a quality appraisal must possess is the strength of causal inference. To our knowledge, such an appraisal that adequately assesses the risk of bias and internal causal validity equally across all our study designs and empirical strategies is not widely available (Ogilvie et al. 2020; Waddington et al. 2017). Therefore, we opted for an approach that adapted the Maryland Scientific Methods Scale by the What Works Centre for Local Economic Growth (Sherman and Gottfredson 1998; What Works Centre for Local Economic Growth 2016). This scoring system focuses on the robustness of the study design and its implementation.

This study design and implementation systems result in a two-number scoring system, the first a score based on the study design from 5, an RCT design to 1, a before/after study. Plus, a second number based on how well the method is implemented from a maximum equal to the study design score and descending as implementation criteria are not met. For example, a score of 5.5 represents a perfectly executed RCT or 5.4 could be an RCT that fails to randomise adequately. There are some key elements that determine the causal strength of papers in this review. First, potential selection issues from the extent to which naturally occurring shocks are random. For example, the likelihood of a sudden medical cost could be associated with, through unobserved heterogeneity, the likelihood of engaging in risky sexual behaviours, for example, through risk-preferences. Second, the appropriateness of the sample and the methods employed. The original authors may have been studying different research questions to the questions of this review, and thus made decisions or chosen samples that limit the strength and validity of their results with respect to our questions. For example, the papers studying the effect of shocks on family planning do not consider transactional or commercial sex as a mechanism and therefore collect together contraceptive methods that both have economic returns (for example, condoms) and non-economic returns (for example, contraceptive pill). They also analyse samples that are less likely to be engaged in transactional or commercial sex, namely couples. Finally, the depth of analysis and examination of key mechanisms depends on choices made by the original study authors. A good example of this is Burke, Gong, and Jones (2015) who separate their sample between high and low HIV prevalence countries to capture how potentially risky behaviours are contributing to overall HIV prevalence. Where there are threats to external or internal validity and causal interpretations, these are highlighted in discussion of results.

Organising analytical framework

To help make sense of the relationships, we are describing we present this organising analytical framework drawn from lessons from the basic labour supply model and Edlund and Korn's (2002) theory of prostitution. Demand for heterosexual sex is derived wholly from men and is a function of their disposable income and the underlying health risks of engaging in transactional or commercial

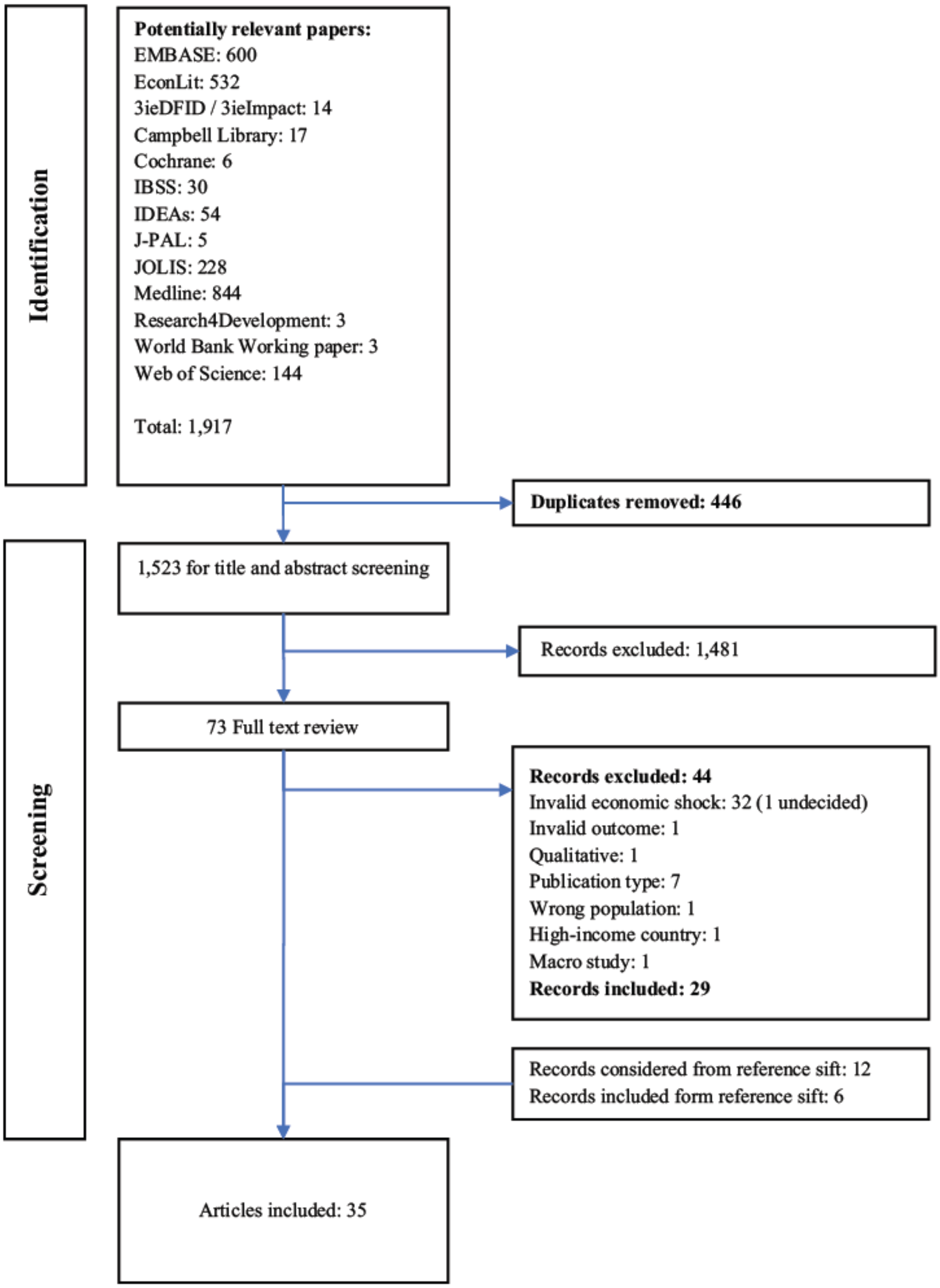

Figure 1. Flowchart of Studies.

sex. Women supply sex and their decision to engage in transactional or commercial sex is determined by the payoff. For sex workers, this is the wage rate or price of a sex act, for those engaging in transactional sex this would be the total benefit that can be obtained which, like income, gives diminishing marginal utility. Other factors are the fixed risk to health and wellbeing for engaging in each sex act, and the variable risk, mainly HIV and STI risk. Women have some control over the variable risk through choice of partners and condom negotiation. Finally, they have alternative employment options available to them. The benefits of sex work increase with the risk internalised by women and so face a maximisation problem to maximise utility by minimising their risk.

Shocks in our model can affect supply and demand sides of the market separately or together. Understanding the characteristics of the shock is important for understanding how the equilibriums are disrupted and why different risky behaviours are employed to cope. The scale of the shock, that is, *idiosyncratic*, affecting individuals or households, *covariate*, affecting groups or communities and *aggregate*, affecting entire economies or regions, helps us to understand how the alternatives for the women might be affected, as well as the impact of the shock on their own non-sexual coping strategies. It also tells us the extent to which the equilibrium is impacted. For example, aggregate or covariate shocks affect both men's disposable income, and the alternative sources of money available to women ,in turn affecting the utility gained from the benefits of commercial or transactional sex. But looking at scale alone is insufficient. The expectation of the length and depth of a shock is vital in understanding a woman's decisions to absorb additional health risk to economically cope with a shock. We therefore categorise shocks into three additional groups regardless of size or scale:

- *Temporary* shocks are one-off or short-lived shocks which at the time are not expected to incur many future payments or consumption shortfalls. These are typically expected to last no more than 2 months.
- *Persistent* shocks last for an extended period, where there is an expectation of effects lasting for some time. These are typically expected to last between 2 months and 2 to 3 years.
- *Permanent* shocks have no expectation of recovery to previous equilibria, typically, those expected to last for more than 3 years.

The effect of shocks on the overall cumulative health risks taken by women is the question we are interested in answering. Bio-marker health outcomes are the realisation of cumulative health risks taken, but are often difficult to collect. Self-reported risky behaviours are a good proxy and help us to understand the pathways by which shocks impact the market conditions that might be leading to health outcomes. Within the risky sexual behaviours, the economic literature categorises risky sexual behaviours into two categories. First, the *extensive* margin, whether a person engages in risky sexual behaviours, and the *intensive* margin, the amount of sex had within a relationship. We also include a third, *riskiness*. Because of the premiums for riskier sex acts, it makes the level of risk accepted by the women a distinct slider from that of intensity alone, that is, it is plausible that a choice exists between engaging in more protected sex versus less unprotected sex to achieve the same economic benefit for the same total risk of ill-health. If riskiness was measured with intensity, you might fail to capture the two elements moving in opposite directions.

Descriptive results of paper results

The search identified 1,523 unique papers. After title and abstract screening, 73 of these were taken for full-text review. A total of 35 papers progressed to data extraction, of which six were included after the reference sift and subsequent full-text review. Of the papers, 13 are published in economic journals, 16 in health or public health journals, two in an interdisciplinary journal, and four are economic working papers. Two-thirds of the papers were published since 2015 indicating the current relevance of the topic, with more recent papers more likely to be examining the effect of shocks as the primary study aim rather than indirectly through the study of other aims.[6] Table 2 summarises key information from the 35 included studies.

Study samples

The vast majority of studies (34/35) focus on sub-Saharan Africa (see Figure 2) with India and Thailand the only non-sub-Saharan African countries to be represented. There is a strong focus on young people with ten studies using samples under 22 years of age. Of the four unique samples in these 10 studies, three are of only women under 22. There are 17 studies with all-female samples (of all ages) and 17 studies of mixed samples, but only one study with an all-male sample. Four studies have samples of female sex workers (FSWs) or 'users of transactional sex'.

Shocks

From the included studies, there are 42 unique shocks analysed.[7] There are an average 1.69 shocks analysed per paper, with the majority of papers (24/35) analysing a single shock. Table 1 summarises the key statistics of the shocks included in this review.

Of the positive shocks there are two unique permanent shocks,[8] six unique persistent shocks and three unique temporary shocks totalling 11. In comparison, there are 31 unique negative shocks, seven temporary, 18 persistent and six permanent. Only one positive shock is naturally occurring compared to 30 naturally occurring negative shocks. Naturally occurring shocks happen frequently outside of the specific study context; therefore, results arguably have more real-world meaning, even if the precise effect mechanisms are not always clear.

The majority of the positive shocks are randomised cash transfers,[9] so the quality and causal inference of these studies is generally strong. However, they often involve multiple payments over an extended period making the effect of the *shock* difficult to differentiate from the *expectation* or gradual income effects on equilibrium risky behaviours.[10]

In terms of scale, most positive shocks are idiosyncratic due to their design rather than covariate or aggregate. However, making a clear distinction between idiosyncratic and covariate shocks is difficult when there are potential spillovers, and it is not always clear what proportion of a community is affected.

In terms of negative shocks, each shock is typically exclusive to a single study. They are concentrated in the persistent category with the remaining split equally between temporary and permanent. These studies are more diverse in their design and empirical strategies as they make use of naturally occurring shocks coupled with available observational data. In terms of scale, the majority are idiosyncratic with typically low proportions of samples affected,[11] making distinction from covariates clearer than the positive shocks (cash transfers). These covariate shocks are often droughts which are unexpected but have large persistent impacts on the household and community, making them strong candidates for causal estimates. The aggregate shocks arise from political instability where all in the sample were affected, at least indirectly, by the shock, possibly limiting causal interpretations because of tricky counterfactuals.[12]

Eighteen studies separate estimates for male and female groups to try to disentangle this; however, six relevant studies do not. For example, Mills et al. (2018) include a positive shock to both males and females but fails to appreciate that the effect on behaviours might differ in direction. Brodeur, Lekfuangfu, and Zylberberg (2018), however, analysed general equilibrium effects by studying the push factors from rural areas for women moving into sex work, as well as the demand shock from U.S. soldiers arriving to certain areas and the interaction of the two.

Descriptive results of risky sexual behaviours

There are 322 outcomes across all studies giving an average of 9.2 outcomes per study. Table 3 shows the number and range of health status outcomes,[13] Table 4 directly measured risky sexual behaviours and Table 5 indirectly measured risky sexual behaviours. All 35 studies analyse at least one risky sexual behaviour but under a third analyse health outcomes.

Figure 2. Map of Africa Showing Countries with Samples Included in this Review. Note: Darker shades represent high cumulative studies in that country. Dashed lines represent countries with DHS surveys used in Burke, Gong, and Jones (2015) or Corno, Hildebrandt, and Voena (2017). Not shown are single samples from India and Thailand.

Table 1. Types of Shocks Analysed.

Shock type	Negative	Positive
Expectation		
Temporary	8	3
Persistent	19	15
Permanent	8	5
Scale		
Idiosyncratic	21	22
Covariate	12	1
Aggregate	2	0

Effect of shocks on risky behaviours

Evidence maps

Figures 3 and 4 summarise the evidence and conclusions found across studies of negative and positive shocks via evidence maps. Each shape indicates a single study, the shape indicating the scale of the shock in that study, with red shapes indicating estimated effects increasing the risk of HIV, green decreasing risk of HIV and grey conflicting evidence. Filled colour indicates statistically significant effects and hollow statistically non-significant. See Appendix E for further information.

Table 2. Summary of Included Studies.

Author and Date	Country or Region	Sample size; [analytical sample[34]]	Study population at baseline or at the time of study	Shock category (direction)	Biomarkers (outcome), Behavioural or self-reported outcomes or Both.	Study design or empirical strategy	Study design and implementation score
(Abiona 2017)	Uganda	15,975; [1,994]	Married women aged 15–50	Drought (-)	Behaviour	Panel fixed effects	3.3
(Alam and Pörtner 2018)	Tanzania	249; [249]	Married or partnered women aged 17–45	Agricultural (-)	Behaviour	Panel fixed effects	3.3
(Baird et al. 2010)	Malawi	2,692; [2,692]	Never married women aged 13–22	Cash transfer (+)	Behaviour	Difference-in-difference	3.3
(Baird, Mcintosh, and Özler 2011)	Malawi	3,796; [2,284]	Never married women aged 13–22	Cash transfer (+)	Behaviour	RCT	5.5
(Baird, McIntosh, and Özler 2019)	Malawi	3,796; [2,049]	Never married women aged 13–22	Cash transfer (-)	Both (HIV)	RCT	5.5
(Baird et al. 2012)	Malawi	3,796; [1,517]	Never married women aged 13–22	Cash transfer (+)	Both (HIV, HSV-2, Syphilis)	RCT	5.5
(Bandiera et al. 2019)	Sierra Leone	5,775; [not stated]	Women aged 12–25	Ebola disruption (-)	Behaviour	Cross-sectional or panel fixed effects ‡	3.3 ‡
(Beauclair, Dushoff, and Delva 2018)	Malawi	2,907; [1,108]	Never married women aged 13–22	Cash transfer (-)	Behaviour	RCT	5.5
(Brodeur, Lekfuangfu, and Zylberberg 2018)	Thailand	85,000 individuals; [778 after collapse]	Commercial sex workers, majority female	Demand and agricultural price (+) (-)	Behaviour	Instrumental variable	4.4
(Burke, Gong, and Jones 2015)	Sub-Saharan Africa	203,796; [77,760]	Nationally representative men and women aged 15 +	Drought (-)	Both (HIV)	Cross-sectional	2.2
(Corno, Hildebrandt, and Voena 2017)	Sub-Saharan Africa and India	393,111; [300,000 +]	Women aged 25+, Indian sample only 'ever married'	Drought (-)	Behaviour	Retrospective panel fixed effects	3.2
(Dinkelman, Lam, and Leibbrandt 2007)	South Africa	4,752; [2,993]	Men and women aged 14–22	Household (job loss, grant loss, etc) (-)	Behaviour	Cross-sectional analysis	2.2

(*Continued*)

Table 2. (Continued).

Author and Date	Country or Region	Sample size; [analytical sample[34]]	Study population at baseline or at the time of study	Shock category (direction)	Biomarkers (outcome), Behavioural or self-reported outcomes or Both.	Study design or empirical strategy	Study design and implementation score
(Dinkelman, Lam, and Leibbrandt 2008)	South Africa	4,752; [2,993]	Men and women aged 14–22	Household (job loss, grant loss, etc) (-)	Behaviour	Panel fixed effects – Pooled and first-difference	3.3
(Dupas and Robinson 2012)	Kenya	226; [2,447 observations]	Females aged 18+: shopkeepers/ entrepreneurs/ engaging in transactional sex	Civil disorder (-)	Behaviour	Panel fixed effects	3.3
(Gong, De Walque, and Dow 2019)	Tanzania	2,400; [2,130]	Men and women aged 18–60	Food insecurity (panel) (-)	Both (STIs)	Panel fixed effects	3.3
(Goodman et al. 2015)	Kenya	1,060; [1,060]	Men and women who care for orphaned children aged 16–21	Cash transfer (+)	Behaviour	Cross-sectional	2.1
(Handa et al. 2014)	Kenya	2,210; [1,433]	Male and female members of orphan households aged 15–25	Cash transfer (+)	Behaviour	Randomised study with no baseline	5.3
(Handa et al. 2015)	Kenya	2,210; [1,547]	Male and female members of orphan households aged 15–25	Cash transfer (+)	Behaviour	Randomised study with no baseline	5.3
(Handa et al. 2017)	Kenya	2,210; [1,429]	Orphans and vulnerable children aged 15–25	Cash transfer (+)	Behaviour	Randomised study with no baseline	5.3
(Jones and Gong 2019)	Kenya	627; [606]	FSW and other vulnerable women aged 18 +	Health (illness) (-)	Behaviour	Panel fixed effects	3.3
(Kilburn et al. 2019)	South Africa	2,537; [2,448]	Women aged 13–22 in school	Cash transfer (+)	Behaviour	RCT	5.4

(*Continued*)

Table 2. (Continued).

Author and Date	Country or Region	Sample size; [analytical sample[34]]	Study population at baseline or at the time of study	Shock category (direction)	Biomarkers (outcome), Behavioural or self-reported outcomes or Both.	Study design or empirical strategy	Study design and implementation score
(Kohler and Thornton 2012)	Malawi	1,402; [1,307]	Women aged 14–24 and husbands, plus random sample top-up	Cash transfer (+)	Behaviour	RCT	5.5
(Low et al. 2019)	Lesotho	12,887; [11,682]	Sexually active men and women aged 15–59	Drought (-)	Both	Cross-sectional analysis	2.2
(Mills et al. 2018)	Uganda	2,170; [1,084]	Men and women aged 18–60 living with HIV	Cash transfer (+)	Behaviour	RCT	5.4
(Molotsky 2019)	Malawi	1,003; [528]	Unmarried men and women aged 13–26	Household, economic, agricultural (numerous) (-)	Behaviour	Panel fixed effects	3.2
(Pettifor et al. 2016a)	South Africa	2,537; [2,448]	Women aged 13–22 in school	Cash transfer (+)	Both (HIV, HSV-2)	RCT	5.4
(Pettifor et al. 2016b)	South Africa	2,537; [2,533]	Women aged 13–22 in school	Health (illness) (-)	Both (HIV, HSV-2)	Cross-sectional analysis	2.1
(Pienaar, Van Rooyen, and Walsh 2017)	South Africa	996; [991]	Men and women aged 25–64 who voluntarily attended health centres	Health (death) (-)	Biomarker only (HIV)	Cross-sectional analysis	2.1
(Robinson and Yeh 2011)	Kenya	192; [192]	Women aged 18 + who are single/divorced/widowed/have multiple partners	Health (illness) (-)	Behaviour	Panel fixed effects	3.3
(Rosenberg et al. 2014)	Kenya	2,212; [684]	Male and female members of orphan households aged 15–25	Cash transfer (+)	Behaviour	Cross-sectional analysis & RCT design	5.3

(*Continued*)

Table 2. (Continued).

Author and Date	Country or Region	Sample size; [analytical sample[34]]	Study population at baseline or at the time of study	Shock category (direction)	Biomarkers (outcome), Behavioural or self-reported outcomes or Both.	Study design or empirical strategy	Study design and implementation score
(Smith, Hein, and Bagenda 2019)[35]	Malawi	3,796; [1,326]	Never married women aged 13–22	Cash transfer (+)	Both (HIV)	RCT	5.5
(Tequame and Tenikue 2017)	Cote d'Ivoire	3,600; [2,017]	Men and women aged 14–49 who took part in voluntary HIV testing	Civil disorder (-)	Both (HIV)	Cross-sectional analysis	2.1
(Venkataramani and Maughan-Brown 2013)	South Africa	4,752; [480]	Men who became circumcised aged 14–22	Health (illness), job loss (-)	Behaviour	Cross-sectional analysis	2.2
(Wagner et al. 2017)	Tanzania	3,710; [3,409]	Men and women aged 18–30	Cash transfer (+)	Behaviour	RCT	5.5
(Wilson 2012)	Zambia	25,146; [16,296]	Nationally representative men and women aged 15 +	Natural resource boom (+)	Behaviour	Repeated cross-sectional analysis	3.2

‡The paper was ambiguous over whether panel data with individual fixed effects were used or if it was limited cross-sectional analysis of follow-up data.

Empirical results

Tables 6 to Table 13 contain the estimates from our included studies split by outcome type and shock direction. In total, one-third of all reported estimates are significant, with 27/35 studies having at least one significant effect reported, despite this, most studies make a conclusion suggesting the effect of shocks.

Health outcomes

Table 6 presents the estimates from positive shocks on health outcomes, respectively. All but one of these outcomes are collected via biological testing[14] and are therefore free from social desirability bias. There are two original studies and one replication study of positive shocks, both persistent cash transfer programmes (Baird et al. 2012; Smith, Hein, and Bagenda 2019; Pettifor et al. 2016a). The majority of the adjusted odds ratios (AOR) in Baird et al. (2012) yield non-significant associations with health outcomes with Pettifor et al. (2016a) also finding non-significant effects of their cash transfer programme on health outcomes. Baird et al. (2012) do find statistically significant protective effects of cash transfer for HIV prevalence in the combined and conditional only analysis plus protective effects for HSV-2 in the combined and unconditional sub-samples only. However, the replication of this study concludes that the evidence of protection against HIV acquisition is somewhat vulnerable to model choice, while the evidence on HSV-2 is more robust (Smith, Hein, and Bagenda 2019). Smith, Hein, and Bagenda (2019) also conducted their own sub-group analysis by wealth finding significant protective effects of UCT against HSV-2 in the poorest groups.

Table 7 presents the estimates of negative shocks and health outcomes. There are two studies that investigate temporary negative shocks. Pettifor et al. (2016b) find non-significant effects on HIV and HSV-2 prevalence, which makes sense given that HIV and HSV-2 are very low-frequency events. A large sample across a long period of time with multiple shocks is needed to detect differences in such low-frequency events. However, as measured outcomes become more frequent, such as with STI symptoms, significant differences are detected between those who suffer shocks (Jones and Gong 2019).

There are four studies exploring persistent negative shocks. Low et al. (2019) largely find non-significant associations between droughts and HIV; however, they do find that young men have lower adjusted odds of contracting HIV during a drought than women. For women, the adjusted odds are significant only at the 10 per cent level. Burke, Gong, and Jones (2015) study cross-sectional DHS data from 19 African countries finding that droughts explain up to 20 per cent of the variation in cross-country HIV prevalence. Despite the cross-sectional analysis, they have a very large sample and solid identification strategy (assuming droughts are exogenous). They find a 0.3 percentage point (ppt) increase or 7.3 per cent increase in HIV prevalence in drought-affected rural areas given a mean HIV prevalence of 4.1 per cent. Similar results were found when including both urban and rural areas. Tequame and Tenikue (2017) find an association between HIV and civil violence for women in Cote d'Ivoire; however, the quality of this before/after study means that this conclusion should be treated with caution. Gong, De Walque, and Dow (2019) find increases in food insecurity led to increases in STI incidence in women.

The two permanent negative shocks considered are withdrawal of CCTs and UCTs and a death in the household (Baird, McIntosh, and Özler 2019; Pienaar, Van Rooyen, and Walsh 2017). The former finds no association whereas the latter finds HIV prevalence is positively associated with experiencing a death in the last year. Overall, there appears to be a link between quasi-random negative shocks and HIV, but the effects of positive shocks are difficult to prove due to small samples and low-frequency events making statistical relationships difficult to tease out.

Table 3. Health Status Outcomes.

Outcome	Definition	n
HIV	Four measures of incidence, 27 prevalence[33]	31
HSV-2	One measure of incidence, six prevalence	7
STI symptoms	Self-reported, or testing positive for, STI	3
Syphilis	All prevalence	4

Table 4. Risky Sexual Behaviours – Direct Outcomes.

Outcome	Definition	n
Extensive margin	**Outcomes that measure any sex (engaging or re-engaging in transactional sex)**	**31**
Non-spouse partners	Having a non-spouse or non-primary sexual partner	7
Sexual frequency †	Having engaged in any sex over a time period, usually interpreted as 'being sexually active'	24
Intensive margin	**Outcomes that measure the quantity of sex**	**48**
Sexual frequency †	Count of sex acts that take place over a period including 'number of clients' for FSWs	19
Multiple partners	Number of different partners (excluding FSWs)	25
Number of sex acts	Count of number of sex acts (only FSWs)	4
Degree of risk	**Outcomes that measure the sex acts that expose individuals to elevated risk of HIV and other STIs**	**59**
Client type	The share of clients that are regular or occasional (only FSWs)	1
Condomless sex	Number of or last sex act being unprotected	51
Safe sex	Composite outcome including condomed sex or abstaining	2
Type of sex act	Number of anal sex acts	5

Transactional sex and other extensive margin outcomes

Transactional sex is the most common outcome measured on an extensive margin, with estimates across four unique positive shocks in five separate studies and 13 unique negative shocks in seven separate studies. Table 8 presents the estimates of positive shocks, and Table 9 for negative shocks on transactional sex and other extensive margin outcomes.

Temporary and persistent positive shocks reveal non-significant effects on transactional sex (Kilburn et al. 2019; Pettifor et al. 2016a; Wagner et al. 2017). The copper price boom in Zambia, a permanent positive shock, Wilson (2012) finds a protective effect of transactional sex for both men and women in a large representative sample that is generalisable to other poor countries. The interaction term analysis by sex suggests larger reductions for men than for women but the difference here is not statistically significant. However, the other permanent positive shock that measures transactional sex is a long run cash transfer that finds no significant changes to transactional sex (Handa et al. 2017; Rosenberg et al. 2014).

For other measures on the extensive margin, following a cash transfer in Malawi, there is a somewhat protective effect in the short-run (mostly significant at the 10% level) against schoolgirls engaging in *any sex* (Pettifor et al. 2016a; Baird et al. 2010; Kohler and Thornton 2012) but an increase in *any sex* in men (Kohler and Thornton 2012). However, concluding *any sex* is transactional or risky is difficult. Baird et al. (2012) and Goodman et al. (2015) find no significant effects of CCTs protecting against *sexual debut*, but Pettifor et al. (2016a) do. A permanent UCT finds a delaying effect on *sexual debut* (Handa et al. 2014, 2017); however, the evidence of CCTs delaying marriage is mixed. Baird et al. (2012) now find a protective effect of the conditional cash in delaying marriage but the unconditional cash not (Handa et al. 2015).

There is only one negative temporary shock, illness to another household member, which shows significant increases in transactional sex across all versions of the estimation[15] (Jones and Gong 2019). This is a good quality study using a sample of FSW and other vulnerable women taking advantage of sexual diaries that include precise dates for sex and shocks allowing good mapping of

Table 5. Risky Sexual Behaviours – Indirect Outcomes.

Outcome and margin	Definition	n
Age of marriage – Extensive	Age or age bracket of marriage	27
Transactional sex †[37] – Extensive	Often defined as engaging in sex for cash or gifts and ever engaging in commercial sex †	42
Sexual debut – Extensive	Age or age bracket of the first sexual intercourse	31
Age at circumcision – Riskiness	Years delayed getting circumcised[38]	7
Age disparity – Riskiness	Number of years between sexual partners, or pre-defined age of elder partners	22
Contraceptive use – Riskiness	Combination of all contraceptives including condoms in a fertility context	10

†Those outcomes that when analysed with a binary variable is an extensive margin outcome, whereas, when measured on a continuous variable, it is a measure of intensity.

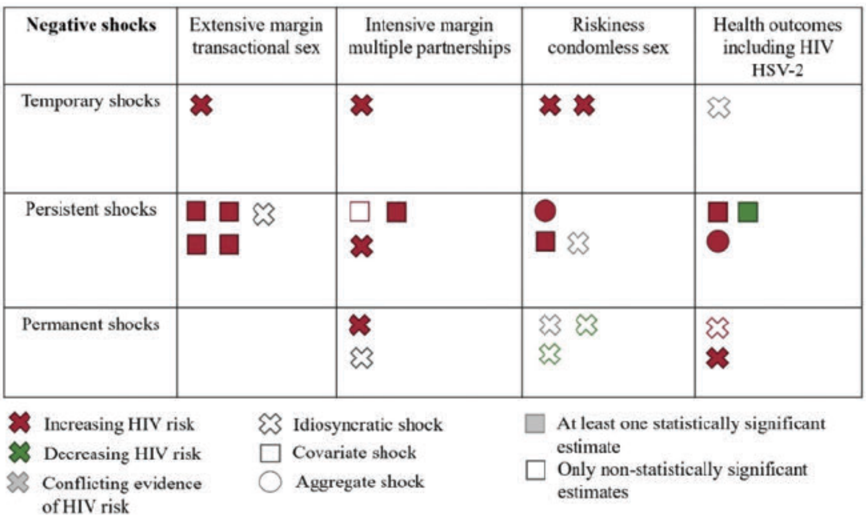

Figure 3. Evidence Map of Negative Economic Shocks and Key Outcomes.

shocks to sex acts.[16] However, when considering the seven-day outcome recall alongside the sample, it is likely that this outcome captures re-entry to, or utilisation of, the transactional or commercial sex market, rather than new entrants exclusively.

There are 12 persistent negative shocks with 23 estimates from six studies for transactional sex on the extensive margin, almost all of which are for females (22/23). Low et al. (2019) perform separate analyses by adult (25–59) and adolescent (15–24) women finding the drought had significant association for adults but not for adolescents (Adults: AOR = 1.46; 95% confidence interval [CI], 1.1–1.93 vs. Adolescents: AOR = 1.27; CI: 0.63–2.56). However, Burke, Gong, and Jones (2015) indirectly find evidence of transactional sex being the channel by which droughts lead to higher HIV prevalence.[17] When asking directly, Tequame and Tenikue (2017) find a significant proportion of those engaging in transactional sex do so because of political unrest in Cote d'Ivoire.[18] Molotsky (2019) finds numerous significant effects of varying shocks but, interestingly, not for agricultural shocks (which include drought). Gong, De Walque, and Dow (2019) find no statistically significant effect on transactional sex for men or women when studying changes in food insecurity as a shock, and Bandiera et al. (2019) find no effect of Ebola disruption on women entering the transactional sex market.

The strongest evidence comes from covariate shocks. It follows that covariate shocks are likely to deplete typical coping strategies available to households more quickly, such as relying on close family and friends, if they too are struck by the shocks. This means households must rely on more atypical methods of consumption smoothing, namely sexual coping strategies.

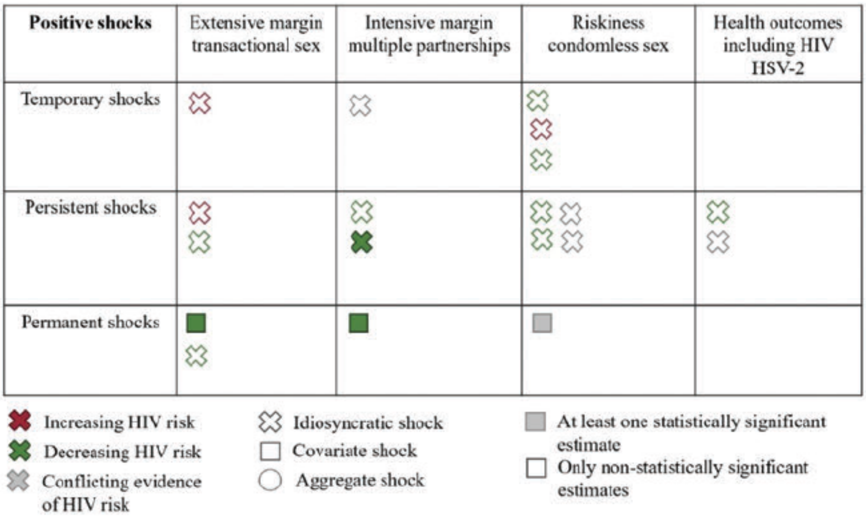

Figure 4. Evidence Map of Positive Economic Shocks and Key Outcomes. Note: Darker shades represent high cumulative studies in that country. Dashed lines represent countries with DHS surveys used in Burke, Gong, and Jones (2015) or Corno, Hildebrandt, and Voena (2017). Not shown are single samples from India and Thailand.

Of the indirect risky behaviour outcomes on the extensive margin, Corno, Hildebrandt, and Voena (2017) find evidence that marriage is used by households as a consumption smoothing device, with a reduction (increase) in the age of marriage for females (males) following droughts in societies where money flows to the bride's (groom's) family.[19] Baird, McIntosh, and Özler (2019) find that marriage occurs soon after the withdrawal of cash transfers in Malawi, highlighting a lack of persistent effects of cash transfers on these behaviours. There is little evidence of negative shocks strongly influencing sexual debuts (Baird, McIntosh, and Özler 2019; Dinkelman, Lam, and Leibbrandt 2007, 2008; Low et al. 2019). Similarly to Jones and Gong (2019) above, Robinson and Yeh (2011) find that FSWs had sex in the days following illness to another household member or recovering from an STI (both temporary negative shocks) which can be interpreted as evidence for utilisation of the transactional or commercial sex markets.[20] Brodeur, Lekfuangfu, and Zylberberg (2018) examined how the presence of the US military and varying crop prices led to the rapid expansion of the sex industry in Thailand. They find that around 50 per cent of the current day variation in sex worker populations is due to demand and supply shifters present at the time of the sex industry's peak in the 1990s.

Overall, across all studies with transactional sex as an outcome, we see only a permanent positive aggregate shock leading to a net reduction in transactional sex. There is no significant effect from other positive shocks, yet there is evidence negative covariate shocks lead to an increase in transactional sex or utilisation of the commercial sex market (for FSWs). The evidence suggests that changes are more responsive to negative shocks than positive shocks and require larger-scale positive shocks to observe these reductions. There is a distinct lack of evidence of exclusive new entrants or withdrawals to transactional sex, which remains an important public health question to answer.

Multiple partners and other intensive margin outcomes

Multiple partnerships is a strong direct measure of risky sexual behaviours on the intensive and extensive margins. Where analysis is of a binary outcome, one or more partners, be it limited to non-primary partners or not, it is capturing changes on both margins. Intensity is better captured when the outcome is a count of the number of partners. Many studies choose to analyse only the former, probably due to left skewed distributions of the number of partners variable. Table 10 and Table 11

Table 6. Estimated Parameters of Positive Shocks on Health Outcomes, HIV, HSV-2 and other STIs.

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Baird et al. 2012)	HIV prevalence	Combined cash transfer (education)	Baseline schoolgirls 13–22	AOR	0.36**	0.14	0.91
	HSV-2 prevalence				0.24**	0.09	0.65
	HIV prevalence	CCT (education)	Baseline female dropouts 13–22		1.37	0.72	2.61
	HSV-2 prevalence				1.03	0.47	2.23
	HIV prevalence		Baseline schoolgirls 13–22		0.09**	0.09	0.98
	HSV-2 prevalence				0.37	0.13	1.03
	HIV prevalence	UCT	Baseline schoolgirls 13–22		0.47	0.14	1.59
	HSV-2 prevalence				0.08**	0.01	0.58
(Pettifor et al. 2016a)	HIV incidence	CCT (education)	HIV negative schoolgirls 13–20	Hazard ratio	1.17	0.8	1.72
	HSV-2 incidence				0.9	0.69	1.19
(Smith, Hein, and Bagenda 2019)	HIV prevalence	Combined cash transfer (education)	Baseline schoolgirls 13–22 (CCT + UCT)	Subject specific odds ratio	0.54	0.19	1.54
		CCT (education)	Baseline schoolgirls + dropouts 13–22		0.42	0.12	1.51

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies.

report the estimates for multiple partnerships and other intensive margin outcomes from positive and negative shocks, respectively.

There is one temporary positive shock, a lottery, three persistent, including two CCTs on educational attendance and one community CCT programme as part of a wider support intervention,[21] and one permanent positive shock, the resource boom. Wagner et al. (2017) find a non-significant impact of the lottery on multiple partnerships of men or women. Pettifor et al. (2016a) also find a non-significant relationship for women and the number of partners, but Baird et al. (2010) do find a significant decrease in the number of partners for young women soon after the introduction of the cash transfer programme.[22] Goodman et al. (2015) find no relationship between their cash transfer intervention and multiple partnerships in Kenya. However, Wilson (2012) finds an overall negative relationship studying men and women combined due to the Zambian Copper boom.[23] The suggestion is that this reduction is likely due to a fall in supply from women and that this outweighs any demand increase from men from the permanent positive shocks.

There are 19 estimates from seven negative shocks across seven studies. One is temporary, four are persistent, and two are permanent negative shocks linked to multiple partnerships. The temporary shock finds illness to another household member increases the number of sexual partners a woman has by 0.755 (point estimate (PE) = 0.755; standard error [SE] = 0.223) (Jones and Gong 2019). Of the four persistent shocks are two unique droughts, one is food insecurity and one civil unrest in Cote D'Ivoire. Of these, the most convincing study, by Burke, Gong, and Jones (2015), finds a significant positive effect from the number of drought shocks a respondent suffers in the past 5 or 10 years and the number of multiple partnerships men have and a similar positive relationship for women but with lower point estimates and significance at the 10 level (estimate of men for shocks over the last 10 years – PE: 0.018; SE: 0.004. Effect for women – PE: 0.003; SE: 0.002). When the shock is binary, that is, 'did a drought occur in the last 12 months?', which is the same period of time as the multiple partnerships recall period, 12 months, the relationship is non-

Table 7. Estimated Parameters of Negative Shocks on Health Outcomes, HIV, HSV-2 and other STIs.

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Gong, De Walque, and Dow 2019)	HIV prevalence	Drought	Urban men aged 15–59	Odds ratio	0.85	0.52	1.4
			Urban women aged 15–59		1.35	0.87	2.08
			Rural men aged 15–59		1.38	0.77	2.46
			Rural women aged 15–59		1.05	0.79	1.38
			Men aged 15–24 vs both genders in non-drought areas	AOR	0.35**	0.17	0.72
			Women aged 15–24 vs both genders in non-drought areas		1.8*	0.96	3.39
			Men aged 25–59 vs both genders in non-drought areas		0.72*	0.51	1.01
			Women aged 25–59 vs both genders in non-drought areas		1.18	0.85	1.65
(Gong, De Walque, and Dow 2019)	STI incidence	Health	Men aged 18–60	Risk difference	−0.026	0.00536	−0.0574
			Women aged 18–60		0.054**	0.00892	0.0991
(Tequame and Tenikue 2017)	HIV – not definitive	Civil disorder	Women aged 15–49 in all regions	Risk difference	0.0042	−0.0056	0.014
			Men aged 15–49 in all regions		−0.0005	0.0093	−0.0103
			Women aged 15–49 in Langnues region		0.0121**	0.00034	0.0239
			Men aged 15–46		−0.0029	0.00886	−0.0147
(Pienaar, Van Rooyen, and Walsh 2017)	HIV prevalence	Death of a spouse	Men and women aged 25–64	AOR	4.91**	2.06	11.73
(Pettifor et al. 2016b)	HIV prevalence	Health	Unmarried schoolgirls aged 13–20	Odds ratio	1.68	0.67	4.26
			Unmarried schoolgirls aged 13–20	Age-adjusted odds ratio	1.89	0.74	4.82
	HSV-2 prevalence		Unmarried schoolgirls aged 13–20	Odds ratio	0.93	0.32	2.59
			Unmarried schoolgirls aged 13–20	Age-adjusted odds ratio	1.08	0.38	3.05
(Burke, Gong, and Jones 2015)	HIV prevalence	Drought	Men and women aged 15+	Risk difference	0.003*	0.00104	0.00496
				Risk difference (interaction shock and urban = 1)	0.004**	>0.0001	0.00792
			Men and women in rural areas aged 15+	Risk difference (interaction urban = 0)	0.003	−0.00092	0.00692
			Men and women aged 15+ in rural areas of low prevalence countries only	Risk difference	0.008**	0.00212	0.0139
			Rural men and women aged 15+ in high prevalence countries		0.008**	0.00212	0.0139
			Rural men aged 15+ in high prevalence countries		0.009**	0.00116	0.0168
(Jones and Gong 2019) reported	At least one STI symptom not reported	Health - many versus few	FSWs and vulnerable women aged 16–25	Risk difference	0.1	not	
(Baird, McIntosh, and Özler 2019)	HIV incidence	Withdrawal of cash transfer	Baseline dropout aged 16–29 (CCT)	Risk difference	0.02	−0.0251	0.0651
			Baseline schoolgirl aged 16–29 (CCT)		−0.001	0.0362	−0.0382
			Baseline schoolgirl aged 16–29 (UCT)		−0.002	0.0431	−0.0471

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies. Standard error not reported in Jones and Gong 2019).

significant. This suggests the effect of shocks on multiple partnerships takes time (for men – PE: −0.007; SE: 0.012. For women – PE: 0.003; SE: 0.004). Still, in Burke, Gong, and Jones (2015) the outcome of *non-spouse partners* there is a significant positive relationship for men and women across almost all shock definitions. This represents a 20% increase for women and 13% increase for men[24] (for men and a *last 12-month* drought – PE: 0.035; SE: 0.017. For women – PE: 0.023; SE: 0.010). Of the other persistent shocks, Low et al. (2019) do not find significant associations but only perform univariate comparisons of drought and multiple partnerships. Gong, De Walque, and Dow (2019) find an increase in the number of women having multiple partnerships because of increased food insecurity but not for men and only when examining linear combination results. Additionally, Tequame and Tenikue (2017) find an increase in the number of partners following civil disorder.[25] Within a sample of FSW and others at high risk of transactional sex, there is strong evidence that, during a temporary health shock, there are increases in the intensity of sex[26] (Robinson and Yeh 2011).

Dinkelman, Lam, and Leibbrandt (2007) find an increased chance of women having multiple partners following a permanent household shock.[27] Dinkelman, Lam, and Leibbrandt (2008) then using the same sample and same shocks, but with somewhat different analysis, find a decrease in the chance of multiple partnerships for women and increase for men both significant at the 10 per cent level. A key limitation with these studies is that the shocks are household level, the financial impacts of which are probably not the responsibility of the sample, adolescent 14–22-year olds, or the shocks took place sufficiently far in the past compared to the recall of behaviours (shocks up to 2 or 3 years ago, behaviours in the last 12 months). Despite the limitation, the opposing evidence for women adds uncertainty to the effect of permanent shocks and further study is required before strong conclusions can be made.

It appears that persistent and permanent expectations of positive shocks with wider scales have beneficial effects on the intensive margin outcomes, primarily multiple partnerships. This would suggest the supply side effect on women outweighs any demand increases coming from men, but evidence is far from conclusive. Evidence from negative shocks is also unclear, Jones and Gong (2019) finding short-run increases in multiple partnerships but Burke, Gong, and Jones (2015) only in the long-run, plus the mixed evidence from the Dinkelman, Lam, and Leibbrandt (2008, 2007) studies.

Condomless sex and other riskiness outcomes

Table 12 and Table 13 present effects from positive and negative shocks on condomless sex and other riskiness outcomes, respectively. There is no evidence that negative permanent shocks lead to changes in condomless sex (Baird, McIntosh, and Özler 2019; Dinkelman, Lam, and Leibbrandt 2007, 2008). However, for the positive shock Wilson (2012) does find a differential effect between men and women through inclusion of an interaction term (shock = 1 & female = 1). This term just exceeds the (non-significant) coefficient on the shock alone, implying there is a small increase in condomless sex driven by women. However, this could be explained by differential social desirability bias in reported answers from men and women.

There are three negative and three positive temporary shocks. Two of the negative shocks are illness to another household member and one defined as FSWs recovering from an STI. Two of the positives are a UCT and a CCT on maintaining HIV status.[28] There are two contradicting results for positive shocks. Kohler and Thornton (2012) find men increase condom use following a cash payment, which they argue fits previous literature finding a positive relationship between wealth and condom use (Luke 2008). However, Wagner et al. (2017) find an increase in *condomless sex* with a non-primary partner.[29] The claim that wealth is positively correlated with condom use for men appears to not consistently hold for temporary positive shocks. This highlights the difference between the level of risky sex at equilibrium (which is more likely affected by persistent and permanent shocks) and risky sex used to correct a disequilibrium, that is, sex for consumption smoothing (more likely from temporary shocks).

Analysis of temporary negative shocks is exclusively in samples of FSWs and other vulnerable women in Kenya, with data collected using sex diaries providing very precise daily data with little recall error. Jones and Gong (2019) find that the number of condomless sex acts increases in the weeks where another member of the household is sick. Robinson and Yeh (2011) find a significant reduction in condom use for women if the respondents have recently recovered from an STI but insignificant when someone else was sick in the household. There are no studies on temporary negative shocks from men or clients of FSWs. Robinson and Yeh (2011) also study effects on other related risky sexual behaviours, finding significant estimates of illness to other household members on anal sex and oral sex but not vaginal sex, evidence of FSWs engaging in riskier behaviours, without necessarily increasing their intensity, that is, the number of sex acts, to pay medical bills.

For negative persistent shocks, there are two contexts in which condom use has been measured. The first is within the fertility context where there is an implication transactional sex is not influencing condom use (Abiona 2017; Alam and Pörtner 2018), and the second where transactional sex is implied. Evidence from the fertility context suggest a strong increase in the purchase and use of contraceptives, including condoms, following droughts suggesting evidence of longer-term consumption smoothing behaviour, through delayed birth, running counter to any transactional sex effects.

For transactional sex, Dupas and Robinson (2012), Gong, De Walque, and Dow (2019), Bandiera et al. (2019) all find reductions in condom use, or increases in unprotected sex, from the negative persistent shocks of civil disorder, food insecurity and Ebola disruption, respectively. Dupas and Robinson (2012) and Gong, De Walque, and Dow (2019) both tailor their studies to investigating users of transactional or commercial sex,[30] but Bandiera et al. (2019) have a more representative sample and outcome, finding an increase in unprotected sex acts but only for those who never use condoms.[31] However, Low et al. (2019) find for both sexes aged 15–24 an increase in condom use at last sex act during a drought at the 10 per cent significance level (AOR: 1.49, 95% CI: 0.99–2.24). They find a larger effect for those aged 25–59 (AOR: 2.42, CI: 2.13–2.76). The younger age group findings somewhat contradict the findings from Bandiera et al. (2019) whose sample is females aged up to 25 years old. There is no evidence that persistent *positive* shocks are associated with condom use.

Venkataramani and Maughan-Brown (2013) find that economic shocks lead to delayed circumcision, an indirect measure of riskiness, by around 2 years, increasing the risk of HIV by 1 ppt per year delayed.

Overall, condomless sex appears to be driven by temporary negative shocks with evidence, suggesting it is used by women to access premiums to help smooth consumption, particularly in samples at high risk of engaging in transactional or commercial sex. But evidence is mixed for more nationally representative samples of women.[32] The lack of protection given by persistent positive shocks could mean transactional condomless sex is not as frequent in equilibrium, thus changes are hard to detect.

Discussion

Heterogeneity of evidence

The main challenge in conducting this systematic review is the heterogeneity evidence. Samples across all papers vary as do the definition of shocks, outcomes, and methods of data collection before any analysis has been completed. Direct comparisons between studies via meta-analysis would be difficult and unhelpful. Our work to broadly categorise shocks across the strata of expectation and scale, rather than by paper, helps to understand how different types of risky sexual behaviour or health outcomes respond. An inevitable limitation is the categorisation and evaluation of study design quality were done through assessment of the context and through details provided within each study introducing subjective elements from the reviewers. All attempts were made to make the key elements that drive our conclusions transparent and precise, namely categorical classification and using an external quality assessment tool.

Quality of evidence

As discussed earlier, a suitable quality assessment tool that focuses on the strength of the causal evidence in a collection of studies based largely on natural experiments was not available to the best of our knowledge. Using a risk of bias tool that was widely available but not suited could have wrongly penalised or inflated the strength of certain studies and would not be beneficial to this review.

The study design quality score of studies of negative shocks is more varied with only one registering a level 5 study design. The majority of studies, eight, exploit true individual level panel data and thus can control for unobservable time-invariant characteristics, key to many economic shock studies. Dupas and Robinson (2012) and Robinson and Yeh (2011) use sex diaries to gather a higher number of measurements per person making data very precise, with limited recall bias and strong results despite small sample sizes. Of the 13 cross-sectional studies, Burke, Gong, and Jones (2015) and Wilson (2012) can be considered strong with large samples, quasi-random shocks and solid identification strategies, the former assessing biomarkers too. Despite positive shocks having a higher study design, they do not ask similar questions to ours and thus attributed effects are a mixture of several possible mechanisms. For example, CCT on education (and UCT to a lesser degree) work through the additional teaching hours mixed with the effect of the shock of cash, which cannot be picked apart. All persistent and permanent shocks suffer from impacting longer run income levels for households which can affect risky sexual behaviour decisions at equilibrium. Our study is concerned with the use of risky behaviours to return to equilibrium for which temporary short-term shocks have a distinct advantage. A lack of positive temporary shocks and unconvincing evidence from persistent positive shocks imply behaviours are more affected by long-run uplifts in income and are largely unresponsive to short-run positive shocks.

Social desirability bias is a problem in most of the studies with self-reported behaviours because risky sexual behaviours are often underreported. Forty-one per cent of the studies analysing risky behaviours do not acknowledge social desirability bias as a potential issue and even fewer outline steps taken to minimise the potential effects. Treibich and Lépine (2019) find FSWs in Senegal report 19 percentage point difference in condom use, 97 per cent versus 78 per cent, when asking directly versus the list experiment method (indirect elicitation). There is little reason to believe that reporting of risky behaviours will differ by shock in retrospective analyses of natural shocks; however, biases could be related to other confounders, such as age. Therefore, this increases type II error, noise, and standard errors in estimates. Additionally, participants in intervention style studies could report differential rates of behaviour because of the Hawthorne effect and social desirability bias combined by thinking intervention benefits might be tied to self-reported behaviours (Rosenberg et al. 2018).

Additionally, the relatively small number of intensive margin outcomes could be due to not reporting analysis of intensive outcomes. Typically, these are continuous variables and require larger changes and variation to give statistically significant results.[39]

Migration

Labour migration is often linked to HIV in LMICs and can be a significant confounder in studies of aggregate and covariate shocks. In relevant studies, three failed to mention migration, 12 did but dealt with it to differing degrees. Dinkelman, Lam, and Leibbrandt (2008), for example, failed to appreciate migration, and it could be having an influence on their conclusions; however, Burke, Gong, and Jones (2015) did a good job of investigating the potential confounding impacts of permanent and temporary migration, finding little evidence that it explains their findings.

Table 8. Estimated Parameter of Positive Shocks on Transactional Sex Outcomes.

Author	Definition of the outcome	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Wagner et al. 2017)	A relationship motivated by cash or gifts in the last 4 months	Cash lottery	Men aged 18–30	Risk difference	0.057	–0.192	0.306
			Women aged 18–30		0.069	–0.115	0.253
(Kilburn et al. 2019)	At least one transactional relationship	CCT (education)	Women aged 13–20 (CCT)	Adjusted population level odds-ratio	1.03	0.87	1.21
(Pettifor et al. 2016a)	Engaging in transactional sex (unclear definition)	CCT (education)	Women aged 13–20	Relative risk	0.95	0.78	1.15
(Wilson 2012)	Engaged in relationship for money or gifts in the last 12 months	Resource boom	Combined men and women aged 15+	Risk difference	–0.046**	–0.0852	–0.0068
			Men aged 15+	Relative difference (female = 0)	–0.048**	–0.0754	–0.0206
			Women aged 15+	Relative difference (interaction shock & female = 1)	0.023	–0.0554	0.101
(Handa et al. 2014)	Having engaged in transactional sexual relationships in 5 years by 2011	UCT	Combined men and women aged 15–25	AOR	0.843	0.461	1.54
			Women aged 15–25		0.979	0.439	2.19
			Men aged 15–25		0.711	0.295	1.71
(Rosenberg et al. 2014)	If current or most recent relationship received money gifts or favours in exchange for sex	UCT	Women aged 15–25	AOR	0.76	0.43	1.33
			Men aged 15–25		1.57	0.6	4.07

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies.

Lessons for policy and practice

The key policy lesson to learn from this review is that protecting women against negative shocks is likely more effective and feasible than hoping for behaviour change through positive shocks, such as cash transfers. Providing protection against consumption dips where formal and informal coping strategies are lacking could prevent women relying on transactional sex. Work on economic protection and safety nets is already ongoing with promising results. See Swann (2018) for a comprehensive review of economic strengthening for HIV prevention, particularly the ‘protection’ interventions. Jones and Gong (2019) present promising results of an intervention encouraging savings as protection against economic shocks. Another promising intervention is offering or encouraging uptake of insurance to populations at risk of transactional sex, which could prove even more effective but is yet untested. The main advantages of savings and insurance interventions over cash transfers are that they provide access to cash at the time of greatest necessity and remove the need to bridge consumption gaps with transactional and risky sex.

Table 9. Estimated Parameters of Negative Shocks on Transactional Sex Outcomes.

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Low et al. 2019)	Having had a transactional sexual relationship in the last year	Drought	Urban women aged 15–24	Odds ratio	1.23	0.52	2.94
			Rural women aged 15–24		3.26 **	1.78	5.98
			Women aged aged 15–24	AOR	1.27	0.63	2.56
			Women aged 25–59		1.46**	1.1	1.93
	Having ever engaged in commercial sex		Urban women aged 15–59	Odds ratio	4.86**	2.2	10.7
			Rural women aged 15–59		1.3	0.7	2.44
(Gong, De Walque, and Dow 2019)	A transactional sexual relationship in the last 4 months	Food insecurity	Men aged 18–60	Risk difference	–0.019	–0.0856	0.0476
			Women aged 18–60	Relative difference (interaction shock & female = 1)	0.033	–0.0278	0.0938
			Women (linear combination)	Relative difference	0.014	na; p value = 0.40	
(Tequame and Tenikue 2017)	Entry into transactional sex market	Civil disorder	HIV negative men and women aged 15–49	*Not reported*	-	-	-
(Molotsky 2019)	Started relationship for cash or gifts	1st combination of shocks	Unmarried women aged 15–21	Risk difference	–0.053	–0.129	0.0234
				Relative risk difference (interaction shock & patrilineal society = 1)	0.198**	0.0294	0.367
		Agricultural	Unmarried women aged 15–21	Risk difference	–0.042	–0.0988	0.0148
				Relative risk difference (interaction shock & patrilineal society = 1)	0.087	–0.107	0.281
		2nd combination of shocks	Unmarried women aged 15–21	Risk difference	–0.008	–0.0629	0.0469
				Relative risk difference (interaction shock & patrilineal society = 1)	0.001	–0.185	0.187
		Household	Unmarried women aged 15–21	Risk difference	0.049*	0	0.098
				Relative risk difference (interaction shock & patrilineal society = 1)	0.083	–0.0836	0.250
		Household + agricultural	Unmarried women aged 15–21	Risk difference	–0.05	–0.121	0.0206
				Relative risk difference (interaction shock & patrilineal society = 1)	0.204**	0.0531	0.355
		Health shock	Unmarried women aged 15–21	Risk difference	–0.027	–0.0721	0.0181
				Relative risk difference (interaction shock & patrilineal society = 1)	0.028	–0.105	0.161
		Financial shock	Unmarried women aged 15–21	Risk difference	0.077**	0.02604	0.128
				Relative risk difference (interaction shock & patrilineal society = 1)	0.01	–0.133	0.153
(Burke, Gong, and Jones 2015)	Not observed – based on occupation and assumptions	Drought	Comparison of men and women in agricultural and non-agricultural occupations	na	na	na	na
(Jones and Gong 2019)	Transactional sex in the last week	Health	FSWs and vulnerable women 16–25	Risk difference	0.0434**	0.0191	0.0677
(Bandiera et al. 2019)	Unclear definition of transactional sex	Ebola disruption	Young women aged 12–17	Risk difference	0.23	–0.299	0.759
			Women aged 18–25		–0.002	–0.0373	0.0332

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies.

Table 10. Estimated Parameters of Positive Shocks on Multiple Sexual Partnerships.

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Wagner et al. 2017)	Number of sexual partners	Cash lottery	Men aged 18–30	Absolute difference	0.328	–0.0758	0.732
	Has a non-primary partner			Risk difference	0.177	–0.0798	0.434
	Number of sexual partners		Women aged 18–30	Absolute difference	–0.112	–0.381	0.157
	Has a non-primary partner			Risk difference	0.112	–0.0860	0.310
(Pettifor et al. 2016a)	Has two or more sexual partners in the last year	CCT (education)	Women aged 13–20	Relative risk	0.86	0.67	1.1
(Wilson 2012)	Has two or more sexual partners in the last year	Resource boom	Combined men and women aged 15+	Risk difference	–0.024**	–0.0436	–0.0044
			Men aged 15+		–0.028	–0.0672	0.0112
			Women aged 15+		0.004	–0.0764	0.0844
(Low et al. 2019)	Has two or more sexual partners in the last year	UCT	Female carers of orphaned and vulnerable children aged 16–21	AOR	1	1	1
			Male carers of orphaned and vulnerable children aged 16–21		1	0.99	1
(Baird et al. 2010)	Number of sexual partners	CCT (education)	Women aged 13–22	Absolute difference	–0.053**	–0.106	-<0.0001
			Female dropouts aged 13–22		–0.112**	–0.206	–0.0179
			Schoolgirls aged 13–22		–0.038	–0.0948	0.0188

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies.

Table 11. Estimated Parameters of Negative Shocks on Multiple Sexual Partnerships.

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Low et al. 2019)	Has two or more sexual partners in the last year	Drought	Urban men aged 15–59	Odds ratio	2.23	0.57	8.68
			Urban women aged 15–59		1.62	0.6	4.4
			Rural men aged 15–59		1.63*	0.97	2.74
			Rural women aged 15–59		0.5	0.2	1.23
(Dinkelman, Lam, and Leibbrandt 2007)	Has two or more sexual partners in the last year	Combination of shocks	Women aged 14–22	Probability difference	0.0377**	0.00046	0.0749
	Has two or more sexual partners in the last year		Men aged 14–22		0.065	−0.0291	0.159
(Dinkelman, Lam, and Leibbrandt 2008)	Has two or more sexual partners in the last year	Combination of shocks	Women aged 14–22	Probability difference	−0.052*	−0.111	0.0068
	Has more sexual partners than in 2000–2001 (more in second period than first)				0.002	−0.0137	0.0177
	Has two or more sexual partners in the last year		Men aged 14–22		0.087*	−0.0130	0.187
	Has more sexual partners than in 2000–2001 (more in second period than first)				0.142	−0.0324	0.316
(Burke, Gong, and Jones 2015)	Has two or more sexual partners in the last year	Drought	Men aged 15+	Risk difference	−0.007	−0.0305	0.0165
	Has a non-spouse partner (add footnote on inclusions)				0.035**	0.00168	0.0683
	Has two or more sexual partners in the last year		Women aged 15+		0.003	−0.00484	0.0108
	Has a non-spouse partner (add footnote on inclusions)				0.023**	0.0034	0.0426
(Jones and Gong 2019)	Number of sexual partners in the last week	Health	FSWs and vulnerable women 16–25	Absolute difference	0.755**	0.318	1.192

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies.

Table 12. Estimated Parameters of Positive Shocks on Condomless Sex Outcomes.

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Mills et al. 2018)	Condom use at last sex	UCT	HIV positive men and women	AOR	0.99	0.11	6.9
(Baird et al. 2012)	Inconsistent condom use with at least 1 partner	Combined cash transfer	Baseline schoolgirls aged 15–22 (CCT + UCT)	AOR	1.08	0.67	1.75
		CCT (education)	Baseline dropouts aged 15–22 (CCT)		0.74	0.44	1.23
			Baseline schoolgirls aged 15–22 (CCT)		1.17	0.67	2.05
		UCT	Baseline schoolgirls aged 15–22 (UCT)		0.96	0.5	1.83
(Wagner et al. 2017)	At least one sex act was unprotected with a non-primary partner over the previous 4 months	Cash lottery	Men aged 18–30	Risk difference	0.216	–0.0486	0.481
			Women aged 18–30		0.081	–0.107	0.269
(Pettifor et al. 2016a)	To have had unprotected sex act in the last 3 months	CCT (education)	Females aged 13–20	Relative risk	0.81	0.67	1
(Kohler and Thornton 2012)	Was a condom used at least once during sex in the last 9 days	CCT (education)	Men aged 14+	Risk difference	0.052*	–0.00876	0.113
			Women aged 14+		0	–0.0588	0.0588
(Wilson 2012)	Proportion of last sex acts with each partner that was protected (district aggregate)	Resource boom	Combined men and women aged 15 +	Absolute difference	–0.006	–0.0864	0.0744
			Men aged 15+		–0.026	–0.0926	0.0406
			Women aged 15+		0.039**	0.00764	0.0704
(Goodman et al. 2015)	Last sex was unprotected	UCT	Female carers of orphaned and vulnerable children aged 16–21	AOR	1	0.99	1
			Male carers of orphaned and vulnerable children aged 16–21		1	0.99	1
(Baird et al. 2010)	Scale of average condom from 1 "never" to 5 "every time"	CCT (education)	Women aged 13–22	Difference in ordered categoric outcome variable	–0.088	–0.645	0.469
			Female dropouts aged 13–22		–0.254	–0.775	0.267
			Schoolgirls aged 13–22		0.039	–0.868	0.946

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies.

Table 13. Estimated Parameters of Negative Shocks on Condomless Sex Outcomes.

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Low et al. 2019)	Condom use at last sex	Drought	Urban men aged 15–59	Odds ratio	1.04	0.75	1.45
			Urban women aged 15–59		0.98	0.64	1.48
			Rural men aged 15–59		0.8	0.6	1.08
			Rural women aged 15–59		0.7**	0.54	0.92
			Men and women aged 15–24	AOR	1.49*	0.99	2.24
			Men and women aged 25–59		2.42**	2.13	2.76
(Gong, De Walque, and Dow 2019)	Sex with a non-primary partner	Health	Men aged 18–60	Risk difference	−0.002	−0.0726	0.0686
			Women aged 18–60	Relative difference (interaction shock & female = 1)	0.049	−0.0314	0.129
			Women (linear combination)	Relative difference	0.047**	0	0
(Dupas and Robinson 2012)	Number of unprotected sex acts per client over 7 days†	Civil disorder	Shop keepers and women who practice transactional sex aged 18+	Absolute difference	0.36**	0.0856	0.634
	Total number of unprotected sex acts over 7 days†				−0.57**	−0.707	−0.433
	Number of unprotected vaginal sex acts per client over 7 days†				0.32**	0.0456	0.594
	Total number of unprotected vaginal sex acts per client over 7 days†				−0.56**	−0.697	−0.423
	Number of unprotected anal sex acts per client over 7 days†				0.05	−0.0676	0.168
	Total number of unprotected anal sex acts per client over 7 days†				0	−0.0392	0.0392
(Dinkelman, Lam, and Leibbrandt 2007)	A condom was used at last sex	Combination of shocks	Women aged 14–22	Probability difference	0.004	−0.118	0.126
			Men aged 14–22		0.011	−0.0968	0.119
(Dinkelman, Lam, and Leibbrandt 2008)	A condom was used at last sex (at 2002)	Combination of shocks	Women aged 14–22	Probability difference	0.05	−0.0362	0.136
	A condom was used at last sex (at 2005)				0.064	−0.0771	0.205
	A condom was used at last sex (at 2002)		Men aged 14–22		−0.051	−0.137	0.0352
	A condom was used at last sex (at 2005)				−0.016	−0.134	0.102
(Robinson and Yeh 2011)	At least one unprotected sex act in a day	Health	Women 18+ who are single, divorced, or separated and have multiple sexual partners	Risk difference	0.03**	0.00452	0.0555
	Total number of unprotected sex acts in a day			Absolute difference	0.063	−0.0193	0.145
	At least one unprotected sex act in the day after recovering from an STI			Risk difference	0.08	−0.0337	0.194
	Total number of unprotected sex acts in the day after recovering from an STI			Absolute difference	0.195	−0.048	0.438
(Jones and Gong 2019)	Number of unprotected sex acts in a week	Health	FSW and other vulnerable women aged 18–35	Absolute difference	0.0826**	0.0318	0.133

(*Continued*)

Table 13. (Continued).

Author	Outcome definition	Shock	Sample description	Estimator	Parameter estimate	95% confidence interval	
(Bandiera et al. 2019)	Those who categorise their condom use as often or always	Ebola disruption	Young women aged 12–17	Risk difference	−0.003	−0.0324	0.0264
	Frequency of sex in the last month for those who report never using condoms			Absolute difference	1.99**	0.551	3.43
	Those who categorise their condom use as often or always		Women aged 18–25	Risk difference	−0.009	−0.0306	0.0126
	Frequency of sex in the last month for those who report never using condoms			Absolute difference	−0.046	−1.6	1.56
(Baird, McIntosh, and Özler 2019)	Condom use at last sex	Withdrawal of cash transfer	Baseline female dropouts aged 18–22 (CCT)	Risk difference	0.03	−0.0288	0.0888
			Baseline schoolgirls aged 18–22 (CCT)		0.015	−0.0654	0.0954
			Baseline schoolgirls aged 18–22 (UCT)		0.05	−0.0441	0.144

* $p < 0.10$, ** $p < 0.05$. All risk differences are percentage point differences on the mean. Reporting and rounding errors lead to some small inconsistencies.
† Results taken from the midpoint week of the crisis (update symbol)

Implications for future research

Our recommendations for future research are twofold: first, future data collection in studies of risky sexual behaviours should collect data on shocks to increase the evidence base but also because suffering an economic shock is a key covariate in risky sexual behaviour studies. Second, data collection methods should be improved by including indirect elicitation for key risky sexual behaviours[36]and increasing data precision with sexual diaries.

Conclusions

In this review, we attempt to shed light on how risky sexual behaviours are affected by economic shocks. Riskiness and extensive margin outcomes are more numerous than intensive margin outcomes. Negative shocks are typically naturally occurring where positive shocks are not. Overall, extensive margin and riskiness outcomes are more responsive to negative shocks than positive shocks with evidence pointing to larger and permanent positive shocks being required to see significant improvements in risky sexual behaviours. Temporary negative shocks are particularly impactful to those already in commercial sex markets or those engaged in transactional sex with riskier sex acts used to increase income in response. However, these shocks are not impactful in more nationally representative samples. By categorising shocks into expectations and scale, we learn that persistent and covariate shocks consistently drive risky sexual behaviours in women. This suggests that women not already engaged in transactional sex markets can turn to these markets once non-sexual copings strategies have been exhausted. CCT and UCT are not consistently effective at improving risky behaviours and associated health outcomes, therefore, protecting women against downside risk of economic shocks is likely to be more effective in the response to HIV.

Notes

1. Defined as behaviours that increase the likelihood of contracting HIV and other STIs (Dimbuene, Emina, and Sankoh 2014). See Table 3 to Table 5 for all included risky behaviours.
2. Transactional sex is defined as: *'non-commercial, non-marital sexual relationships motivated by the implicit assumption that sex will be exchanged for material support or other benefit'* by Stoebenau et al. (2016) and the STRIVE network. In this paper, we consider 'transactional sex' that is motivated by economic needs under the assumption that other transactional sexual relationships are on average unaffected by economic shocks. See Stoebenau et al. (2016) for full explanations of transactional sex, including motivations driven by transactional sex as 'material expressions of love' or transactional sex for 'improved social status'.
3. Sex explicitly in exchange for money or gifts which has many overlapping features with the broad definition of transactional sex and can be viewed as sub-category of all transactional sex.
4. Results of sub-group analyses were not collected but important lessons from the sub-group analyses were noted for discussion in the results where appropriate.
5. All pertinent estimates were gathered from included papers, i.e. those models where the effect or association of a valid shock was estimated on a valid outcome. Where an author specified multiple versions of models, the estimates from the main model were extracted. There was one replication study, the estimates of which were only collected where they differed in statistical significance or direction from the original study (Baird et al. 2012; Smith, Hein, and Bagenda 2019).
6. Forty-seven per cent of papers directly study shocks pre-2017, the median year for published studies, and 56 per cent post-2017.
7. Excluding repeat analysis of shocks across papers and combined shocks where analysis is also done of their constituent parts.
8. Four of five are studies of the impact of a long-term cash transfer programme in Kenya (Handa et al. 2014, 2017, 2015; Rosenberg et al. 2014).
9. Cash transfers that were conditional on STI status were excluded because they change the existing risk/reward decision women are making. In other words, it is impossible to distinguish between the income effect and price effects in these cases. One exception is Kohler and Thornton (2012) where we include the cash transfers, but only include the analysis of outcomes after the cash is paid and the conditionality ceased.

10 With a total of 16 different cash transfer arms analysed against relevant outcomes, there are many estimates on slightly different sub-samples or definitions of cash transfers that do not occur in studies of naturally occurring shocks which have far fewer estimates.
11 These shocks are: one agricultural, nine health shocks, four household shocks, and three shocks are combinations of various shocks.
12 See Dupas and Robinson (2012) and Tequame and Tenikue (2017), the former makes inference analysing temporal changes at the person level, addressing well concerns with time trends. The latter attempts to compare, less successfully, those more and less affected by civil unrest.
13 Jones and Gong (2019) collect self-reported STI symptoms, all ten other studies collect health outcomes with a biological test, with four studies investigating positive shocks and seven negative.
14 Jones and Gong (2019) analyse self-reported STI incidence.
15 Contrary to most other transactional sex outcomes, the recall on this outcome in this study is 7 days which is appropriate for the shock.
16 A problem with many other observational studies is the recall is long or imprecise and there is potential bias with differential reporting for those who have suffered large economic shocks.
17 The authors based this on the hypothesis that drought differentially affects genders in rural and urban locations.
18 Reporting only answer to questions on why they have transactional sex.
19 Child marriage is an important factor within the extensive margin of sex for consumption smoothing too, but this arguably aligns more closely with the forced marriage literature than transactional sex due to the lower agency of the young women at risk. Therefore, we do not expand our discussion further on child marriage.
20 Jones and Gong (2019) also find *any sex* took place after illness to another household member.
21 Cash is given to community groups of the siblings of orphan and vulnerable children in the programme who decide how it is to be distributed. The wider intervention administered alongside the cash transfers has 'elements of psychosocial support, microfinance, entrepreneurial and other life skills training, cash transfer, and sex education in Kenya' (Goodman et al. 2015).
22 Statistically significant estimate for the baseline dropouts only.
23 There was no significant relationship for each gender separately but the size and direction of point estimates for men and women support the combined result.
24 The definition of non-spouse partnerships in this paper includes those 'monogamous cohabiting union' and single sexually active individuals, so a portion of this measure is capturing single partner relationships. Therefore, only a small number of these relationships might be considered risky and the result of the estimation could be interpreted as a delay in marriage due to shocks rather than representing an increase in risky behaviours.
25 Note quality limitations.
26 Outcomes include number of partners and number of sex acts, which in the context of commercial sex work fit conceptually with multiple partnerships and other intensity measures.
27 Their shock definition includes several permanent shocks: Loss of job, loss of grant, loss of support from outside the household, and the shock must have had a moderate or severe financial impact which itself introduces potential endogeneity.
28 The analysis is of behaviours since the conditionality has ceased (Mills et al. 2018).
29 However, the result is only significant when those in the conditional arm are included. The conditionality is to remain STI free violates our definition of a shock. However, point estimates for the conditional inclusions and non-conditional only are very similar (0.206 vs 0.216) with a reduced sample size in the non-conditional arm raising the standard error sufficiently to be non-significant.
30 Gong, De Walque, and Dow (2019) measure unprotected sex with non-primary partners without reporting changes in spousal condom use, and Dupas and Robinson (2012) study FSWs and find an increase the number of sex acts per client that are unprotected but equally a reduction in the number of clients that they have. They do not report the overall proportion of sex acts that are now unprotected, which would have been useful additional statistic.
31 There is no significant increase in condom use generally, a non-significant increase in frequency of sex overall, so the increase in unprotected sex appears to be capturing an absolute increase in unprotected sex driven by those who never use condoms and, thus, may be more risk loving. The authors note that this was unexpected because condom use was known by the sample to be protective against Ebola.
32 That is, samples that do not recruit based on likelihood or evidence of transactional sex.
33 In RCTs prevalence is usually preferred to incidence to avoid potential Hawthorne effects from HIV testing at baseline.
34 Largest sample analysed.
35 Replication of (Baird et al. 2012) study.
36 See Lépine, Treibich, and D'Exelle (2020) and Treibich and Lépine (2019).
37 Measures of transactional sex in the literature often conflate it with commercial sex work. This is a limitation of this outcome measure and future research should recognise this distinction in their work (Wamoyi et al. 2019).
38 See Venkataramani and Maughan-Brown (2013).

39 For example, Molotsky (2019) transactional sex from 'multiple survey questions' and includes those who 'reported ever receiving gifts or money from their partners', implying their data could have been analysed to measure the intensive margin also.

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Appendix A. Extended Methods

We searched the following databases of academic studies and institution/organisation websites for peer-reviewed and grey literature: 3ie review and impact evaluation databases, Medline, EMBASE, EconLit, Web of Science, JOLIS, IDEAS/RePEc, J-PAL, World Bank working paper series, Research4Development. Inter-American Development bank evaluations, Asian Development Bank Evaluation Resources, Agence Francaise Developpement, African Development Bank Evaluation Reports, USAID Development Experience Clearing House and ELDIS were also searched but yielded no additional studies.[1]

The search terms were designed to identify papers that examined the relationship between an economic shock and risky sexual behaviours of men and women in LMIC settings. Search terms were in English but non-English studies were included if they had an English title and abstract to facilitate screening. Databases[2] were searched using terms for economic shocks, specifically: 'economic', 'income' or 'consumption' with 'shock', 'fall', 'decline', '(in)security' or 'crisis' to capture all papers that might include economic shocks. These results were then combined with the following search terms to capture the risky sexual behaviours that can be used for consumption smoothing, namely 'HIV', 'AIDS', 'HSV-II', 'STI', 'sexually transmitted infection', and risky sexual behaviours: 'risky sexual behaviour', 'unprotected sex', 'commercial sex', 'transactional sex', 'multiple partners' or 'intergenerational sex' resulting in papers that include both an economic shock and risky sexual behaviour. These papers were then filtered to include only LMICs as per the World Bank classification. A draft search strategy was peer-reviewed by the London School of Hygiene and Tropical Medicine library providing feedback which was incorporated into the final search. A full list of search terms can be found in Appendix B. Websites without advanced database search functions[3] had simplified searches of 'economic shocks' and 'income shocks' linked with 'risky sex' and 'HIV'. Website searches took place in November 2019, with final database searches taking place in January 2020 once the search strategy had been peer-reviewed.

Title and abstract screening

[1]Initial searches included literature review databases, namely Cochrane and Campbell Collaboration, to find similar or duplicate reviews.

[2]EconLit, Medline, EMBASE.

[3]Web of Science, JOLIS, IDEAS/RePEc, J-PAL, World Bank working paper series, Research4Development.

For the purposes of abstract screening, economic shocks and risky sexual behaviours required precise definitions. The definition of economic shocks needed to capture meaningful impacts on study participants but retain the shock element setting them apart from studies of long-run macro-economic changes. We defined an economic shock as:

'An unexpected, sudden and significant change in income or expenditure of a household, which if unaddressed would have meaningful impacts on household consumption'.

This definition highlights that the shock must have clear potential for an impact on household finances leaving risky sex as a possible consumption smoothing mechanism. The *unexpected* term ensures that those behaviours influenced by the expectation of future shocks are excluded. Additionally, more gradual changes in economic circumstances are more likely to change a person's equilibrium acceptance of risky sexual behaviours and not reflect changes motivated by consumption smoothing.

Despite this definition, some uncertainty remained, so a conservative approach was taken at the screening stage to include those studies with unclear shocks. For example, food insecurity can be indicative of persistent poverty in the household (their long-run economic circumstances), or it can be indicative of a 'sudden change' in economic resources leading to a shortage of food or consumption power. If measured at multiple points in time, food-insecurity can be a good proxy for experiencing economic shocks. Where this was unclear, studies were evaluated more closely in the full-text review.

The risky sexual behaviour outcomes had to satisfy the following two criteria:

(1) The behaviour is expected to increase the risk of exposure to HIV or is a direct measure of exposure to HIV;
(2) The behaviour is expected to generate an economic return such that it can be used to smooth consumption in the study population.

A paper is included if at least one outcome satisfies the two criteria above and it contains a valid economic shock. Most risky sexual behaviours that increase the risk of exposure to HIV and that are used for consumption smoothing are clear and well documented in the literature.[4] However, there are others that are more nuanced, and measure risky sexual behaviours indirectly. Primarily, a transactional sexual relationship is not necessarily risky if the right precautions are consistently taken. However, on aggregate, these relationships are considered risky for women because the men who typically engage in these relationships are older, have higher condom bargaining power, have had more sexual partners and so have a higher chance of having HIV themselves. Couple this with that the economic incentives for women to accept riskier sex acts; transactgional sex is considered risky. Another example is age-disparate relationships measured via child-marriage. Similar to many transactional sexual relationships, women who are married very young are at greater risk of HIV. The husbands of these young women are typically older with a higher risk of HIV because of more previous sexual partners and, in some societies, polygamous marriages (Clark, Bruce, and Dude 2006; Meekers and Calvès 1997; Leclerc-Madlala 2003; Luke 2003). Dowries paid in either direction mean marriage of young women can be used directly by households incentivising such arrangements (Corno, Hildebrandt, and Voena 2017). On the other hand, intimate partner violence or forced sex is strongly associated with HIV but is not used by men or women as a consumption smoothing device so are excluded. Family planning provides another interesting context for measuring risky behaviours. Unprotected sex for planned pregnancy is conceivably lower risk because of increased knowledge of STI and HIV of sexual partners. Fewer individuals in this setting are engaged in multiple partnerships and have a higher chance of access and adherence to preventative HIV treatments. However, condomless sex in this context is still not risk free, particularly in polygamous marriages and, therefore, should the outcome include condom use (the part that has proven potential economic motivations), it would satisfy both criteria to be included as an outcome.[5]

Other inclusion criteria are the study must include measures of heterosexual sex by men or women, assess the effect or association of shocks on our list of outcomes and be published after 1990. This study was limited to quantitative studies only, but no studies were excluded on the basis of study design. Full details of the inclusion and exclusion criteria are included in the

[4]For example, engaging in commercial sex, condomless sex, anal sex, multiple partnerships, age-disparate relationships etc.
[5]We differentiate results between condomless sex in the context of family planning and condomless sex in other contexts to reflect the difference.

Appendix B. Inclusions and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
People/	population	All men and women in heterosexual relationships. People living with HIV if in serodiscordant relationships.
	Homosexual relationships, papers focussing exclusively on those living with HIV. Studies focussing on children younger than adolescent are excluded.	
Exposure/	treatment	Studies must explicitly explore the effect of economic shock, defined as 'an unexpected, sudden and significant change in income or expenditure of a household, which if unaddressed would have meaningful impacts on household consumption'. This includes but is not limited to the following negative shocks: medical expense, death in the house, religious festival, extreme weather (droughts, floods, agricultural), criminal (economic), food insecurity. Positive shocks: lottery win, monetary gift, cash transfer (conditional and unconditional), positive weather event (agricultural boom). Include studies with sub-group analysis stratified by economic shocks.
All papers without an	economic shock. For example – these are to be excluded. Shocks as outcomes to be excluded. e.g. 'HIV led to food insecurity'.	
Primary outcome	measures	All risky sexual behaviours including but not limited to, for non-sex workers: unprotected sex, transactional sex, number of concurrent partners, sexual debut, age disparate relationships, child marriage. For sex workers: numbers of clients/partners, unprotected sex, (re)entry to commercial sex markets, anal sex. For both: HIV, STIs.
e.g.	Exclusively safe sexual practices and Intermate partner violence.	
Countries	Low- and middle-income countries.	High income countries.
Study design	All study design or empirical strategies that include an effect of the shocks: RCT, Multi-variate cross-sectional, fixed-effects, regression discontinuity, instrumental variable, synthetic control, other randomised study design, other intervention studies indirectly assessing shocks.	Qualitative, univariate analysis. Reviews, non-impact evaluations.
Dates	1990 onwards.	Before 1990.
Languages	Any language.	No English title and abstract available.
Publication status	Peer reviewed published and grey literature, including working papers.	Comment, editorials, conference abstracts.
Abstracts	With Abstract.	Without Abstract.

Appendix C. Search Terms

	Search Terms
Economic shocks	economic$ adj3 shock$ OR negative adj3 shock$ OR income$ adj3 shock$ OR income$ adj3 volatil$ OR income$ adj3 fall$ OR income$ adj2 declin$ OR income$ adj3 insecurit$ OR income$ adj3 securit$ OR economic$ adj3 insecur$ OR economic$ adj3 secur$ OR catastrophic$ adj3 pay$ OR catastrophic$ adj3 expen$ OR catastrophic$ adj3 shock$ OR Episodic adj3 poverty OR househ$ adj2 crisis$ OR income$ adj2 crisis$ OR socioeconomic$ adj2 shock$ OR social$ adj2 econom$ shock$ OR social$ adj2 econom$ declin$ OR consumption$ adj2 fall$ OR consumption$ adj2 shock$ OR consumption$ adj2 declin$ OR consump$ adj2 smooth$ OR risk$ adj2 coping$ OR coping$ adj2 strat$ OR Drought$ OR flood$ OR food adj3 insecur$ OR food adj3 secur$ OR health$ adj2 shock$
Risky sexual behaviours	HIV$ OR Human immunodeficiency virus OR AIDs OR acquired immune deficiency syndrome OR HSV OR Herpes simplex virus OR STI OR sex$ transmit$ infec$ OR STD$ OR sex$ transmit$ disease$ OR risky sexual behavio?r$ OR risk$ adj3 sex$ OR unprotected sex$ OR contraceptiv$ OR unsafe adj3 sex$ OR condomless adj3 sex$ OR consistent adj2 condom adj2 use$ OR sex$ adj2 work$ OR Female$ sex$ worker$ OR FSW$ OR commerc$ adj2 sex$ OR transac$ adj2 sex$ OR sex$ adj2 debut$ OR age adj2 marriag$ OR multi$ adj2 partner$ OR sex$ act$ OR sex$ adj3 client$ OR anal adj3 sex$ OR intergenerational adj3 sex$ OR age adj2 differential$
Included studies	Economic shocks' AND 'Risky sexual behaviours'

This search was conducted on EconLit, equivalent searches completed on Medline and EMBASE

Appendix D. Shock descriptions by paper

Authors and date	Shock description	Country or Region	Direction and Expectation type	Shock scale
(Abiona 2017)	Drought measured as the difference in historic rainfall from the previous 12 months and defined as below the 25th percentile of historic rain plus floods if above the 75th percentile of historic rain.	Uganda	Negative persistent	Covariate
(Alam and Pörtner 2018)	Agricultural shocks defined as accidental crop loss of greater value than 200 Tanzanian shillings (TZS) collected via surveys.	Tanzania	Negative persistent	Idiosyncratic
(Baird et al. 2012)	The primary paper of a series included with multiple shocks: CCT, UCT, Pooled CCT and UCT, The condition is educational attendance and covers enrolled and unenrolled schoolgirls receiving cash over 2 years.	Malawi	Positive persistent	Covariate
(Baird et al. 2010)	See Baird et al. (2012)	Malawi	Positive persistent	Covariate
(Baird, Mcintosh, and Özler 2011)	See Baird et al. (2012)	Malawi	Positive persistent	Covariate
(S. Baird, McIntosh, and Özler 2019)	See Baird et al. (2012)	Malawi	Positive persistent	Covariate
(Bandiera et al. 2019)	Disruption to Villages from the Ebola crisis split into high and low based on if the villages were isolated or not.	Sierra Leone	Negative persistent	Covariate/
aggregate				
(Beauclair, Dushoff, and Delva 2018)	Assesses the impact immediately after the withdrawal of the cash transfer from Baird et al. (2012).	Malawi	Negative permanent	Idiosyncratic
(Brodeur, Lekfuangfu, and Zylberberg 2018)	Includes two shocks: Demand boom from US military in Thailand Agricultural price shocks applied as a continuum of price as the shock	Thailand	Positive persistent *followed by* negative permanent	Covariate

(*Continued*)

Authors and date	Shock description	Country or Region	Direction and Expectation type	Shock scale
(Burke, Gong, and Jones 2015)	Drought measured as the difference in rainfall to historic levels by DHS grid locations defined as drought when below the 15th percentile, and summed per location over the previous 10 years. The same definition is also calculated for only the last year to give a binary treatment variable for outcomes measured over the last 12 months.	Sub-Saharan Africa	Negative persistent	Covariate
(Corno, Hildebrandt, and Voena 2017)	Drought measures as below the 15th percentile of historic rainfall for each location.	Sub-Sharan Africa and India	Negative persistent	Covariate
(Dinkelman, Lam, and Leibbrandt 2007)	A composite shock defined as if a respondent's household experienced one of the following: death, job loss, loss of grant, loss of external support and the impact of the shock is moderate or severe financial impact.	South Africa	Negative permanent	Idiosyncratic
(Dinkelman, Lam, and Leibbrandt 2008)	See Dinkelman, Lam, and Leibbrandt (2007)	South Africa	Negative permanent	Idiosyncratic
(Dupas and Robinson 2012)	Civil disorder following the 2007 elections in Kenya concluding in February 2008.	Kenya	Negative persistent	Aggregate
(Gong, De Walque, and Dow 2019)	Food insecurity measured over time with individual fixed-effects therefore relying upon variation in food insecurity implying economic shocks.	Tanzania	Negative persistent	Idiosyncratic
(Goodman et al. 2015)	Cash transfer available to households with orphan and vulnerable children decided by their peers in community groups, measured one or two years following the cash transfer.	Kenya	Positive persistent	Idiosyncratic
(Handa et al. 2014)	UCT given to families of orphaned and vulnerable children in Kenya randomised within locations. Locations are 4th administrative unit below province, district, division and consists of a group of communities.	Kenya	Positive persistent	Idiosyncratic
(Handa et al. 2015)	See Handa et al. (2014).	Kenya	Positive persistent	Idiosyncratic
(Handa et al. 2017)	See Handa et al. (2014).	Kenya	Positive persistent	Idiosyncratic
(Jones and Gong 2019)	Includes two health cost shocks measured as illness to another household member gather at the weekly level for a weekly panel or alternatively as illness to another household member in 3 out of 12 weeks.	Kenya	Negative temporary	Idiosyncratic
(Kilburn et al. 2019)	HPTN 068 cash transfer programme conditional on educational attendance.	South Africa	Positive persistent	Idiosyncratic
(Kohler and Thornton 2012)	Cash Transfer conditional with behavioural outcomes assess once conditionality has ceased.	Malawi	Positive temporary	Idiosyncratic
(Low et al. 2019)	Drought defined as below the 15th percentile of historic rainfall per location.	Lesotho	Negative persistent	Covariate
(Mills et al. 2018)	One-off UCT payment to HIV positive individuals.	Uganda	Positive temporary	Idiosyncratic
(Molotsky 2019) idiosyncratic	Analyses a series of shocks suffered by households cut in several ways but all consisting of: Community level shocks – drought, crop disease, crop price drop, high food price; Household level shocks – illness, death, household business failure, death of livestock, job loss, loss of remittance or aid payments, household break-up, theft, dwelling damage; Cuts of data include: community level, household level, both community and household, economic shocks, family shocks, both family and economic shocks.	Malawi	Negative persistent	Covariate/
(Pettifor et al. 2016b)	HPTN 068 cash transfer programme conditional on educational attendance.	South Africa	Positive persistent	Idiosyncratic

(*Continued*)

Authors and date	Shock description	Country or Region	Direction and Expectation type	Shock scale
(Pettifor et al. 2016a)	Shocked are those respondents with a sick parent who was bed-ridden in the last 30 days.	South Africa	Negative temporary	Idiosyncratic
(Pienaar, Van Rooyen, and Walsh 2017)	Death of a spouse in the last 12 months is the only shock included from this study.	South Africa	Negative permanent	Idiosyncratic
(Robinson and Yeh 2011)	Several health cost related shocks consisting of: Illness to the responding FSW that was not an STI, although the effect was not estimated because of endogeneity issues; Illness to another household member; An STI to the responding FSW; Income lost to the responding FSW due to illness, although the effect was not estimated.	Kenya	Negative temporary	Idiosyncratic
(Rosenberg et al. 2014)	See Handa et al. (2014).	Kenya	Positive permanent	Idiosyncratic
(Smith, Hein, and Bagenda 2019)	See Baird et al. (2012).	Malawi	Positive persistent	Idiosyncratic
(Tequame and Tenikue 2017)	Political instability following elections in Cote D'Ivoire.	Cote D'Ivoire	Negative persistent	Aggregate
(Venkataramani and Maughan-Brown 2013)	Two shock analysed separately and combined which are: Illness to any household member Income shock defined as a job loss, loss of grant or business failure.	South Africa	Negative persistent	Idiosyncratic
(Wagner et al. 2017)	Cash transfer in the form of a lottery analysing behaviours of winners against those who did not win. Conditionality has ceased before the outcome's recall started.	Tanzania	Positive temporary	Idiosyncratic
(Wilson 2012)	Copper price boom that led to regional boom in jobs directly and indirectly because of the mining industry. Variation in boom depending on number and size of copper mines led to varying positive economic shock in the region.	Zambia	Positive permanent	Covariate

Appendix E. Evidence map notes

The evidence maps in Figures 3 and 4 are intended to visually display the range and direction of evidence but do not account for the weight or quality of studies. Each shape represents a study with green indicating an effect that protects against, or reduces, HIV risk, red increasing HIV risk, and grey conflicting. The shape is solid filled for a study with a statistically significant effect estimated at the 5 per cent level and no fill when statistically non-significant effects are estimated. The type of shape is determined by the shock's scale.

Studies only appear in each cell once and each study in each cell is labelled with the following priorities. First, a study is considered on the statistically significant estimates it contains; if it has at least one estimate significant in a direction of either increasing or decreasing HIV risk, it is assigned the appropriate colour filled shape. At this level, a study is only considered conflicting if there are statistically significant estimates for both increasing and decreasing risk.

Second, if a study has no statistically significant results for the shock and outcome of that cell, we consider the point estimates. If all are in the same direction, a colour is assigned; if there is at least 1-point estimate in both directions, then it is considered conflicting. There is no further sorting of the estimated effects.

In some cases, the point estimates were exactly 0 (or 1 depending on the model used) and so were considered neutral with no influence on the colour assigned. Where there was more than one shock with differing scale, we took the primary or largest scale shock as given.

3.2 Post-script

Since the paper intends to cover changes in behaviour from changes in the income channel, studies of conditional cash transfers (CCTs) were excluded. CCTs modify the underlying incentives and change the opportunity cost of risky sex by conditioning income on certain behaviours, such as school attendance or remaining STI-free. In other words, they 'nudge' participants to forgo instant gratification by positively incentivising specific behaviours or outcomes (Medlin and de Walque, 2008). Recent literature reviews cover these topics well across risky sex, HIV and other themes (de Walque, 2020; Richterman and Thirumurthy, 2022; Stoner et al., 2021). Entry to a lottery conditional on a negative STI test is successful alone in lowering HIV incidence (Nyqvist et al., 2018), and when combined with an educational condition (Gorgens et al., 2019). More conventional CCTs incentivising safe sex have mixed results - de Walque et al. (2012, 2014, 2016) find a protective effect against STI infection sustained over time; however, Kohler and Thornton, (2012) find the promise of money in the future had no impact on behaviours. Conditions on educational attendance also appear effective by changing the opportunity cost of dropping out and being more likely to rely on transactional relationships, but improvements in direct and indirect risky behaviours are not sustained in the long run (Baird et al., 2019, 2012). It appears interventions designed to influence behaviours work when rewards are close in time to the behaviours they aim to affect, but promises of future rewards are less effective.

Taking this additional finding in the context of the Research Paper where unconditional cash transfers and other small positive economic shocks had little impact on behaviours because cash transfers are typically too small to prevent the use of consumption smoothing behaviours. The addition of conditions appears to improve the effectiveness of cash. By also encouraging education or healthy behaviours, it adjusts the opportunity cost of engaging in such risky behaviours relative to other coping strategies resulting in such coping strategies being utilised less.

3.3 Additional References

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Chapter 4 – Conceptual Framework

4.1 Introduction

This chapter presents a conceptual framework to demonstrate the mechanism by which women use risky sexual behaviours to earn additional income and consumption smooth in the face of economic shocks. In doing so, it offers an explanation as to why HIV transmission disproportionately affects adolescent girls and young women. As discussed in Chapter 2 and 3, economic uncertainty is causally linked to risky sexual behaviours and increases the risk of HIV and other STIs. The literature, however, does not present a comprehensive conceptual or theoretical framework to help understand the mechanism. This chapter draws on ideas of structural economic gender inequalities meaning many women, particularly those in atypical family structures, face significant barriers that limit economic opportunities and poor economic resilience among women in African economies. This opens the possibility of commercial and transactional sex either as a primary source of income or a coping strategy to smooth consumption in the face of economic uncertainty. Engaging in commercial and transactional sex and associated risk premia available at the sex act level increase women's risk of STIs and HIV as a direct consequence of coping with the economic shocks.

This conceptual framework generates a series of predictions that are tested in the subsequent empirical chapters of this thesis. The predictions pertinent to the thesis are that anticipated and unanticipated economic shocks will both increase the use of risky sex at the extensive and intensive margins, as well as the riskiness of the sex itself. It also predicts that the behavioural response is sensitive to the magnitude of the shock at the individual and broader local economy level, plus the availability of alternative sources of income and coping strategies. Importantly, this Chapter's framework is the first that applies to both commercial and transactional sexual relationships regardless of self-identification, highlighting the common incentives for risky sex and the need for additional focus on transactional relationships.

4.2 Conceptual Framework

Key to this conceptual framework is the risk premium, the premium attached to riskier sex acts such as unprotected sex, available to women engaging in commercial and transactional sex that it reflects their choice and trade-off between health and wealth. Previous literature has conceptualised these premia alone within commercial sexual relationships (Gertler, Shah, and Bertozzi 2005). Importantly, our framework extends this conceptualisation from only commercial sex to include women engaging in transactional sex and that entering into such relationships is risky. It argues that using risky behaviours for consumption smoothing can be viewed as a rational risk-coping decision evaluated against an individual's opportunity cost.

The conceptual framework adapts and builds upon previous work in the literature from Gertler, Shah, and Bertozzi (2005) and Treibich and Lépine (2019) that model risk premiums and the utility of FSWs. Gertler et al. (2005) explain the decision of FSWs to engage in risky sex because of the price premium, whereas Treibich and Lépine (2019) adapt the theoretical framework of Geoffard and Philipson (1996) to show how utility theory can explain FSW decisions. The framework is also influenced by insights from the broader empirical and theoretical literature linking risk premia to risky behaviours and sex markets (Edlund and Korn 2002; Ito, Lépine, and Treibich 2018; Rao et al. 2003; de la Torre et al. 2010; Robinson and Yeh 2011; Cunningham and Kendall 2011; Cunningham and Shah 2018; Arunachalam and Shah 2013; Egger and Lindenblatt 2015; Lépine and Treibich 2020; Burke, Gong, and Jones 2015; Oster 2012b; 2005; 2012a).

Transactional and commercial sexual relationships are both modelled, focusing on the common economic incentives that apply to FSWs and a significant subset of women engaged in transactional relationships. Namely, those engaging within the paradigms of 'sex for basic needs' and 'sex for improved social status' because it positions women as engaging in transactional sex to obtain goods and services of economic value to them and therefore exposed to economic incentives (Stoebenau et al. 2016). In general, men have a preference for unprotected sex (Randolph et al. 2007) and would be willing to transfer or promise goods and services of a greater value in exchange for more preferential sex. The demand from men and the upward-sloping supply curve from women set the context for rational and compensated risky sexual behaviours to take place.

This framework attempts to model the risk premium as the driver of risky sex through the lens of utility-maximising agents who participate in commercial, transactional or both types of relationships. Similar to how FSWs might be profit maximisers via prices and income, users of transactional sex obtain services or goods that have intrinsic value to them. Wealth is the term we use to capture the utility gained from the value of the income and valuable services or other goods obtained from sexual partners. The framework predicts the risky sex decisions of women at the margin where such women have agency and autonomy to make such decisions. Not all women engaging in sexual exchange have the autonomy to engage in such relationships or over decisions within relationships. As previously mentioned, these coercive or exploitative relationships, while deserving of attention, are not open to the same economic incentives and are beyond this framework's scope.

4.2.1 Utility

We start by defining the utility of women who engage in transactional relationships as being a function comprised of two inputs, health (H) and consumption (C), with a Cobb-Douglas form, represented by equation [1]. Both have positive but diminishing marginal utility.

$$U(Woman) = f(H, C) = H^x C^y \qquad (1)$$

where $x + y = 1$. Health is modelled as an overall stock of health possessed by the woman at a point in time. Loss from this stock of health due to mental or physical harm can be temporary or permanent and diminishes utility. Consumption is modelled as a continuous variable and approximates the consumption power of the woman modelled. It includes income or implicit value expected from sexual exchange, income from non-sex work and non-liquid wealth that can be called upon if needed - for example, formal safety nets, investments, savings, and support from family members. Importantly non-liquid wealth includes implicit support from partners, such as support from transactional sex partners.

Men want sex; they gain utility from sex and moreso from risky sex acts and are willing to pay more for it (Randolph et al. 2007). When seeking a sexual partner or a sex act with an existing transactional partner, they have a budget in which to do so. This budget could be an explicit amount of money akin to commercial sex work or an implicit value they are willing to promise or transfer to the partner at a future date. For simplicity, we model this as a linear budget line. Each client has a differing slope, determined by their marginal utility from riskier acts. See Figure 4.1.

As utility maximisers, women wish to minimise the risks to their health whilst maximising their income, consusmption and wealth. Risks to health come from a wide range of actions in the sex market. The primary focus of this framework is to model the risk of HIV, a permanent loss of health stock, through unprotected sex; however, it applies to a wide range of potential health losses. Unprotected or condomless sex is a behaviour that directly increases the risk of HIV; however, other indirect behaviours also increase the chance of other physical and mental health losses and be a step on the pathway to HIV. For example, a man may prefer to have sex at home or somewhere remote because of increased privacy. To the woman in this situation, it presents a risk to her health because it puts her in an unfamiliar environment where her bargaining power is reduced and might give the implication of danger[3]. Therefore, her preference is likely to be a safer space like her home or somewhere with support nearby to empower herself over the engagement. Of course, not all male preferences have a direct risk trade-off for women, but for simplicity, we assume women would be willing to accommodate such non-risky preferences for free, leaving only risky preferences negotiable by the price.

4.2.2 Price differential

We can further express the price of risky sex through equations and figures using the example of price negotiation for unprotected sex, as per Gertler, Shah, and Bertozzi (2005). To reiterate, I model price and unprotected sex, but this can be substituted for more implied transfers or promises of support or material gifts and other risks to health from risky male preferences. For a given sex act, the payoff for the male having protected sex is:

$$U(Client^p) = V - B - P^p \tag{2}$$

where V *is the* utility from an unprotected sex act that is equal to his maximum willingness to pay not to use a condom, B is the disutility from using a condom (his utility can be negative if there is utility gained from using a condom) and P^p is the price paid to have protected sex, or the risk-free price. His utility from unprotected sex is:

$$U(Client^u) = V - P^u \tag{3}$$

where P^u is the price paid for unprotected sex. The opportunity cost of a male's time is assumed to be zero. A woman engaging in a transactional sex act has her utility determined by the following:

$$U(Woman) = P + H^{na} - rH^a - A \tag{4}$$

[3] Despite the reassurances of the satirical character Dennis Reynolds (2010), this 'implication of danger' in uncertain environments causes serious harm to mental and physical health (Sanders 2004) and is captured in the variable risk.

where P is the price received, and A is the opportunity cost of the woman's time, i.e., the value of the next best alternative, and represents the minimum price acceptable for any sex act. A is determined by the alternative forms of wealth available to them. rH^a represents the risk, r, of an adverse health event occurring, H^a, because of a risky sex act. H^{na} represents no adverse health event, or the existing stock of health. Expected health following the engagement represented in equations [1] is equal to $H = H^{na} - rH^a$ and expected wealth is equal to $W = P + F(A)$. In other words, wealth following an engagement is determined by the price and a function of the factors that make up the minimum acceptable price. We write risk as:

$$r = r_t + r_v \tag{5}$$

where the overall risk to health is made up of the fixed risk, r_t, absorbed by engaging in the sex act, e.g. the risk associated with the stigma from being discovered, and the variable risk, r_v, of each sex act. Internal stigma, as modelled in Ito et al. (2018), the damage to self-worth and self-esteem through engaging in commercial sex acts is absorbed in the fixed risk term, and external stigma, any additional risk of discovery and associated consequences to physical and mental health from risky sex are contained within the variable risk term.

The minimum price a man would have to pay for a transaction to take place is a function of the fixed risk, as is the reservation price an FSW would require to consider entering the sex market.

$$U(woman^p) = P^p + (1 - r_t)H - A \tag{6}$$

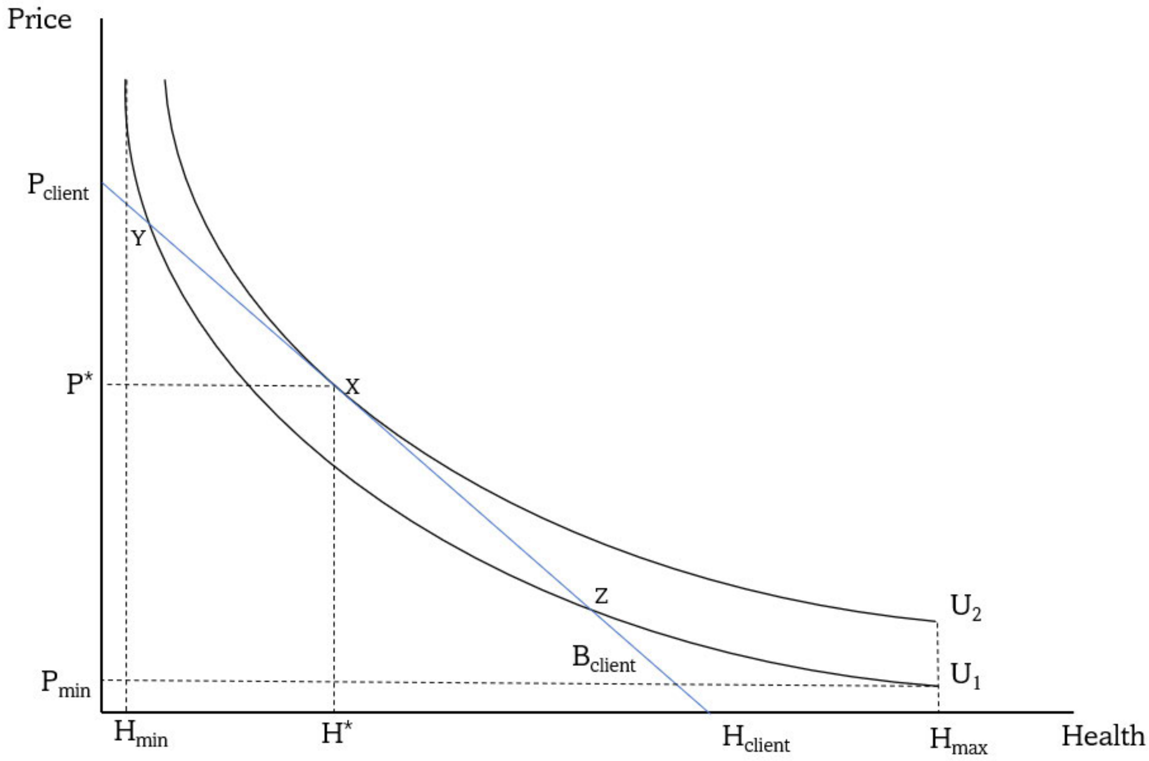
$$U(woman^u) = P^u + (1 - r_t - r_v)H - A \tag{7}$$

Continuing with the condomless sex example, in the protected case, $r_v=0$, and in the unprotected case, $r_v>0$. From equation [6], we can see that the minimum, or reservation, price a man must pay must exceed the opportunity cost of the woman's time plus compensation for the fixed risk. Equation [7] shows us that the risk premium for unprotected sex is a function of the variable risk.

4.2.3 Matching in the short run

Figure 4.1 summarises what has been described so far. It contains the Cobb-Douglas utility curves of a woman (U_1, U_2) from equation [1] and the linear budget line of a man based on equations [2] and [3]. It describes a situation where a transaction will occur because there is an overlap between the man's willingness to pay and the woman's willingness to accept.

Figure 4.1: Utility curve and budget lines of a possible transaction.



A woman enters the sex market with an endowment of health without any temporary health loss signified by, H_{max}, and a reservation price, P_{min} (or P^p in the equation [2]). The maximum risk she is willing to take, H_{min}, is the point at which she would not accept any money for such a sex act. These define her utility curve, U_1, representing the points at which a woman is willing to internalise health risk in exchange for increasing prices or value obtained because of the sex act. This is akin to her elasticity of price with respect to health risk and is determined by how she values the transformation of health to money, r_v. The area to the right of this curve are points at which the woman would accept a transaction because the utility obtained is greater than her initial indifference curve. The man's budget line is represented by B_{client}, with, P_{client} the highest price they can pay for the riskiest and most desired sex act (in this a risk the woman would not be willing to take at all) and H_{client} the safest sex they are willing to accept. The area to the left of this budget line represents all transactions acceptable to the man. We represent the budget line or the marginal rate of substitution between riskiness and utility for men as constant. In reality, budget lines are more likely to be concave, with men more willing to reach an agreement than demand another step up in women's health risks.

In Figure 4.1, there is an overlap where the range of acceptable sex acts and associated prices in the area between U_1 and B_{client}, where points Y and Z represent the two extremes of the health-consumption trade-off that could be achieved. Through negotiation, the woman maximises her utility and agrees to a point as close to U_2 as she can achieve, leading to an agreed price and risk level of P^* and H^* at point C. The greater the bargaining power the higher the price and associated utility curve she can achieve.

We can model this in the equations. As per Gertler et al. (2005), the utility of the man and the woman can be solved using the Roth-Nash bargaining framework (Ellis and McGuire 1990; Nash 1950; Roth 1979). For simplicity, let's assume point Y in Figure 4.1 represents an unprotected sex act and point Z represents a protected sex act, and the following determines the choice between these options[4]. For protected sex (or less risky sex), P^p is maximised in the following,

$$P^p \; max \quad (V - B - P^p)^g (P^p - A)^{1-g} \tag{8}$$

Where g is the bargaining power of men and $1 - g$ is women's bargaining power relative to the men. If this equation is less than zero, no transaction takes place. The equilibrium price for protected sex is:

$$P^p = (1 - g)(V - B) + gA \tag{9}$$

In other words, the price equilibrium is the weighted average of the maximum that the male partner is willing to pay for protected sex and the minimum a woman is willing to accept to supply protected sex. The price equilibrium for unprotected sex is:

$$P^u = (1 - g)V + g(A + r_v) \tag{10}$$

The price equilibrium is the weighted average of the maximum that the client is willing to pay for unprotected sex and the minimum the sex worker is willing to accept to supply protected sex.

4.2.4 Multi-period model

[4] The figure also represents other points including X, the most preferred option for the woman. In reality this would be a compromise that might come following several round of negotiation.

Modelling single transactions tells us how individual decisions are made but to use these ideas to predict the impact of economic shocks on behaviours, the models need to be aggregated over multiple time periods. We can define the consumption and income of a woman's household as:

$$Consumption_t = Income_t \pm \Delta A_t \tag{11}$$

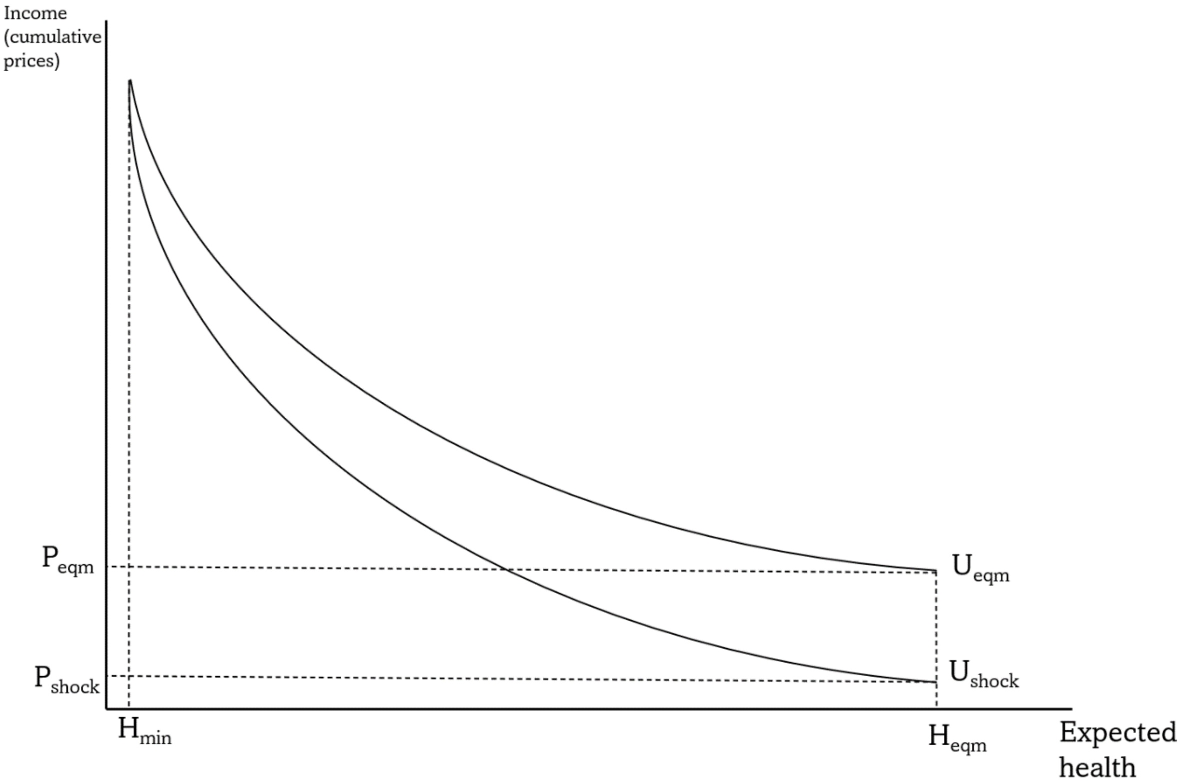
$$Income_t = \sum_{n=1}^{t} P^p(1 + (r_t + r_v)) \tag{12}$$

where t indicates time periods. $Income_t$ is the sum of the price of the value obtained from sex acts, n, which is the reservation price multiplied by the cumulative risk attached to each act. $Consumption_t$ represents a household's consumption costs in time period t, including both discretionary and essential spending. A is still the opportunity cost of their time but now we consider the change in ΔA_t in the period t. In other words, in a period where *income>consumption,* the excess is stored as savings or as built-up implicit support to be called upon when needed. When considering economic shocks, it includes the value of their coping strategies or other income-earning opportunities. For example, it includes the households' investments, including financial products and contributions to informal insurance or building social capital, i.e. by contributing time or in-kind support to a community member in need. Consumption can be increased by extracting some value from these coping strategies or inputting spare capital to increase A for the future. It can be argued the payoff of transactional sexual relationships falls into this category. An investment in social capital that can be utilised in future to cope with shocks.

4.2.5 Economic shocks

Applying economic shocks to this framework means we can predict what changes we will see in the risky behaviours in sex markets. As discussed in Chapter 3, some characteristics of shocks have differential impacts on predicted behaviours. First, consider an idiosyncratic negative shock affecting only women, see Figure 4.2. Let P_{eqm} and U_{eqm} represent the pre-shock endowment of health and consumption or the equilibrium levels. The impact of the shock could act in several ways on equation [12]; through A, the alternative sources of income or social capital, such as a decrease in the value of assets or loss of a productive household member; or through increased essential consumptions, e.g. food or medical expense. To maintain consumption, equation [12] has to be balanced. Some women may deplete their stock of wealth, A, to cover the shock and maintain consumption, e.g. reliance on a family member, insurance payouts, support from sexual partners or savings. Most women at risk of transactional sex, however, do not have enough formal sources of *A,* or are unwilling to consume from A as it has a different marginal propensity for consumption/utilisation (Shefrin and Thaler 2004). Therefore, they must make up the loss through income, either by increasing the number of sex acts, *n,* or increasing the risk premium achieved on each sex act, r_v, equation (13). In Figure 4.2, the economic shock acts by pivoting the equilibrium utility curve to the left around the fixed maximum health risk a woman is willing to accept. The effect is a lower price for a given level of risk and a higher risk acceptance for a given price.

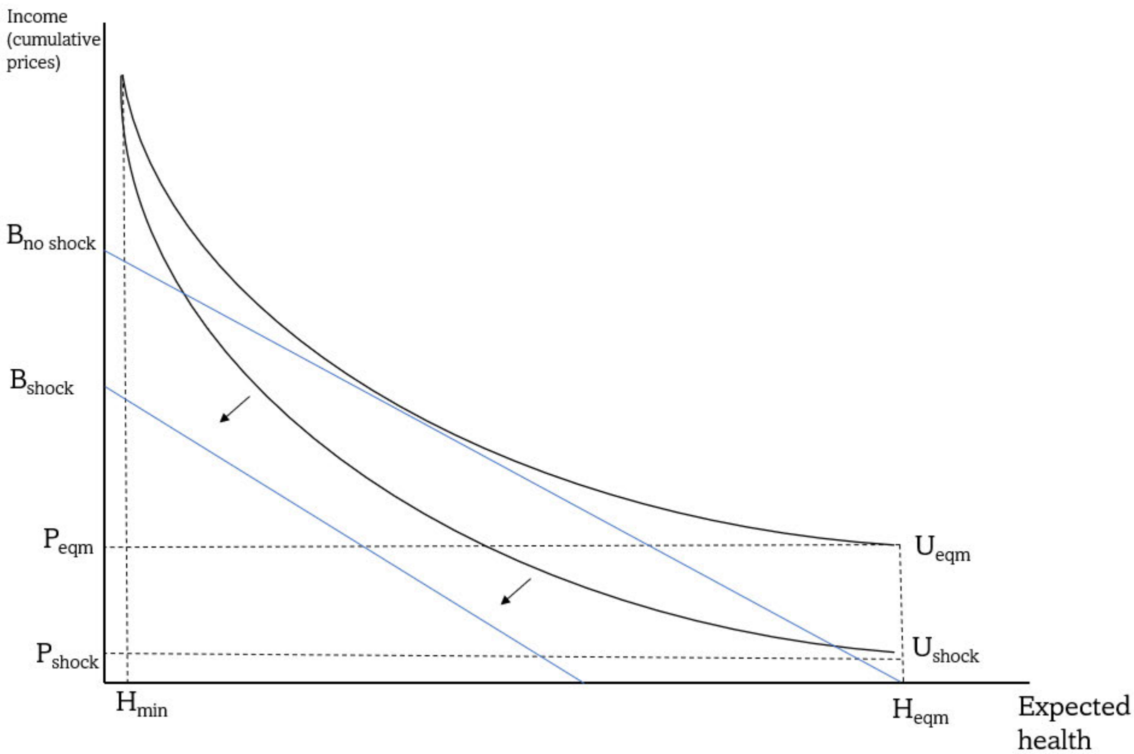
Figure 4.2:Impact of idiosyncratic shock on women's utility



It is evident in Figure 4.2 that the range of sex acts acceptable to the woman has increased, i.e. the area to the right of the curve has increased. The drop in the reservation price would mean women suffering economic shock are more likely to match with men increasing the extensive margin of transactional sex. A shock is unlikely to lead to women engaging in transactional sex immediately, so the shift from U_{eqm} to U_{shock} can take place over time when money becomes tighter and alternative economic opportunities dry up. Our framework implies that by boosting *A* during economic hardship, women are less likely to lower their reservation price and engage in risky sex acts, with supportive evidence in the literature from cash transfers (Baird et al. 2012) and savings interventions (Jones and Gong 2021). Often though, unconditional cash transfers alone are not large enough, or targeted enough to significantly prevent this increase. As discussed in the post-script of Chapter 3, the introduction of conditions that increase the opportunity cost of *A* has been shown to be effective in reducing risky behaviours and negative health outcomes.

Now let's consider a covariate shock. This shock is larger in scale and affects entire communities or regions, meaning men are impacted as well. Therefore, they have less to spend, shifting their budget line inward, see Figure 4.3. As with the idiosyncratic shock, women's utility curves fall because they require more money to consumption smooth; however, when this is coupled with a fall in the budget line because men are demanding less, women may not receive enough income through their initial utility curves drop. As their savings and alternative forms of wealth dry up, their utility curves will drop even further in order to compensate, meaning they are open to engaging in higher-risk and lower-paid sex acts in order to compensate.

Figure 4.3: Effect of a covariate shock

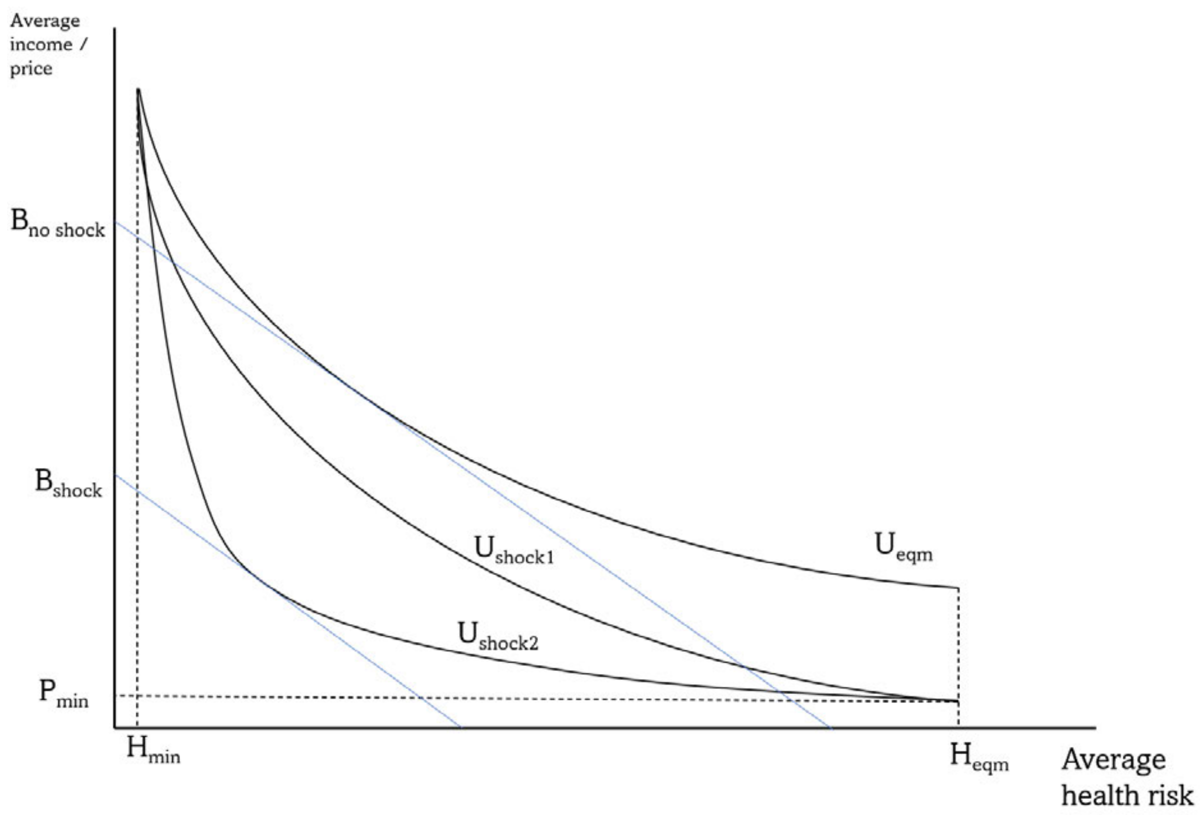


4.2.6 Market effects

Up to here, we have only considered impacts on an individual to understand how individuals risk changes in the face of economic shocks. To learn about changes in the broader sex market, we need to consider the aggregate market of all women and men at risk of engaging in transactional sex, see Figure 4.4.

As demonstrated, following a covariate shock, fewer transactions will be matched, and for a woman's fixed risk tolerance (i.e. the concavity of their indifference curve), more risky sex acts will take place. But also, the average risk tolerance, and therefore, risky sex acts, will increase on average, see Figure 4.4. Relatively more risk-averse women cannot match with men they may drop out of the market, favouring their other means of support captured in *A*. The remaining women in the market who can match are those with higher risk tolerance and willing to trade health risk for a lower payoff. This is represented by the average utility curve of women in the market shifting to be more risk-loving, U_{shock1} to U_{shock2}. New research suggests that economic shocks are driving changes in risk tolerance that suggest the concavity of individuals curves might lead to increases in risky behaviours also (Holden and Tilahun 2023).

Figure 4.4: Effect of covariate shock on the overall market



4.2.6.1 Shock type and expectations

The scale and type of shock can impact behaviours differently, depending on changes in *A,* first defined in equation [4] as the alternative sources of income and coping strategies. For example, the death of a relative relied upon for consumption smoothing reduces the value of *A*; thus, our model would predict an increase in risky sex acts by lowering an individual's reservation price.

The expectation of how long a shock will last could impact behaviours through differential marginal propensity for utilisation of coping strategies. In this example, women might want to increase their income knowing there has been a permanent loss to their support network rather than further deplete their stored wealth, leading to long-term behavioural changes. Whereas a single payment health expense might be more likely to use savings.

As discussed in Chapter 2, coping strategies utilised depend on the scale of shocks, and Chapter 3 finds that persistent shocks consistently lead to increases in risky behaviours. The study of windfalls also suggests that expectations are important in how people cope with shocks (Thaler 1990; Kramer and Kunst 2020; Hastings and Shapiro 2013).

4.2.6.2 Anticipation

Knowing when a shock will occur is important knowledge in preparing coping strategies. Economic theories, such as the permanent income hypothesis, suggest pre-emptive contributions to A to smooth consumption when the shock is realised (Friedman 1957; Deaton 1991). Indeed it is common for those working in agriculture to make seasonal earnings last the year (Rosenzweig and Wolpin 1993), but there is also a wealth of savings literature investigating why people consistently fail to save adequately even with the means to (Peetz and Buehler 2009). Therefore, anticipation does not necessarily mean protection from shocks. This idea is explored further in Chapter 6.

4.3 Discussion

4.3.1 Summary of framework predictions

As alluded to previously, there are a number of predictions our framework can make that already have supportive evidence in the literature. These include the protective effect of improving alternatives to engaging in transactional or commercial sex, the role demand from men plays in the size of sex markets, the individual and average levels of risky sex acts, impacts of the criminalisation of size and riskiness of sex markets, and the association of poverty and poor economic empowerment with participation in transactional and commercial sex markets. It allows us to have a greater understanding of the impact an economic shock will have.

Below are listed the specific hypotheses tested in the empirical papers of this thesis:

1) Economic shocks will lead to an increase in risky sex on the extensive margin and the level of risk within each sex act. These include unanticipated and anticipated shocks where individuals cannot pre-save enough nor choose to avoid the shock.
2) The greater alternative forms of income and support available, A, the smaller the behavioural impact following shocks. Covariate shocks will amplify the increase in risk taken within sex acts but have an ambiguous impact on the extensive and intensive margins.

4.3.2 Limitations of the framework

It is worth noting the drawbacks and limitations of this framework in its reflection of reality. First, a large subset of those engaged in transactional and commercial relationships do not do so because of economic incentives and therefore does not explain all risky sex. Those being coerced or exploited might be engaging through fear of violence or other consequences, such as deportation. Transactional sex under the paradigm of 'sex for material expression of love' (Stoebenau et al. 2016) could lead to riskier sex if the woman's incentive is to please their partner who desires unprotected sex, or perhaps as a show of commitment and trust, both of which are not conceptualised in this framework. The paradigm of 'improving social status' (Stoebenau et al. 2016) through sex is another intangible element not adequately modelled in this framework. Whilst we can think of potential improvements in social status as increasingly valuable to women, the interaction with risky sex acts with this is not straightforward. Social status is the value you hold in other people's minds and whilst men could promise greater social rewards, should others believe it was obtained through potentially stigmatised risky sex, it may harm these efforts creating an incentive for safer sex.

The catch-all term, A, for alternative uses of time captures external factors that can shift the underlying willingness to accept risky sex acts, but it is arguably crude and lacks the nuance to reflect reality well. Again, the conceptualisation paradigms of transactional sex such as 'improved social status' highlight these potential motivations (Stoebenau et al. 2016). An example inspired by Edlund and Korn's (2002) 'theory of prostitution' is that women are engaged in commercial sex work to obtain future financial security or intimacy through finding a husband. Therefore, within interactions with clients identified as a potential future spouse, their marginal utility to consumption/wealth and health will be different and unprotected or riskier sex might build trust.

Asymmetric information about HIV and other STI statuses mean prices negotiated are inefficient and lead to the increased spread of diseases. The framework does not include knowledge of STI status in the bargaining framework but implies that the uncertainty would push average prices up. However, prices for unknown serodiscordant matches would be lower and therefore lead to more of these matches than optimal. A good proxy for the likelihood of a partner being HIV+ is the underlying STI prevalence in a community, and it has been observed that risk premiums increase with such disease burden accounted for (Arunachalam and Shah 2013).

Finally, the framework assumes time to work is unlimited and that women face few barriers to engaging with clients. In reality, there will be time constraints and limits on the feasible number of clients that can be engaged with, particularly in situations where anticipated shocks are approaching. Whilst not modelled explicitly, these constraints apply another level of complexity to the matching and bargaining of risky sex acts. Given the uncertainty of future interactions, it is likely to lead to risker and better pay once a negotiation starts.

4.4 References

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Chapter 5 – Methods

From this point in the thesis, the focus is on generating new empirical findings in line with research aims 3, 4 and 5. This section provides an overview of the methods used in the thesis. First, I introduce the primary data from Senegal used in Chapters 6 and 7, including the sampling and survey design, as well as details of the primary outcome and how it is measured using the list experiment technique. I also describe my role in the primary data collection and how the COVID-19 lockdowns impacted it. Second, I give an overview of the secondary data sources that are used in Chapter 8: the Demographic Health Surveys (DHS) and precipitation datasets. I describe the key features of these datasets that make them ideal for pursuing my research aims. I also describe how the various drought measures are calculated. Finally, I describe and justify using quasi-experimental research methods to pursue my research aims.

5.1 Context

5.1.1 Sub-Saharan Africa context

Understanding the sub-Saharan African context is important for understanding why HIV still disproportionately impacts the continent and is the geographical focus for this thesis. Africa remains the poorest continent, with vast inequalities between and within countries. Seven of the ten most unequal countries on earth are in Africa, and despite great successes in reducing poverty across the continent, the average GDP per capita in sub-Saharan Africa is just $1,493 in 2021, ranging from $771 in Burundi, the poorest country on earth, to $8,635.3[5] in the small but resource-rich country of Gabon (World Bank 2023). There remain more people living in poverty in Africa today than in the 1990s, and the continent is characterised by rapidly growing populations, particularly in urban centres. Africa is home to many of the fastest-growing cities in the world, with urban areas housing over 500 million people (OECD, United Nations Economic Commission for Africa, and African Development Bank 2022) and is predicted to contribute more than half of global population growth between 2015 and 2050 (United Nations 2015). The changing

[5] Excluding Mauritius or Seychelles which are both more wealthy detached culturally and economically from mainland sub-Saharan Africa.

demographics of Africa will shape the continent’s economic, political and health in the years to come, as well as their approach to eliminating HIV as a public health threat.

There are a number of contextual factors that contribute to HIV remaining a severe public health challenge in SSA. Poor nutrition and high rates of sexually transmitted infections (STIs) increase individuals’ risk of acquiring HIV (Galvin and Cohen 2004; Katona and Katona-Apte 2008). Poverty, often the root of high STIs through inadequate access to healthcare and poor nutrition, also increases susceptibility to HIV through stress and weakened immune systems (Segerstrom and Miller 2004). Healthcare systems in Africa are characterised by underdeveloped infrastructure with limited and unsustainable funding, meaning that much of the population must pay high OOP payments for essential health services. In the context of HIV, most individuals infected are unable to pay for the full costs of essential HIV medication, and so there remains a reliance on external sources of funding and pharmaceutical companies to subsidise costs in order to maintain adherence rates. The rates of catastrophic health payments across all health issues in African countries are some of the highest in the world and continue to rise (Wagstaff et al. 2018). The continent's provision of protection against economic shocks is poor, characterised by a lack of formal safety nets (Banerjee and Duflo 2007; Dercon 2002).

Sexual exchange via transactional and commercial relationships is prevalent across SSA, creating the environment for risky sexual behaviours to be utilised for consumption smoothing. Transactional sex is widespread in SSA, particularly in southern and eastern Africa (UNAIDS and Strive 2018), where HIV incidence remains persistently high.

5.1.2 Senegal context

Senegal is the study setting for Chapter 6 and Chapter 7. Senegal is located in West Africa, within the Sahel and tropical savannah climatic regions of Africa. It has a GDP per capita of $1,637, slightly higher than the SSA average of $1,493 per capita and is classified as a lower-middle-income country by the World Bank (2023). Health spending is 4.13% of GDP compared to 4.98%, the continent’s average, making it around the average regarding wealth and health spending. Senegal is one of the most stable African countries, despite the proximity to instability in neighbouring countries of Mali and Mauritania and has had three peaceful transitions of power since independence in 1960.

Senegal’s health system is fragmented and provides low protection against OOP payments and low service coverage across the population, particularly in rural areas and areas outside the capital city of Dakar. Around 25-30% of individuals are part of risk-pooling insurance programmes, primarily workers and retirees from formal public and private sector jobs. The remaining population faces high OOP payments to access essential healthcare (USAID 2016). Vulnerability to economic shocks is high, with few public safety nets. Financial inclusion is very low, with only 17% of the population possessing an active bank account; therefore, access to credit and financial services to cope with shocks is very low (World Bank 2016). HIV prevalence, on the other hand, has remained very low, <1%, through investments in HIV testing and treatment infrastructure (World Bank 2022; CDC 2022). Despite that, HIV among FSWs remains high, with estimates ranging from 19.9% to 5.9% in 2016 (Baral et al. 2012; Kane et al. 2009; Wang et al. 2007; Mukandavire et al. 2018). Female sex workers are a key group involved in HIV transmission dynamics across the developing world (Baral et al. 2012) and are identified by UNAIDS as a "key population" (UNAIDS 2018).

Globally, sex workers face a 26 times higher risk of contracting HIV than women aged 15 to 49 (UNAIDS 2022). As a result, in Senegal, resources to tackle the AIDS epidemic are prioritised towards FSWs. This has taken the form of a law implemented in 1969, a colonial-era law inherited from France, that makes the registration of FSWs with a health centre and police compulsory to receive a monthly medical check-up that test and treat STIs for free. FSWs who do not register face a six-month prison sentence if arrested by police. Despite the free healthcare available to FSWs, many choose not to register for fear of their work being discovered by their family and friends. Upon registration, they must carry their *carte sanitaire*, a distinctive booklet that records their completed health checks and is presentable to police on request. There is no reason a woman would possess such a booklet other than as a registered FSW. As a result, stigma towards FSWs is high and means access to healthcare is difficult; thus, many choose to have minimal contact with the health system, particularly those unregistered.

5.2 Survey of FSWs in Senegal

The first data source comes from an observational cohort study called: "Optimising the Public Health Benefits of sex work Regulation in Senegal", led by my supervisor Dr Lépine. It followed a cohort of around 600 FSWs in Dakar, Senegal in 2015 and 2017. These surveys collected information on socioeconomic variables, including household information, sexual behaviours, sexual activity, risk preferences, client information, savings behaviour and information on economic shocks. In 2020 a third wave of data collection took place, allowing me to contribute to survey design and collect information related directly to my research aims whilst maintaining the panel element of the dataset. The specific research objective addressed using this dataset was "To determine the effect of an anticipated economic shock on risky behaviours in FSWs" where the anticipated economic shock studied is Tabaski, the religious festival of Eid al-Adha celebrated in West African Muslim communities. Data collection took place between 29th June and 28th July 2020, just before the festival in 2020.

5.2.3 My role

I contributed to the survey design, field protocols and data collection, all crucial elements to the empirical analysis pursuing my research objectives. The COVID-19 pandemic prevented travel to the field, meaning plans for this survey in relation to my thesis had to be scaled back. This included limiting the complexity of new additions to the survey since in-person training was not possible but took place remotely, which I supported. It also reduced my role in monitoring and supervision to be entirely remote. Despite this, training, data collection and processing were designed so that I could keep in regular contact with the field teams reporting issues and potential improvements that could be made to the survey and data collection in near real-time. The following sections describe key data collection elements and go into further detail about my contributions.

5.2.4 Fieldwork and protocols

Entering the project after two waves of the survey, much of the infrastructure, personnel and participants were already in place. The observational nature of this project meant the survey in 2020 could proceed with our collaborators in the Ministry of Health and Cheikh Anta Diop University in Dakar taking the lead on the implementation of the fieldwork using the instructions and protocols from previous waves of the survey despite COVID-19 international travel restrictions. Enumerators employed in previous waves of the survey were re-employed to build on their knowledge of the project, protocols and rapport with respondents and health centre staff from previous waves. Whilst the data collection took place during the COVID-19 pandemic, most of the lockdown precautions had been lifted in Senegal by this time; nevertheless, all necessary precautions were taken to minimise the risk of transmission and protect both respondents and enumerators from COVID-19. Enumeration teams were split across four health centres used for this survey within Dakar, namely, Mbao, Rufisque, Pikine and Diamnadio, with interviews taking place at the respondent's preferred location.

Key changes made to the protocols vital to the empirical work was the distribution of lists to enumerators that determined the order respondents should be approached for an interview. Enumerators were instructed to make arrangements with each respondent at the soonest possible opportunity so that the order of interviews remained as close to that of the list as possible. Contact was made in the days leading up to the first day of fieldwork at the health centres to ensure they started at full capacity and hit their interview number targets. Lists were split across the four health centres assigning respondents to their last preferred health centre, but accommodations were made if they preferred another location.

5.2.5 Survey design

The third wave of the survey was updated to include modules that directly addressed the relevant research objective. This included additional modules on economic shocks suffered by FSWs and Tabaski in 2020, found in module 6 of the questionnaire (see Appendix 2). Questions about the type and details of economic shocks were adapted from the literature, in particular Wagstaff and Lindelow (2014). Since this paper and the wider literature do not address shocks in this specific context, the module was developed alongside experiences from researchers in Senegal, my supervisors and qualitative work completed as part of earlier waves of this project. We asked questions regarding the objective impact of the shocks, the time in relation to the survey they took place, the expectation of how long the impacts are expected to last and any self-reported sex work behaviours changes to capture both subjective and objective impacts. We asked about the most common shocks suffered by those living in LMICs, including, health shocks, theft, loss of family members or remittances and changes in the price of staples, but also covered those specific to this population and the stigma they suffer, namely eviction and divorce or abandonment.

A second part of the module asked questions pertaining to Tabaski in the current year and previous years. These focussed on the costs and when they were incurred in relation to the survey, an important part of the identification strategy in Chapter 8.

5.2.6 Data management

Data was collected via surveys programmes in ODK and completed on tablets. Data was uploaded to a secure server at LSHTM at the end of each day of fieldwork. Part of my role was to perform data quality checks in near real-time as interviews were completed. I set up a data pipeline where fieldworker supervisors uploaded the data at each day's end to run through a series of data quality checks in Stata. These checks returned data points inconsistent or impossible in the raw data, along with identifying information passed onto supervisors and addressed by enumerators. Usually, errors found within a couple of days of the interview meant mistakes were quickly corrected by recontacting respondents via phone and confirming the answer to those questions. Once data collection had concluded, data was cleaned and prepared for analysis by myself and others in the research team for their own research agendas. Informed consent was sought from all respondents, and data was anonymised before any processing or viewing of the data took place in line with ethical clearance and research protocols.

5.2.7 Sampling

The original research aimed to analyse the impacts of the registration policy present in Senegal (Ito, Lépine, and Treibich 2018). Therefore, the original sample from 2015 took a purposive approach by stratifying to obtain equal shares of registered and unregistered, also known as clandestine, sex workers recruited across the four previously mentioned health centres in Dakar. Health centres were chosen because they are the locations registered FSWs went for their monthly health checks and the staff of which aided in the initial recruitment. The proportion recruited from each centre was determined by the total number of FSWs registered at that centre. Therefore, the original sample is not strictly statistically representative of FSWs in Dakar, but follows methods commonly used to sample FSWs in Africa (Heckathorn 1997; Magnani et al. 2005). The most recent estimate for the proportion of FSWs in Dakar that are registered is 43% (APAPS & IRESSEF 2014). FSWs are characterised by hiding their identity and are often transitory in nature, both professionally falling into and out of sex work over time but also geographically moving between places often. Tracking FSWs after multiple years can be tricky since those that have left sex work are hard to contact, often intentionally; hence attrition between waves was high – close to 30%. In 2017, the stratification by registration status was relaxed, but the objective was to track as many FSWs as possible. New FSWs were added to the sample using the same methodology as the initial recruitment but without the registration stratification. The same method was also used to recruit new FSWs to replace lost FSWs in the third wave in 2020. The original sample size was determined in order to detect a minimum change of 10 percent in condom use following economic shocks, so it was imperative to maintain the cross-sectional sample of around 600 respondents for the analysis in this thesis.

5.2.8 List Experiment

The primary risky sexual behaviour studied in Chapters 6 and 7 (and in much of the literature) is condomless sex or unprotected sex acts among FSWs. Reporting such behaviour is subject to sensitivity and social desirability biases, the desire to report what the interviewer or anyone they think we learn their answer considers socially responsible or desirable answers. The Senegalese context amplifies this because sex work is legal if FSWs remain STI-free and adhere to HIV medication. Therefore the feeling among FSWs is that they "should" be using condoms and will therefore report that in interviews, especially amongst those registered. It is also the case that women may be more likely, in general, to report ethical or socially desirable answers (Dalton and Ortegren 2011).

The outcome measure was derived from the list experiment indirect elicitation technique to minimise the impact of social desirability bias. The list experiment allows respondents to answer sensitive questions without the fear their answers will be discovered. Therefore, we can gather more accurate prevalence estimates and reduce the potential attenuation bias when estimating marginal effects – a potential problem in many studies on risky behaviours. Previously, the list experiment method has been used for eliciting self-reported answers for topics including abortion (Moseson et al. 2021; Bell and Bishai 2019), voting preferences (Gonzalez-Ocantos et al. 2012; Holbrook and Krosnick 2010), use of micro-finance loans (Karlan and Zinman 2012), opinions on undocumented migrants (McKenzie and Siegel 2013), gay marriage (Lax, Phillips, and Stollwerk 2016) and racism (Krumpal 2013) and has been shown to be effective to measure condom use (LaBrie and Earleywine 2000; Treibich and Lépine 2019; Treibich and Exelle 2019). Typically, the list experiment is used to estimate the prevalence of risky behaviours across a sample, but it also allows one to estimate the difference in prevalence between two sub-groups within a sample. This means it can be used with natural experiments where we test the difference between the prevalence in constructed "exposure" and "counterfactual" groups.

There is debate over the effectiveness of the list experiment in measuring sensitive behaviours. Firstly it is not effective is protecting against other forms of sensitivity bias such as self-deception or fears of repercussions of reporting unprotected sex. For example, FSWs might view themselves as low- or high-risk individuals and thus report answers that fit this view of themselves rather than the truth. Or, registered FSWs may fear answers will be learnt by their doctor, who might be less likely to sign off their *carte sanitaire,* preventing them from working. From a methodological point of view, Lensvelt-Mulders et al. (2016) performed a meta-analysis finding it more accurate than direct face-to-face questioning at estimating prevalence. In contrast, several other studies find issues often derived from the implementation of the method, including whether it is understood by respondents (Haber et al. 2018). Whilst understanding these issues and limitations, many of these are less of a threat in this survey. First, this survey round was the third time enumerators had been trained in the method and for most respondents, the second or third time they have had to answer this type of question. Second, we used the validated double list experiment method, which adds robustness and power to estimates (Lépine, Treibich, and D'Exelle 2020). In the surveys that took place in 2015 and 2017, when asked directly, the condom usage rate was 97%, but using the list experiment, it was 78% and 80%, respectively (Treibich and Lépine 2019; Lépine, Treibich, and D'Exelle 2020) suggesting social desirability is pervasive and justifying the list experiment's use.

5.2.8.1 Implementation

The list experiment is implemented by asking respondents how many of the following statements they agree with. Within the programming of the survey, each respondent is randomly allocated to either a treatment group or a control group with equal chance. The randomisation is done using an invisible random number generated within the survey. The "control" group is read a list of three nonsensitive statements meaning the maximum they can agree with is three. The treatment group is asked four statements, three identical to the control group, plus one statement regarding the sensitive behaviour. They can agree with a maximum of four statements. In our survey, the control group were read the following nonsensitive statements:

- It is safer to bring a client home than going to the hotel.
- I prefer that the client pays me before the sexual intercourse.
- Monday is the day I have the greatest number of clients.

The treatment group are read the same three statements plus the sensitive statement inserted in position two:

- It is safer to bring a client home than going to the hotel.
- *I used a condom during my last intercourse with a client.*
- I prefer that the client pays me before the sexual intercourse.
- Monday is the day I have the greatest number of clients.

To work out the prevalence of the sensitive behaviours, the researcher simply takes the mean number of statements of the treatment group and subtracts the mean number of statements of the control group. The key assumption is that the mean number of nonsensitive statements agreed with is the same in the treatment and control groups, given that respondents are randomly assigned to each group. Therefore the difference between the two means is the proportion of the treatment group that agreed with the sensitive statement. The primary benefit of this approach is that provided the assumptions (detailed in the next section) hold, neither the researcher nor the enumerator are not able to know what a single respondent answered to that question.

Aids are often used to help respondents to count the number of statements they agree with rather than indicating the specific statements they agree with. In Senegal, we gave them beads and instructed them to hold them behind their back and pass them from one hand to the other when they heard a statement they agreed with. They then showed the number of beads to indicate how many statements they agreed with.

In our case we used the double list experiment method by implementing a second list experiment immediately after the first in the survey. Results from the second can be combined with the first to give a more robust prevalence since each respondent faces the sensitive statement. This second iteration uses the same randomised groups but reverses their roles with the new set of nonsensitive statements below:

- The majority of my clients are Senegalese.
- I usually spend the whole night with my client.
- I usually solicit clients by phone.

But the same sensitive statement:

- I used a condom during my last intercourse with a client.

The control group in iteration one, those who received only nonsensitive statements, now receive the set of statements with the sensitive statement included. Again in position two. Those who received the sensitive statement in the first iteration now receive only the nonsensitive statements.

The prevalence of, or proportion of the sample engaging in the risky behaviour can be estimated using regression analysis with single and double list experiment data. The empirical methods to estimate marginal effects from these data are specified in the research papers and chapters in which they are used.

5.2.8.2 Internal validity

The method relies on three key assumptions to be internally valid (Blair and Imai, 2012):

i. Successful randomisation of the participants to treatment and control lists.
ii. Absence of design effects - the inclusion of the sensitive statement does not change answers to the nonsensitive statements.
iii. Absence or minimisation of ceiling and floor effects - the number of respondents who either agree or disagree with all nonsensitive statements should be minimised to avoid compromising the implicit privacy of the list experiment method.

The validity of this list experiment has been verified in the literature, but the steps are repeated here as per Lépine, Treibich, and D'Exelle (2020) and Blair and Imai (2012).

Randomisation for the list experiment was conducted first in the 2017 survey, with new respondents allocated alternately to the two groups. Table 5.1 shows randomisation was successful, with only one of 38 characteristic variables significantly different between the control and treatment groups. Table 5.2 shows the results for design, floor and ceiling effects. Rows 5 and 6 of Table 5.2 show no design effects in List A, but there is some evidence of a design effect in Row 6 of List B because no one agreed with 0 statements in the control group. The treatment group has only 2 agree with 0 statements and for all other number of statements there is no sign of a design effect. An alternative method for testing the design effects detailed in Chuang et al. (2021) finds there is no significant difference between estimates from the first and second lists. Additionally, my own test of design effect by including an interaction term of the list treatment variable and list assignment (list A or list B) in the double list regression will capture the differential effect of answering the sensitive statement depending on which control list was received. This also gives a non-significant difference suggesting no overall concerns for design effects.

Table 5.1: Test of randomisation with descriptive statistics

Stat.	Mean			*Difference*
Variable	All	List A	List B	A. vs. B
Beauty (mean/10)	5.8	5.8	5.8	0
Age (years)	39	38.4	39.6	1.2
Risk preference (0-2)	0.8	0.8	0.8	0
Number of children	3.1	3.1	3	-0.1
Dependency ratio	1.4	1.5	1.3	-0.2
New FSW to survey (%)	35.8	35.6	36	0.4
Marital Status: Never Married (%)	21	20.9	21.1	0.1
Marital Status: Married (%)	0.8	0.4	1.1	0.8
Marital Status: Divorced or separated (%)	70.4	70.8	70.1	-0.6
Marital Status: Widowed (%)	7.8	7.9	7.7	-0.2
Education: No education (%)	51.4	49.4	53.3	3.8
Education: Koranic only (%)	0.8	1.2	0.4	-0.8
Education: Elementary (%)	26.1	26.5	25.7	-0.8
Education: Middle? (%)	13	15	11.1	-3.9
Education: Secondary (%)	8.6	7.5	9.6	2.1
Education: University (%)	0.2	0.4	0	-0.4
Registered (%)	46.9	44.7	49	4.4
Has a second job (%)	37.2	34.4	39.8	5.5
Logged typical earnings (all, CFAF)	11.7	11.7	11.7	0.1
Wealth: Poorest (%)	32.5	32.8	32.2	-0.6
Wealth: Poor (%)	10.5	11.9	9.2	-2.7
Wealth: Neither (%)	16.9	16.2	17.6	1.4
Wealth: Rich (%)	21	18.2	23.8	5.6
Wealth: Richest (%)	19.1	20.9	17.2	-3.7
Both parents are alive (%)	22.4	21.3	23.4	2
Both parents are dead (%)	32.1	29.2	34.9	5.6
Has some available savings (%)	23.5	23.7	23.4	-0.3
Age of last client (years)	43.7	43	44.4	1.4*
Last client was a regular client (%)	80.7	84.6	77	-7.6**
Likely last client had HIV (%)	4.1	4.7	3.4	-1.3
Client consumed alcohol at last sex (%)	10.4	11.6	9.2	-2.3
Price was negotiated(%)	46.1	45.8	46.4	0.5
Last sex took place outside (%)	7.6	8.3	6.9	-1.4
Duration of last sex (mins)	12.7	13.1	12.4	-0.7
Last sex included fellatio (%)	16.2	15.5	16.9	1.4
Last sex included anal sex (%)	0.6	0.4	0.8	0.4
Stayed the night at last sex-act (%)	7.6	7.6	7.7	0.1
Last client was rich (%)	5.4	4	6.9	2.9
Observations	514	253	261	514

*** p<0.01, ** p<0.05, * p<0.1

Rows 1 to 4, Table 5.2 shows there is no floor or ceiling effect for List A. The control group has fewer responses (<10%) for 0 and 3. Row 3 of List B shows there is some sign of a ceiling effect (23% for agreement with three statements) and so privacy could be compromised for some respondents in this list treatment group. When examining the control statements for list B, we note that COVID could have increased the likelihood of all three being agreed with. The first, “The majority of my clients are Senegalese.”, is designed for most to agree with, but with reduced international travel due to COVID, the chance of local clients increases. For the second and third,”I usually spend the whole night with my client.” and ”I usually solicit clients by phone.” COVID has closed bars and clubs throughout the data collection period meaning a common place for finding clients and performing sex acts is closed off, potentially pushing solicitation to phones and encouraging sex acts to take place at home, increasing the chance of overnight stays. However, social desirability bias in our case, acts to over-report condom use; therefore, reporting four agreements would not constitute a socially undesirable answer. In our case ceiling effect will not influence the FSW's propensity to be dishonest and should not affect our results.

Table 5.2: Test of design, floor and ceiling effects

Estimated Proportions	Source	N	Number of reported items (y) 0	1	2	3	4	Sum
List A								
Row 1	Treatment list	261	0.004	0.034	0.544	0.391	0.027	1
Row 2	$Pr(Y_i \leq y \mid T_i=1)$		0.004	0.038	0.582	0.973	1	
Row 3	Control list	253	0.0079	0.344	0.565	0.083		
Row 4	$Pr(Y_i \leq y \mid T_i=1)$		0.008	0.352	0.917	1	1	
Row 5	Row 4 - Row 2 (<0)		0.004	0.313	0.335	0.027		0.679
Row 6	Row 2 - Row 4 (y-1)(<0)		-	0.03	0.231	0.056	0.000	
List B								
Row 1	Treatment list	253	0.008	0.036	0.289	0.577	0.091	1
Row 2	$Pr(Y_i \leq y \mid T_i=1)$		0.008	0.043	0.332	0.909	1	
Row 3	Control list	261	0.000	0.149	0.617	0.234		1
Row 4	$Pr(Y_i \leq y \mid T_i=1)$		0.000	0.149	0.766	1	1	
Row 5	Row 4 - Row 2 (<0)		-0.008	0.106	0.434	0.091		0.623
Row 6	Row 2 - Row 4 (y-1)(<0)		-	0.043	0.183	0.143	0.000	

In summary, randomisation appears to have generated balance between the two list groups, but there is a chance of a ceiling effect in list B. Since we know the direction of condom use bias is towards over-reporting their use, any ceiling effects do not violate privacy and therefore do not pose a threat to validity.

This description of the list experiment and tests of validity are broadly repeated in Chapters 6 and 7 utilise the method, but it felt essential to cover it in extra detail here at the outset.

5.3 DHS and Precipitation Data

In Burke, Gong, and Jones' (2015) seminal paper, they found that drought explains up to 20% of the cross-country variation in HIV in Africa. They use DHS datasets and attempt to explore the mechanisms for this finding, including transactional sex, but do not have the required data to form a solid conclusion. Chapter 9 uses more recent DHS datasets that now contain vital questions on transactional sex (that were previously absent) to address research objective five: "To examine if drought, as a proxy for economic shocks, leads to greater transactional sex and to explore if transactional sex is a key causal pathway in the relationship between drought and HIV in sub-Saharan Africa found in the literature."

The DHS project is a series of surveys conducted in more than 85 LMICs worldwide since 1984 and is the best quality multi-country data source that includes individual HIV test results, transactional sex questions and GPS data to link to precipitation datasets. It also has the advantage of being the same source of data as Burke, Gong, and Jones (2015).

5.3.1 DHS survey methods

Primarily repeated cross-sectional surveys, the DHS are known for their consistency, high response rates, quality enumerators, and national representativeness. The consistency of definitions and methods across countries makes the indicators collected vital population health indicators for many countries and used across governments and those in international development and global health. The DHS collect a wide range of objective and high-quality self-reported socioeconomic and sexual health indicators. The DHS contains all the elements required to address research objective 5 – "*To examine whether drought-induced economic shocks lead to greater transactional sex in sub-Saharan Africa."* It contains HIV, transactional sex and the GPS locations of clusters that is linkable to external precipitation datasets. Other advantages include results being directly relateable to Burke, Gong, and Jones (2015), minimising potential systematic differences between survey or data collection methods and allowing similar models to be run.

From 2015, the key transactional sex questions were added following work by the STRIVE group at LSHTM to replace the previous unreliable and inconsistent version of the question (Stoebenau et al. 2018). This and other questions pertaining to sexual health could be sensitive to respondents, so DHS interviewers take steps to ensure privacy, and they always use gender-matched interviewers to minimise the risk of social desirability bias (Demographic and Health Survey 2022). The GPS information is linked to the smallest sampling cluster and is randomly displaced between 2 and 5 kilometres to ensure the privacy of respondents. Any displacement is adjusted to ensure clusters remain within at least the second administrative level of the country where the survey occurs. The sample is based on a two-stage cluster design. First, a draw of enumeration areas from census data, followed by listing the selected areas with a random draw of households within that area. This results in surveys representative at the regional, national and residence (rural/urban) levels using inverse probability weights provided in the datasets.

5.3.2 Precipitation datasets

Two precipitation datasets were used to calculate drought measures. The initial intention was to perform the analysis with a single dataset, but variations in the literature and advice from my research committee led me to use a second dataset as a robustness check. To the best of my knowledge, entirely separate precipitation datasets have not been used as a robustness check in the economics literature of drought shocks on risky behaviours. However, recent research is beginning to look at the variability in results by varying weather datasets (Michler et al. 2022).

The first data source I use is the University of Delaware (UDEL) monthly precipitation dataset that has a 0.5 x 0.5 degree resolution from 1900-2017 (Matsuura and Willmott 2018). This is the data source used in Burke, Gong, and Jones (2015) and allows for the closest comparison of results. The second data source is the Global Precipitation Climate Centre (GPCC) (Schneider et al. 2011) that uses the same degree resolution as the UDEL data but has a different method for estimating the rainfall, so it ends up with slightly different calculated rainfall levels for each time period and geographic coordinate. This data source has been used in more recent literature examining droughts' effects on risky sexual behaviours (Treibich et al. 2022). The authors kindly shared their calculated drought data for Malawi for verification and quality-checking purposes.

5.3.2.1 Drought measures

To use drought as an economic shock, it must be an accurate proxy for the definition of an economic shock. Consider the definition used in Chapter 3 of this thesis: "An unexpected, sudden and significant change in income or expenditure of a household, which, if unaddressed, would have meaningful impacts on household consumption". Rainfall is typically correlated with higher crop yields (Yamoah et al. 1998), and a severe drought clearly leads to local food shortages and significant reductions in household consumption power; finding the precise time and level it causes behavioural change is difficult, however. Agricultural income is typically seasonal, so income from up to a year in the past will be spent in the present. Expectations of the next harvest and income-earning opportunities also determine current spending. There is no agreed level or measure of drought determined to constitute an economic shock; therefore, decisions have to be made to ensure our measures do constitute economic shocks accurately.

Within the health and economic behaviours literature, two broad measures are utilised: a binary variable based on the percentile of rainfall for a given location (Burke, Gong, and Jones 2015; Abiona 2017; Abiona et al. 2022; Low et al. 2019; Corno, Hildebrandt, and Voena 2020; Epstein et al. 2022) and drought (Treibich et al. 2022) and flood (Nagata et al. 2022) periods based on the Standardised Precipitation Index (SPI). Typically, percentile measures compare cumulative rainfall in a specific 12-month period for a certain coordinate against its historic mean. Burke, Gong, and Jones (2015) mapped their measure of sub-Saharan Africa to maize crop yields, the main staple in the region, determining their 15th percentile was highly damaging to staple crops. However, it remains a coarse measurement that does not adequately capture severity or account for near-drought sufferers. The agriculture literature finds similar conclusions measuring cumulative 12-month periods (Zaal et al. 2004; Larsson 1996) and cumulative growing season rainfall (Fermont et al. 2009). SPI are more complex and widely used in agriculture and hydrology literature (Yamoah et al. 1998; Diao et al. 2007). SPI is used extensively in this literature as a predictor of drought, but no specific work is determining their utility as a proxy for economic shocks. The method of their calculation is more nuanced, allowing different timescales to be accounted for but are converted into droughts in a broadly similar way to the percentile measures.

SPI uses the deviation of precipitation for a given location by fitting a gamma distribution to the historic rainfall for a particular place. The probability density function then determines specific precipitation levels relative to this historic distribution. Finally, the calculation is transformed into a normal distribution with a mean zero and variance one to obtain the SPI values (Blanc 2012; World Meteorological Organization, et al. 2012). The SPI generated is equal to the standard deviation from the median precipitation. An advantage of this measure is that the normalisation of the rainfall means a range of climatic zones can be represented in the same way, a distinct advantage when comparing across SSA countries. Depending on the use case, timescales are specified of between 1 to 48 months to calculate the SPI. For example, to calculate the SPI for August 2022, with the three-month timescale, the programme will sum rainfall from June, July and August 2022 and compare to the sum of rainfall from those three months for every year going back to the start of the reference period. Longer timescales are more suitable for water management and deep groundwater analysis, whereas shorter timescales are better for agriculture, particularly places without irrigation. The measure's design suggests a timescale of one to six months for measuring agriculture impacts (World Meteorological Organization, et al.

2012). A historic reference period of at least 30 years is required (Guttman 1999), so we used a historic period from 1950, giving over 60 years for reference data.

Using these parameters, a monthly timeline of SPI is calculated equal to the standard deviation of each month compared to the historic distribution. According to McKee, Doesken, and Kleist's (1993) classification of droughts, a moderate drought begins when SPI falls below -1.0 and ends when the SPI return to 0. Severe and extreme droughts begin when the SPI drops below -1.5 and -2.0, respectively and all end when SPI returns to 0. By design, the SPI of -1.0 occurs with a probability of approximately 16% and therefore is equivalent to the 15th percentile level of rainfall used in the literature. The primary advantage of the SPI measure is the ability to map droughts over the course of a year, knowing precisely when the effects will have been felt and for how long compared to the percentile measure that treats an entire year as 1 unit of time. For instance, a year with a prolonged moderate drought followed by damaging floods could appear as a fairly average year in the percentile measure, whereas the SPI can assign the appropriate drought period to that year.

Therefore, to develop the most accurate drought measures, drought periods were mapped to a series of different time periods for the analysis to capture the impacts of past droughts and the expectation of future impacts of drought. First, the previous 12 months were determined by the interview month in the DHS to capture current and future expectations of drought. Second is the agricultural season, or growing season, determined by the most popular crop for a specific country by area using crop calendars (Sacks et al. 2010). Third, using the precipitation season defined as the months in which at least 5% of the country's annual rainfall typically falls, according to the Climate Change Knowledge Portal (World Bank 2022). The agricultural cycle was difficult to define objectively and understandably turned out to be similar to the precipitation cycle, so it was scrapped in favour of the latter. To capture that past income makes up a large portion of current expenditure in agricultural households, we calculated the precipitation season as the *last completed precipitation season* dependent on when the DHS occurred in each country. In other words, all in a country had the same "last precipitation season" assigned to them, often including rainfall from more than 12 months ago.

The extraction and manipulation code was written from scratch in Stata. SPI calculations were done using an open-source program provided by the National Drought Mitigation Center (World Meteorological Organization, et al. 2012). After initial GIS matching and descriptive analysis were completed, the data manipulation and generation were repeated for the second dataset, GPCC. Given the numerous choices that could be made across the datasets and methods, over 350 different drought measures were generated per matched DHS cluster that all plausibly measured drought as an economic shock in a slightly different way. Investigating the association of different drought measures to economic shocks is beyond the scope of this thesis but deserves attention. To illustrate, Table 5.3 shows the cross-tabulation of drought assignment using the SPI drought period measure, indicating if more than 80% of the last precipitation season was in drought compared to the percentile measure, which indicates if the last precipitation cycle's cumulative rainfall fell below the 15th percentile. These two measures used in the empirical Chapter 9 show that only 81.6% share an assignment between the two measures.

Table 5.3: Example of difference between SPI and percentile drought measures

		More than 80% of the last precipitation season in moderate drought –			
		No drought		Drought	
		N	%	N	%
The last precipitation below 15th percentile	No drought	140,325	77.4%	10,807	6.0%
	Drought	22,575	12.5%	7,611	4.2%

5.4 Quasi-experimental Study Design

Since the empirical portion of this thesis focuses on estimating the impact of negative economic shocks on human behaviours, conducting randomised studies is impossible. Imposing a sudden and unexpected economic loss on individuals to study their reaction is ethically objectionable, meaning the research has to rely on real-world instances of quasi-random or naturally occurring economic shocks. A crucial element of the empirical studies is identifying causal impacts with non-randomised economic shocks. Therefore, shocks must be chosen and constructed such that they affect participants or groups exogenously - both to the empirical model outcome and to any potential unobservable confounders. The advantages of this approach are that no economic or ill health is brought on participants because of this research, the shocks are relevant to the contexts I am working with and can be estimated using linear regression and ordinary least squares estimators. However, ruling out all external unobservable factors affecting shocks and outcomes is not possible, meaning all eventualities need to be accounted for when building variables, proxies and counterfactuals used within empirical models.

Three shocks are defined and analysed within this thesis's empirical chapters. Their respective research papers describe the variable construction and identification strategies in greater detail. Here is a brief outline of the challenges and choices made in selecting these shocks.

The first shock is *Tabaski,* an Islamic religious festival in which there is deep-rooted social pressure for those celebrating to buy a sheep or goat to sacrifice for the household feast because the animal's quality reflects the household's social status. In the urban setting of Dakar, animals are driven into the city in the final few days before the festival, and this is when most residents purchase their animals. This minimises the time urban households have to store an animal but also inflates prices as buyers have no more time to buy an animal. This shock a significant challenge. It is anticipated; therefore, defining or constructing the counterfactual is not straightforward. As is argued in Chapter 6, the shock is largely unavoidable due to social and religious expectations from the community, minimising individuals' ability to avoid the costs of the celebration. Using those that choose not to celebrate, either by religion or economic circumstances, will differ in ways that are not observable that will likely affect risky behaviours, biasing any estimates impact. To counter this, we opt for an internal comparison of those with differing proximity to the festival, i.e. proximity to the expensive animal purchase. It considers that respondents are unable to prepare for the purchase ahead of time adequately and are expected to feel the economic pressure exerted by the festival due to difficulties in forgoing the large purchase. The order – and hence the date – in which respondents were interviewed is exogenous and is used as the basis for the internal comparison. A second element in determining the proximity of the last sex act to Tabaski is the timing of the last sex act that is not exogenous. We investigate this in more detail in the chapter itself. Together it means we can attribute the difference in risky behaviours of those interviewed 'close to' the festival and those interviewed 'far from' it to the economic pressures of Tabaski.

Second, using the same dataset of FSWs in 2020, we examine whether health shocks are associated with risky sexual behaviour. Health shocks act as an economic shock because of the associated medical costs to treat the illness or injury and lost income from missed work and plausibly act in a near random manner. We made two critical choices in choosing how to ask the question in the survey. First, we asked if other household members other than the respondent were sick. The economic element will be present, particularly for their children, but any potential reverse causality or influence over catching illness will be independent of the respondents' resultant behaviours. Importantly we do not use expenditure or consumption data to proxy a shock because this is endogenous to the circumstances of the household leading to bias linked to reporting as those reporting health shocks will have a greater ability to pay medical bills. Second, we chose to ask the question in the same module as asking about the last sex act (the same sex act our outcome variable refers to) to ensure the respondents were clear that any illness was in the household at the same time as the sex act as well as any associated behaviour changes. Health shocks have been used to assess the impact of economic shocks in the literature previously (Jones and Gong 2021; Robinson and Yeh 2011).

Finally, drought is used as a proxy for an economic shock to households in the final empirical chapter. To be a valid shock, the probability of drought has to be equal for all participants, i.e. random, each year and have a random magnitude. It is arguable that the first is satisfied, given that humans have little control over the weather; however, climate change could mean persistent changes in climatic and weather conditions in different study regions that could already be leading to behaviour changes that confound our findings. For example, persistent and severe droughts leading to increased desertification of the Sahel could be a symptom of persistent changes in the global climate (Mayans 2020). None of the countries studied are in the Sahel, but the argument can be made for other regions of the world and Africa. The best drought calculations use unit-specific historic comparisons to compare places with differing rainfall levels. The key assumption is that relative differences to this historic average within regions lead to similar economic impacts. For African households, the extent to which they can predict the impact of drought depends on the accuracy of weather models, the distribution of information and the realisation of the drought in the period before harvest. In other words, if the drought occurs at the start of a growing season, farmers might have more time to adapt than a drought that hits right at the end. Even with good forecasts and a long lead time, the extent to which individuals affected can mitigate the impacts is negligible in many African countries, where governments offer little insurance and safety nets. Migration is a possible response to persistent droughts and a key concern for our empirical strategy, considering the cross-sectional nature of the DHS datasets. It remains a limitation of all studies using droughts without rich data on people's movements in response.

5.5 Ethical Approval

The research contained within this thesis was approved by the LSHTM ethics committee (reference: 17196/RR/14359 & 21228/RR/19282). The DHS is a publicly available dataset once permission is granted. Permission was obtained to undertake this analysis. There were no major ethical considerations in using the DHS since survey data was already anonymised when received, and I had no direct input into the data collection. Ethical approval for research conducted in Senegal was also granted by the Senegal Research Committees (ref: SEN19/88). Ethical approval was also granted by University College London (UCL) and the National Ethics Committee for Health Research in Senegal (CNERS). Approvals from LSHTM and CNERS are attached in Appendix 3 at the end of the thesis.

The research was conducted in accordance with all national and international requirements for the protection of individual rights throughout the study. Participation in the study was entirely voluntary and anonymous and only after voluntary informed consent was acquired. The right to refuse and the ability to withdraw at any point were explained before any questions were asked. The information collected is treated as confidential, and the results only be presented in aggregate form to prevent any breach of confidentiality or identification of individuals. No major additional ethical considerations needed to be taken into account for undertaking this additional wave of the survey. The following steps were taken to ensure anonymity and make the process as safe as possible for the respondents.

- Cooperation from health centres to support the sampling methods was required. Previous successful waves of data collection in 2015 and 2017, as well as existing connections within FSW groups and enumerators, achieved this.
- The study does not pose any risks to the participants. Participation in this study does not present a risk for FSWs since confidentiality is guaranteed, and anonymity is respected during the recruitment and interview process. However, the study addresses sensitive issues that can cause stress to participants. This was taken into account through intensive and comprehensive training of enumerators, most of whom have training in sociology, anthropology or psychology, informed consent of the respondents and anonymisation of data. Whilst the majority of the enumerators had performed the survey in 2017, training materials and methods were used by the team in Dakar to train new enumerators. Every possible effort was made to conduct interviews in private with at most an enumerator and supervisor present, ensuring no other FSWs or outside members of the public were present or could overhear them. However, participants were reminded they could withdraw from the interview at any time they wished.
- An existing element of the survey is a series of quantitative games that involve monetary payments to test economic behaviours through experimental games. The maximum amount that can be received was capped at 9500 FCFA (around euros 14.5 at the time), and will approach compensation for their time in participating in the survey. In addition, participants were only informed of this financial reward after they consented to participate in the study to ensure that the amount was not influencing their involvement.

Past collaborations with CNERS during 2015 and 2017 confirmed that the surveys were conducted in compliance with the ethical context of Senegal. CNERS performed site visits to ensure compliance with protocols and ethical procedures and raised no issues.

5.6 Sources of Public Information

Permission to use DHS datasets then downloaded from:
https://dhsprogram.com/data/available-datasets.cfm

University of Delaware datasets can be downloaded from:
http://climate.geog.udel.edu/~climate/html_pages/download.html

GPCC precipitation datasets can be downloaded from:
https://opendata.dwd.de/climate_environment/GPCC/full_data_2018/.

Crop calendar dataset: https://nelson.wisc.edu/sage/data-and-models/crop-calendar-dataset/index.php

Code for calculating percentile droughts, manipulating precipitation for the SPI programme and linking to GPS-linked datasets such as DHS can be found on my website:
https://sites.google.com/view/henry-cust

The download for the SPI programme and documentation can be found at:
https://drought.unl.edu/monitoring/SPI/SPIProgram.aspx

5.7 References

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Chapter 6 – Research Paper 2: Trading HIV for Sheep

Anticipated economic shocks are rarely studied in the literature surrounding risky sexual behaviours, as detailed in Chapter 2 and Chapter 3. This chapter uses primary data from Senegal to examine the impact of anticipated spending for the religious festival Tabaski on risky sexual behaviours of female sex workers.

This research paper, currently under review, is the first to study an anticipated shock with risky sexual behaviour. It utilises the interview order as an exogenous exposure to the festival to identify the impacts to condomless sex using the list experiment. The strong findings and the innovative use of the list experiment are critical contributions to the wider literature. The findings demonstrate that a broader range of shocks lead to risky behaviours than previously thought, particularly given how many celebrate and how frequent celebrations such as Tabaski are.

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RESEARCH ARTICLE

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Trading HIV for sheep: Risky sexual behavior and the response of female sex workers to Tabaski in Senegal

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Abstract

We use a cohort of female sex workers (FSWs) in Senegal to show how large anticipated economic shocks lead to increased risky sexual behavior. Exploiting the exogenous timing of interviews, we study the effect of Tabaski, the most important Islamic festival celebrated in Senegal, in which most households purchase an expensive animal for sacrifice. Condom use, measured robustly via the list experiment, falls by between 27.3 percentage points (pp) (65.5%) and 43.1 pp (22.7%) in the 9 days before Tabaski, or a maximum of 49.5 pp (76%) in the 7 day period preceding Tabaski. The evidence suggests the economic pressures from Tabaski are key to driving the behavior change observed through the price premium for condomless sex. Those most exposed to the economic pressure from Tabaski were unlikely to be using condoms at all in the week before the festival. Our findings show that Tabaski leads to increased risky behaviors for FSWs, a key population at high risk of HIV infection, for at least 1 week every year and has implications for FSWs in all countries celebrating Tabaski or similar festivals. Because of the scale, frequency, and size of the behavioral response to shocks of this type, policy should be carefully designed to protect vulnerable women against anticipated shocks.

KEYWORDS

condomless sex, economic shocks, female sex workers, HIV, risky sexual behavior, Tabaski

JEL CLASSIFICATION

O12, I12, I15, D14

1 | INTRODUCTION

Today female sex workers (FSWs) face 26 times the odds of contracting HIV compared to their female counterparts in sub-Saharan Africa, up from 13 times in 2018, and are considered a highly vulnerable and key population in the ongoing fight against HIV (UNAIDS, 2018, 2022). In Senegal, HIV prevalence is very low, ≤1%, and credits investments in HIV testing and treatment in keeping prevalence among the general population low (CDC, 2022; World Bank, 2022). However, the prevalence is 19.9% and a concentrated epidemic among FSWs in Senegal (Baral et al., 2012; Kane et al., 2009; Wang et al., 2007). We examine whether Tabaski, an anticipated but largely unavoidable economic shock, leads to risky sexual behaviors in FSWs in Senegal. Eid al-Adha, or Tabaski in West Africa, is observed as one of the most important annual religious and cultural celebrations in the lunar calendar. The 'feast of sacrifice' involves the purchase and ritual sacrifice of a sheep or goat to be cooked and eaten by families and shared with their communities. There is large social and religious pressure to celebrate the quality of their animal as a mark of social status (Aker et al., 2020). In Senegal, around 800,000 animals are sacrificed each year (Sambou & Africanews, 2021), and the most sought-after animals can fetch as much as €2,200, though typical prices are closer to €200 (Cluzel, 2020). Prices for animals rise dramatically in the days and weeks leading to Tabaski. Animals are not the only costs associated with Tabaski, fabrics, clothing and gifts are additional essential expenses all those celebrating incur.

Unanticipated shocks are typically only unexpected in their timing, but not necessarily in their size and frequency; for example, in the absence of insurance, everyone knows they are likely to become ill during their lifetime with associated health expenses, but predicting when is difficult. Empirically, there is evidence that households in low-income countries are unable to adequately smooth consumption in the face of large shocks (Gertler & Gruber, 2002). Female sex workers earn a premium for riskier sex acts (Gertler et al., 2005; Rao et al., 2003) and are incentivized to take additional risks during economic hardship. Previous literature finds this premium is relied upon by FSWs and those engaging in transactional sex[1] to cope with unanticipated economic shocks (Cust et al., 2021). For instance, Burke et al. (2015) find that up to 20% of the cross-country variation in HIV prevalence is due to droughts in sub-Saharan Africa, and there are increases in risky behaviors in response to health and civil unrest related economic shocks (Dupas & Robinson, 2012; Robinson & Yeh, 2011). Whilst there is a relatively large literature on the role of shocks on HIV and risky behaviors but no studies of anticipated shocks.

Anticipated shocks, such as Tabaski, differ in one crucial way; there is very little uncertainty. The date is known, and the size is predictable. Given the near-perfect information, economic theory suggests households would save a portion of income throughout the year to pay for this unavoidable expense, with few real-life implications[2] (Deaton, 1991; Friedman, 1957). However, the social and religious pressure to celebrate and the high price of animals means the minimum full participation cost is high, with high social costs associated with partial or no participation. That is, there is a social cost if your family does not celebrate or have an animal to share with the community. Therefore, Tabaski mimics the economic pressure felt from unanticipated shocks. Tabaski also affects entire communities, limiting the utilisation and effectiveness of informal insurance through networks, typically relied upon in lower-income countries to consumption smooth. There are few policies designed to protect against it and little research on its welfare impacts. This limits the ways in which FSWs can raise money for Tabaski outside of sex work.

This paper studies whether Tabaski elicits similar behavioral responses as unanticipated shocks in the context of commercial sex work. We find inadequate consumption smoothing, with only 10% of FSWs having enough savings to cover the cost of the festival and 62.7% relying on sex as their main method of paying for the costs. Our main finding is that sex acts that took place in the 4–7 days before Tabaski have a condom use prevalence 49.5 percentage points (pp) lower than those that took place more than 23 days before Tabaski, controlling for sex acts in between and recall bias. Those who are yet to buy an animal are unlikely to be using condoms at all, indicating that the economic pressure of Tabaski is likely to be driving risky sexual behaviors in FSWs in Dakar.

Our research design exploits the quasi-random order of interviews in the third wave of a longitudinal survey of around 600 FSWs to examine the effect of Tabaski on condom use and whether the economic shock or economic pressure[3] is the mechanism for this result. Sensitivity and social desirability bias mean condom use is over-reported in our data and is an issue in the risky behaviors literature more widely. We find that when asked directly in our face-to-face interviews, FSWs report that 98% of their last sex acts were protected with a condom, and by using these data in our models, the effects of Tabaski were completely hidden. We, therefore, use the list experiment method[4] to minimize social desirability bias in our outcome and estiamtes.

Our results contribute, first, to the small but growing literature on the effect of religious celebrations as an economic shock and is the first paper to do so in relation to risky sexual behaviors (Aker et al., 2020; Banerjee & Duflo, 2007). Second, our findings contribute to the literature on risky sexual behaviors in response to economic shocks by showing anticipated shocks elicit a similar response as unanticipated shocks (Burke et al., 2015; Gong et al., 2019; Jones & Gong, 2021; Robinson & Yeh, 2011). Third, our study is the first to use the list experiment within observational data seeking to identify a causal relationship in a quasi-experimental analysis. The significance of this paper is that it sheds light on a novel and important cause of risky sexual behavior in a key population at the focus of the HIV prevention effort. Whilst the prevalence of HIV is lower compared to some countries, Tabaski and other similar religious festivals or holidays occur each year in countries with large FSW populations with higher rates of HIV and therefore, our results are significant for HIV prevention policy around the world.

We start this paper by presenting a conceptual framework to illustrate the decisions and trade-offs for FSWs in the face of an anticipated economic shock. Second, we describe our data, showing descriptive statistics of the sample and Tabaski. Third, we outline the identification and empirical strategy required for estimating the effect of Tabaski on sexual behaviors. We then present the results of our primary analysis and investigations into the threats and mechanisms, followed by robustness checks. Finally, we discuss the implications and limitations of our results before concluding.

2 | CONCEPTUAL FRAMEWORK

Our conceptual framework presents the mechanisms through which Tabaski will affect the decision of FSWs and their clients, showing how unprotected sex is used as a means of consumption smoothing by FSWs. We build upon previous frameworks, including Treibich and Lépine (2019) and Gertler et al. (2005).

$$D = f(I, U_{client}(R)) \tag{1}$$

$$S = f\left(P, R^f, R^v, A\right) \tag{2}$$

Equation (1) illustrates the demand for sex, D, and is made up of clients' disposable income, I, and their expected utility, U_{client}, which is a function of the risk, R, of the sex act. An important assumption is that men prefer unprotected sex (Randolph et al., 2007). The underlying risk of HIV and other STIs is assumed to be constant, and the impact on preference for condoms is the same for men and women; therefore, cancel out. This leaves the men's preference for protected sex as the key difference driving the positive relationship between price and risk, or the risk premium.

Equation (2) represents the supply for sex where P is the price of a sex act, R^f is the *fixed* risk of working as a sex worker, including the risk of violence and social stigma from each sex act supplied. R^v is the *variable* health risk for which FSWs have some control. I.e. choice of partners, location of the sex act and condom use negotiation. This risk is positively correlated with price at the sex act level due to the client's willingness to pay to increase with risk and FSWs' disutility of taking health risks. At the time of the study, PrEP was not readily available to FSWs and, therefore, did not enter the conceptual framework and does not pose an issue for our findings. Finally, A represents the risk-coping strategies available to FSWs, in other words, the sources of income or support they can call upon to help smooth their consumption around Tabaski. For example, their savings, additional potential income from a second job, support from clients (outside of sex act related earnings), support from family and friends, or any formal support available from government or NGOs.[5]

$$U_{fsw} = f(H, I) \tag{3}$$

$$\frac{\partial I}{\partial R} > 0 > \frac{\partial H}{\partial R} \tag{4}$$

For FSWs, utility is derived from income, I, and health, H, Equation (3). Female sex workers maximize utility based on their returns to income and health. Their utility is increasing in income and health. Income is positively associated with risk through the fixed and variable risk, $R^f + R^v$, but decreases in health through the risk of HIV, STIs and violence, Equation (4).

$$S = f\left(U_{fsw}(H, I), A\right) \tag{5}$$

Finally, since an FSW's income is determined by the price received and their health by the risks taken during sex acts, we can substitute the FSW's utility function into the supply function to give Equation (5). Therefore, the quantity and riskiness of sex supplied by each FSW depend upon their own appetite for risk and the rate at which they can transform health risk into additional income.

Our basic framework allows us to make testable predictions by introducing an economic shock, namely Tabaski. It is a covariate shock affecting the entire community rather than just individuals and has a known impact and date. As the shock nears, the marginal utility of income increases because their discount rate increases. In other words, if we view Tabaski as a challenging savings target, as the time left to reach that target falls, the amount an FSW values income today versus income after Tabaski increases. Female sex workers can raise additional cash from sex work in three ways. First, they can expand supply by increasing the number of hours they work or the number of clients they see. Second, increasing the number of sex acts with each client - leading to an increase in R^f. Third, by negotiating and offering riskier sex, increasing R^v, and charging a relatively higher (or less discounted) price, P. Increasing activity on the extensive or intensive margins is difficult when clients will also be considering the upcoming costs of Tabaski. This fall in demand, combined with a potential increase in the supply of sex will lower the average price but have an ambiguous effect on intensity. By offering riskier sex, the price also has upward pressure, again meaning there is an ambiguous impact on price. However, Tabaski's associated demand fall from clients and supply increase from FSWs both work in driving risky behaviors higher in order for FSWs to maintain or increase their income.

A mediating factor is the coping strategies available to FSWs, A. Since the shock affects the entire community, including an FSW's network and clients who all celebrate and feel the same economic pressures, it eliminates or reduces the effectiveness of informal coping strategies and resilience from non-liquid assets (Aker et al., 2020; De Weerdt & Dercon, 2006; Fafchamps, 2010; Townsend, 1995). Debt[6] and savings are the only effective means of coping with this shock (Deaton, 1991).

3 | DATA AND DESCRIPTIVE ANALYSIS

3.1 | Sample

We use the third wave of a longitudinal dataset of FSWs in Dakar, Senegal, that took place from 29th June (32 days before Tabaski) until July 28, 2020 (3 days before Tabaski) with Tabaski on July 31, 2020. The first two waves took place in 2015 and 2017. The third wave, in 2020, was designed specifically to analyze the effects of Tabaski and is the only data used in this paper. The first wave recruited 654 FSWs of 18 old or older living in Dakar using a respondent-driven methodology, which represented around 15% of the total number of FSWs in Dakar at the time (APAPS & IRESSEF, 2014). Sex work is legal in Senegal if FSWs register with authorities and attend free health check-ups to confirm they are STI-free or adhering to antiretroviral drugs. Despite this, around 57% of FSWs in Dakar choose not to register because sex work is morally condemned, and fear of discovery is significantly heightened with registration (APAPS & IRESSEF, 2014; Ito et al., 2018). Registered FSWs were recruited by the midwife in charge of their monthly medical examinations (a registration requirement) from four Dakar sites. Those unregistered, referred to as clandestine FSWs, were recruited from leaders of informal FSW groups, called causerie, that contain both registered and unregistered FSWs. Clandestine FSWs were invited to participate in surveys at the same health centers as the registered. Each participant was given 3000 CFAF (around $5) to cover time and transport costs. In 2020, interviews lasted around 1.5 h and took place at venues near the health centers, taking all measures to minimize COVID transmission.

An objective of the original sample was to analyze registration policy, meaning that around 50% of those recruited were registered, a restriction relaxed in subsequent waves when replacing attrited FSWs (Ito et al., 2018). Replacement in waves two and three were achieved using the same respondent-driven methodology as wave one, with the proportion of unregistered FSWs now over 53%. Table 1 summarizes the key variables for the sample used in this analysis. The average FSW in the sample is 39 years old and in a household where each adult provides for 1.4 dependents. 37.2% of FSWs earn on average, 51.9% of their income in the last 30 days from their second jobs. This implies the majority of money earned by our sample comes from sex work, with only a few having opportunities to earn significant amounts outside of sex work.

3.2 | Tabaski

Of the 514 active sex workers, 83% intended to celebrate Tabaski in 2020.[7] Overall, FSWs expect Tabaski to cost around 172,000 CFAF (around 311 USD[8]) in 2020. Our sample intended to spend 93,000 CFAF (168 USD) on animals consumed as part of the celebration.[9] The other festival costs were typically clothes, presents and supplementary food. In the context of our sample, the total personal cost of Tabaski was 121% of a typical month's earnings from sex work, with the personal contribution to the animal costing 67% of a typical month's earnings from sex work.[10]

Purchasing an animal is not straightforward; they are bought alive and must be stored, fed and cared for until the sacrifice. Because many urban households do not have the facilities for storing animals, they must wait until a few days before the feast when large numbers of animals are bought from rural areas to be sold in the city. The prices rise dramatically as a result.[11]

Of active FSWs that celebrate Tabaski, 60% (250 of 418) expect to purchase or contribute to the purchase of an animal, but only 13 of these (5%) had done so at the time of the interview, at a median of 18 days before Tabaski. Of those that have not yet bought an animal, over 90% reported a lack of money being the main reason - not storage problems (5%). Respondents expected to purchase the animal on average 3 days before Tabaski[12] at a time when prices are likely to be at their peak.

Figure 1 shows that the majority of FSWs (62.7%) relied on their sex work to pay for the costs of Tabaski. Only 20.7% of FSWs relied on their networks as the main source of support. The 'non-sex' category contains both savings and income from other sources and was relied upon by fewer than 9% as the main funding source. Less than half of those relying on their network for some of their funding categorized it as their main source of funding, implying resources within networks were scarce. Only

TABLE 1 Descriptive sample statistics.

	N	Mean/%	Std. Dev	Min	Max
Characteristics					
FSW Age (years)	514	39	9.7	19	63
New respondent to the survey (%)	514	35.8			
Registered (%)	514	46.9			
Gneezy-Potter risk preference (/2)	514	0.82	0.8	0	2
FSW Interviewed behind schedule (%)	514	9.7			
Time preference (%)	514	80.7			
FSW Household dependency ratio	514	1.4	2.2	0	26
Economic characteristics					
Earnings in last 30 days, all sources (CFAF)	512	79,452	99,337	0	1,100,000
Earnings from sex in the last 30 days (CFAF)	512	63,520	86,315	0	900,000
Has savings available tomorrow (%)	514	23.5			
If savings available, quantity (CFAF)	121	208,101	801,941	800	8,000,000
Has a second job (%)	514	37.2			
Non-sex earnings last 30 days (%)	190	51.9			
Both parents are alive (%)	514	22.4			
Both parents are dead (%)	514	32.1			
Household in debt (%)	509	55.0			
Highest education level					
No education(%)	514	51.4			
Koranic education (only) (%)	514	0.8			
Primary education(%)	514	26.1			
Middle school (%)	514	13.0			
Secondary school(%)	514	8.6			
Tertiary education (%)	514	0.2			
Marital status					
Never married (%)	514	21.0			
Married (%)	514	0.8			
Divorced or separated(%)	514	70.4			
Widowed (%)	514	7.8			
Last sex act characteristics					
Age of last client (years)	511	44	9.6	20	71
Last client was a regular (%)	514	80.7			
Last client has HIV (%)	514	4.1			
Client consumed alcohol (%)	511	10.4			
FSW Consumed alcohol (%)	511	6.5			
Negotiation for price took place (%)	512	46.1			
Last sex in a public place (%)	514	7.6			
Duration of sex-act (mins)	514	13			
Fellatio took place (%)	513	16.2			

(Continues)

TABLE 1 (Continued)

	N	Mean/%	Std. Dev	Min	Max
FSW Stayed the night (%)	511	7.6			
Last client was rich (%)	514	5.4			
Self-reported condom use with last client* (%)	512	97.3			

Note: * Condom use prevalence using list randomisation is 65%. Information from Wave 3 only for N = 514, our analytical sample who are active FSWs, we drop those tracked but are no longer active sex workers N = 92. N < 514 due to missing data - refusals and 'don't know' responses. Gneezy-Potter is an investment game to determine the risk aversion of individuals with values of 0 to 2 (Charness and Gneezy, 2010). FSW household dependency ratio is the ratio of children and under 65's to adults in the FSWs household. Time preference is a percentage of those who prefer money today instead of twice as much in one weeks time. Earnings variables are collected by asking FSWs their typical monthly earnings (not reported here but referred to in other sections) and over the last 30 days (reported in the table). Savings variables are defined by asking FSWs if they have savings available to use tomorrow and how much. Non-sex earnings only for those with second jobs. All last sex act characteristics are as reported by the FSW with the best of their knowledge - 'Last client has HIV' equals 1 when the FSW reports a 100% chance the client has HIV.

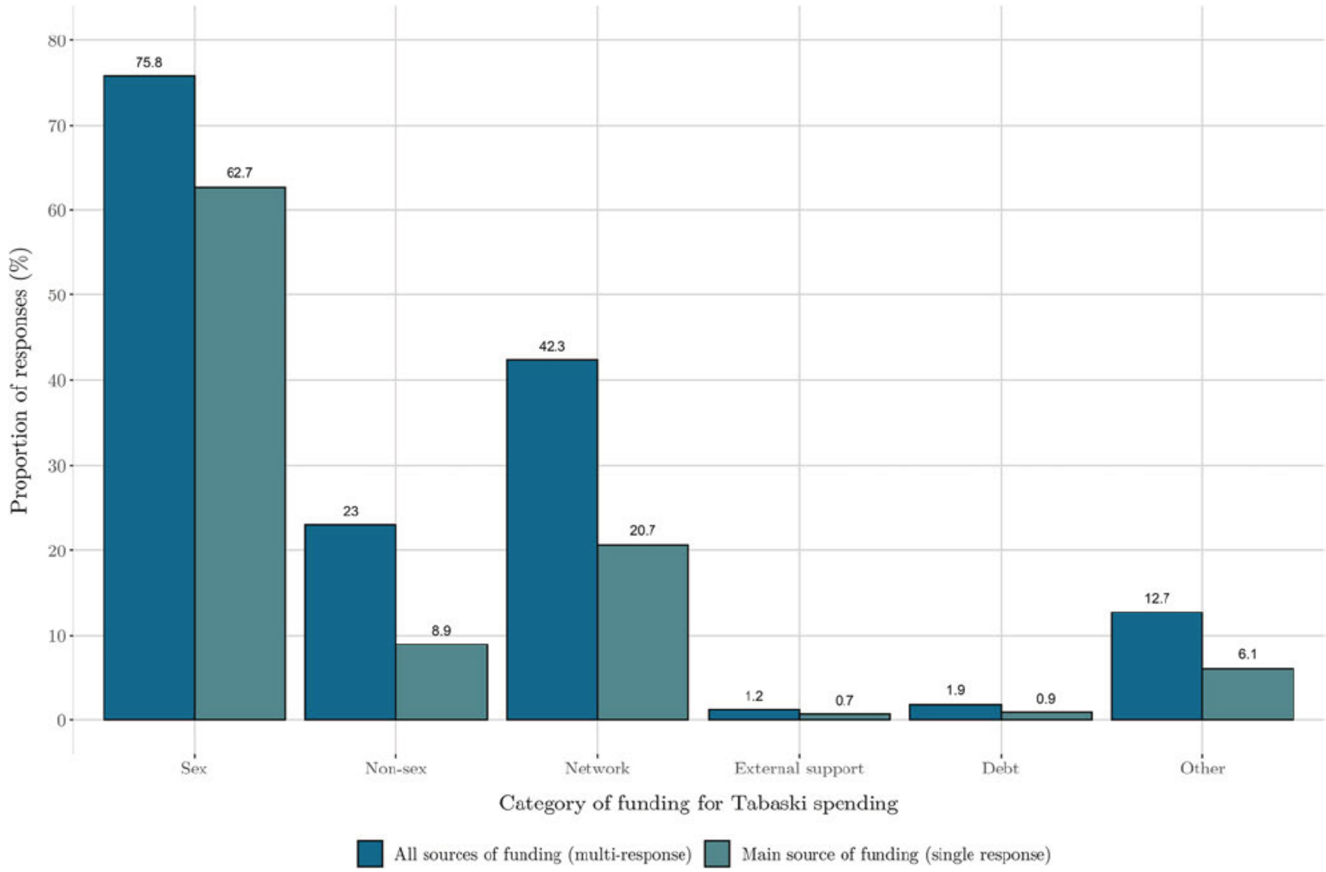


FIGURE 1 Tabaski funding sources. Bar heights are the percentage of female sex workers (FSWs) that selected each category. 'All sources of funding' allowed respondents to tick as many sources as they had contributing to their costs. 'Main source of funding' allowed respondents to select only their main source of funding. Only those who are celebrating Tabaski.

27% have non-zero savings, with only 10% enough savings to cover their expected cost of the animal. Those with savings do have a high mean level relative to the cost of Tabaski. Data from the second wave in 2017 shows that only 27% had savings available and 11% had enough to cover the average cost of Tabaski,[13] implying that savings rates are low around this time regardless of COVID.[14] Low levels of savings are consistent with findings from other low-income households in Africa (Dupas & Robinson, 2013). If FSWs had enough alternative sources of income and coping depth, that is, sufficient A in Equation (2). In that case, our framework predicts the cost of Tabaski would not require taking on additional risks, R^f and R^v. Table 2 summarizes these data about Tabaski.

We asked FSWs about their subjective views on the effect of Tabaski in general on their work. 43% of FSWs who *did not* plan to celebrate Tabaski this year said the number of customers fell, compared to 26% who said they increased. 55% of these

TABLE 2 Tabaski summary.

	N	Yes	Mean	Proportion
Number celebrating Tabaski in 2020 (n)	514	426		0.83
Those celebrating Tabaski				
Intending to purchase an animal* (n)	418	250		0.60
Already bought an animal (n)	250	13		0.05
Total expected cost of Tabaski (CFAF)	426		111,982	
Total expected other costs of Tabaski (CFAF)	426		60,656	
Average number of people celebrating with (n)*	424		9	
Those celebrating but not purchasing an animal				
Expected cost when not purchasing an animal (CFAF)	176		37,744	
Earnings in the last 30 days - all source (CFAF)	176		71,316	
Earnings in the last 30 days - sex work only (CFAF)	176		55,833	
Those intending to but yet to buy an animal				
How many days before intending to buy animal* (Days)	214		3	
Total expected cost of Tabaski (CFAF)	237		167,110	
Total expected cost of the animal (CFAF)	237		92,468	
Propotion sharing Tabaski costs with at least 1 other (n)	235	108		0.46
Typical earnings over 30 days - all sources (CFAF)	235		169,187	
Typical earnings over 30 days - sex work only (CFAF)	235		139,068	
Earnings in the last 30 days - all source (CFAF)	235		88,536	
Earnings in the last 30 days - sex work only (CFAF)	235		71,921	
Some savings available tomorrow (n)	237	63		0.27
If available, amount of savings available** (CFAF)	63		281,692	
Enough savings to cover expected cost of animal (n)	236	22		0.09

Note: * Missing values due to "don't know" and "more than 1 year in future" being excluded. ** Only those that have savings available.

same non-celebrating FSWs said their income dropped, compared to 15% who said it increased, implying that overall, Tabaski depresses the market. Those who *are* planning to celebrate this year were more favorable about Tabaski's effect on the market without tipping the balance overall. However, those celebrating are more likely to be exerting additional effort to earn income, perhaps even displacing the work of those not celebrating. Table 2 shows reduced self-reported recent earnings compared to typical earnings.[15]

The magnitude of the shock is understated, and it is greater than what is considered a catastrophic health expense, categorized as 40% of monthly expenses after subsistence (Xu et al., 2003). Total Tabaski costs around 138% of total monthly expenditure, with the animal alone costing 75% for Tabaski celebrators. The percentages are 95% and 51%, respectively, accounting for their available savings. For those not purchasing an animal, the costs of Tabaski are still significant, over 50%.

3.3 | List experiment for condom use

Our primary outcome was condom use during the most recent sex act with a client, measured using the list experiment method. The use of this indirect elicitation method is required given that 98% of FSWs declare to have used a condom during their last sex act when asked directly by an enumerator. This prevalence is 65% when estimated using the list experiment. In the second wave of this survey, direct questioning yielded a prevalence of 97% and 78% via the list experiment (Treibich & Lépine, 2019), implying the use of condoms is a socially desirable behavior and is over-reported. Previously, the list experiment method has been used for eliciting self-reported answers for topics including abortion (Bell & Bishai, 2019; Moseson et al., 2021), voting preferences (Gonzalez-Ocantos et al., 2012; Holbrook & Krosnick, 2010), use of micro-finance loans (Karlan & Zinman, 2012), opinions on undocumented migrants (McKenzie & Siegel, 2013), gay marriage (Lax et al., 2016) and racism (Krumpal, 2013) and has been shown to be effective to measure condom use (LaBrie & Earleywine, 2000).

The list experiment allows respondents to answer sensitive questions without the fear their answers will be discovered. It minimizes social desirability bias and attenuation bias when estimating marginal effects - a problem in many studies on risky behaviors.[16] Typically, the list experiment is used to estimate the prevalence of risky behaviors across a sample, but it also allows one to estimate the difference in prevalence between two sub-groups within a sample. We exploit this to find the difference between FSW's sex acts that are 'close to' and 'far from' Tabaski as *shocked* and *unshocked* sex acts. We use the validated double list method that improves the efficiency of estimates (Treibich & Lépine, 2019) compared to the single-sided list experiment detailed in Blair and Imai (2011, 2012).[17]

3.3.1 | Implementation

During the survey, when an enumerator reaches the list experiment question, their respondent is randomly allocated to the treatment or control groups for the list experiment by the survey program and asked how many of the following statements the respondent agrees with. It then lists either three non-sensitive statements for the control group:

- *It is safer to bring a client home than going to the hotel.*
- *I prefer that the client pays me before the sexual intercourse.*
- *Monday is the day I have the greatest number of clients.*

Or for the treatment group, it lists the same three non-sensitive statements plus a sensitive statement of interest in position 2:

- *It is safer to bring a client home than going to the hotel.*
- *I used a condom during my last intercourse with a client.*
- *I prefer that the client pays me before the sexual intercourse.*
- *Monday is the day I have the greatest number of clients.*

The key assumption is that the average number of non-sensitive statements agreed with is the same for the treatment and control groups. Therefore the difference in the average number of statements agreed with between each group is the prevalence of condom use at the last sex act.

The double list experiment method simply repeats the list experiment with a new set of non-sensitive statements and reverses the treatment and control groups allocated in the first experiment. This means over the two experiments; each respondent receives the sensitive statement at least once. The second set of non-sensitive statements are:

- *The majority of my clients are Senegalese.*
- *I usually spend the whole night with my client.*
- *I usually solicit clients by phone.*

The prevalence can also be estimated using OLS regression analysis. When estimating the prevalence using the double list experiment, each respondent appears in the model as two observations, one when they were in the control group and one in the treatment group of the list experiment. More detail is provided in Section 4.2 of the Empirical Strategy. As you can see, the advantage of this method is that there is no way for the researcher to back out the true answer to the sensitive statement that a respondent has, providing privacy to answer in confidence. This strength is also a drawback since the interpretation of findings can only be made about a group's prevalence and not at the individual level.

3.3.2 | Internal validity

The method relies on three key assumptions to be internally valid:

1. Successful randomization of the participants to treatment and control lists.
2. Absence of design effects - the inclusion of the sensitive statement does not change answers to the non-sensitive statements.

3. Absence or minimization of ceiling and floor effects - the number of respondents who either agree or disagree with all non-sensitive statements should be minimized to avoid compromising the implicit privacy of the list experiment method.

The validity of this list experiment has been verified in the literature (Lépine et al., 2020; Treibich & Lépine, 2019). In summary, randomization was successful, but there is a chance of a ceiling effect in list B. Since we know the direction of condom use bias is toward under-reporting, any ceiling effects do not violate privacy and, therefore, do not pose a threat to validity. For completeness, we report the test of the assumptions in Appendix 11.

4 | EMPIRICAL STRATEGY

4.1 | Survey design and identification

The key variable in our identification of the effect of Tabaski on condomless sex is the number of days between an FSW's last sex act and Tabaski, denoted by T^D. Its determinants are two-fold, T^{int}, the interview date in relation to Tabaski, and, T^{act}, the time since the last sex act, see Figure 2. Since the analysis is internal, comparing equivalent sub-samples 'close to' and 'far from' Tabaski, we primarily perform an intention-to-treat analysis with the whole sample regardless of their personal level of economic pressure felt by Tabaski. We explore differing sub-samples in Section 5.3.

To ensure the exogeneity of the interview date T^{int}, we distributed a list of respondents (those interviewed in wave two) in a randomised order to enumerators. These lists were organized weekly and included spaces for new respondents as replenishment for anticipated attrition of around 30%. Enumerators were instructed to arrange and conduct interviews, moving down the list to arrange interviews at the earliest possible opportunity. Enumerators each received their own list but shared their time to ensure respondents could be interviewed at their earliest preferred opportunity. Should respondents not be interviewed in their allocated week, they were prioritized during the following week's scheduling.

Because the shock is anticipated, and we know that most animal purchases occur in the few days before the sacrifice, we expect the economic pressure to build as this purchase nears, but we do not know if or when behavior change will start to occur. We use T^D in two ways to determine when an effect occurs and the size of any effect. First, T^D is used to define a binary variable categorizing sex acts as 'close to' or 'far from' Tabaski and run individual models for each level of T^D. Second, we use T^D to define time blocks to be included in the same model.

4.2 | Estimating equations

We use five equation structures to investigate the impact of Tabaski and its mechanisms. Multivariate analysis of list experiment data is explicated in Imai (2011), Blair and Imai (2012), Moseson et al. (2017) and Lépine et al. (2020). The first specification uses a dummy variable called 'close to' Tabaski defined by sex acts within a specific value of T^D. Figure A1 is an example of how a sex act is allocated to a 'close to' and 'far from' Tabaski. The cut-off value of T^D is incrementally changed from four, the lowest value (and closest to Tabaski), to 28 and is estimated by the following equation:

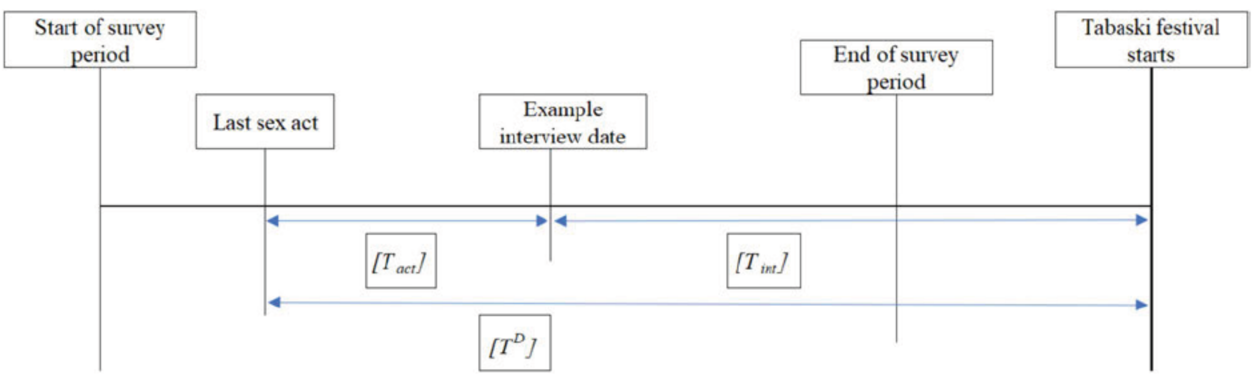


FIGURE 2 Illustration of key survey dates.

$$LE_i = \beta_0 + \beta_1 LT_i + \beta_2 T_i^D + \beta_3 LT_i \times T_i^D + \beta_4 List_{Ai} + \beta_x^z X_i^z + \beta_y^z LT_i \times X_i^z + u_i \quad (6)$$

Where LE_i is the number of statements that FSW agrees with during the list experiment. LT_i indicates if the FSW was in the list experiment treatment group that included the sensitive condom-use statement. T_i^D is a dummy variable that indicates if the last sex act, i, was 'close to' Tabaski or within T^D, days of Tabaski. X_i^z is a series of controls variables: 'being new to the survey', 'having a delayed interview', FSW age and a measure of risk aversion.[18] $List_{Ai}$ is a dummy variable indicating if the respondent was a member of the list experiment treatment group for the first or second set of sensitive statements. Because we use the double list experiment, each FSW has two observations, and we estimate robust standard errors clustered at the FSW level to account for this. u_i is the error term across all specifications and is assumed to be independent, with normal distribution, zero mean and constant variance. We vary the value of T^D from four, its lowest possible value, to 28, estimating a separate regression for each. The coefficient of interest is β_3, which represents the prevalence difference in condom use between those who had their sex act 'close to' Tabaski compared to those who had their last sex act 'far from', defined by T^D.

Next, we include sub-groups within this previous specification, Equation (6), to investigate heterogeneous effects and to explore the potential mechanisms:

$$\begin{aligned} LE_i = \beta_0 + \beta_1 LT_i + \beta_2 T_i^D + \beta_3 G_i + \beta_4 LT_i \times T_i^D + \beta_5 LT_i \times G_i + \\ \beta_6 T_i^D \times G_i + \beta_7 LT_i \times T_i^D \times G_i + \beta_8 List_{Ai} + \beta_x^z X_i^z + \beta_y^z LT_i \times X_i^z + u_i \end{aligned} \quad (7)$$

Where G_i indicates a dummy variable equaling one when the FSW is part of the sub-group in question. β_7 is now our parameter of interest representing the condom prevalence difference between those in sub-group G_i, if their sex act was 'close to' Tabaski. Sub-groups are used to examine differential impacts of time to Tabaski between Tabaski celebrators and non-celebrations, those that are yet to purchase an animal and those not as well as those in the upper or lower half of the wealth distribution and those with and without available savings.

The advantage of the first specification is that it allows us to pinpoint if there is an effect of Tabaski by varying the definition from four to 28 days. However, this means that as we incrementally change T^D, observations move from the 'far from' group to the 'close to' Tabaski, meaning we do not have a consistent 'far from' comparison group to see how the effect changes over time. The next specification attempts to resolve this by defining a series of time blocks and estimating compared to a fixed reference block in a single regression using the following equation:

$$LE_i = \beta_0 + \beta_1 LT_i + \beta_2 ListA_i + \beta_c W_i^b + \beta_d W_i^b \times LT_i + \beta_x^z X_i^z + \beta_y^z LT_i \times X_i^z + u_i \quad (8)$$

Where W^b is a dummy indicating if a sex act occurs in the time block W with b indicating the block number. $b = 1$ is the block closest to Tabaski, and therefore, the β_d are our parameters of interest, indicating the prevalence difference between these blocks and our reference block. We use two block lengths of four and 7 days, and our reference block is always the block furthest from Tabaski.[19] The advantage of this specification is that we can see the magnitude of any effect over time with a consistent comparison group.

The third specification gives additional depth and robustness to complement the results from the first two specifications because it dispenses with T^D as our proxy measure of Tabaski pressure. Instead, we use dummy variables indicating if an FSW is a 'Tabaski celebrator' and if they have 'not yet bought an animal' as time-invariant indicators of suffering relatively more economic pressure from Tabaski in the following equation:

$$LE_i = \beta_0 + \beta_1 LT_i + \beta_2 H_i + \beta_3 LT_i \times H_i + \beta_8 List_{Ai} + \beta_x^z X_i^z + \beta_y^z LT_i \times X_i^z + u_i \quad (9)$$

Where H_i is a dummy variable of our shock variable of interest. β_3 is our parameter of interest and is interpreted as the condom prevalence difference between those in shock group H_i and those who were not across the whole sample. These shock variables are not exogenous, and results are treated as associative rather than causal.

For outcomes measuring risky sex other than condom use, namely price and client types, which are not subject to the same level of social desirability bias, we can dispense with the list experiment model structure. We also have access to information on both the last and penultimate sex acts for certain outcomes (client type and price of sex act), so we estimate the following models in cross-sectional (last sex act only) and pooled (both last and penultimate sex acts[20]):

$$Y_{ia} = \beta_0 + \beta_1 T_{ia}^D + \beta_2 A_{ia} + \beta_x^z X_{ia}^z + u_{ia} \quad (10)$$

Where Y_{ia} is the alternative outcome of interest, T_{ia}^{D} is the continuous variable of 'days between sex act and Tabaski', and A_{ia} represents the sex act fixed effect for penultimate sex act a. All other assumptions are the same as previous.[21]

4.3 | Validity

To check the validity of our estimates, we verify that there are no systematic differences in FSWs according to the number of days between the interview and Tabaski since such differences may explain patterns in condom use, see A1.

4.3.1 | Date of interview, T^{int}

We do however identify two potential threats to the exogeneity of T^{int}. First, from 'new FSWs' who replace respondents and are answering the survey for the first time in the third wave. The anticipated attrition rate between waves was around 30%, so spaces were left in the lists for new FSWs to be recruited. New respondents were recruited from the network of existing FSWs to maintain the sample of around 600 FSWs. In practice, enumerators did not recruit a uniform number of new FSW respondents across the duration of data collection. Toward the end of data collection, the number of new FSW respondents rises because research teams were prioritizing the continuation of the sample until this point, see Figure A3.

The second threat comes from 'delayed' interviews. Not all interviews were conducted when scheduled, with around 10% of respondents interviewed at least 1 week later than their list position. These FSWs were likely to have busy schedules or be less organized, characteristics which could be conceivably linked to their propensity to use condoms and through other unobservables. We include controls for 'new respondents' and if the 'interview was one or more weeks delayed' to address these potential biases.

Table A1, column 1, in the Appendix, shows the time-invariant characteristic determinants of 'date of interview' relative to Tabaski, T^{int}. This confirms 'new respondents' and 'delayed' interviews are conducted closer to Tabaski but that there are no other significant differences. We explore the potential for bias further in the robustness checks, Section 6, presenting evidence that these variables are unlikely to drive our results as they do not predict condom use when isolated away from Tabaski.

4.3.2 | T^{act} and recall bias

A third possible source of endogeneity is that the T_{act} portion of T^{D} is not randomly assigned. Ideally, T_{act} would be sufficiently small in determining T^{D} that this imbalance would be trivial. However, the mean T_{act} is 11.2 days (median 3 days) and mean T_{int} is 16.8 days (median 16 days), meaning T_{act} is skewed away from zero and makes up a large portion of T^{D}, particularly when T^{D} is low. We can view T^{act} as a proxy for the frequency of sex acts or the intensity at which an FSW works, which could be related to condom use and bias in our results. T^{act} is also likely to be influenced by the proximity of the interview to Tabaski. A complicating factor is recall bias in reporting last sex characteristics. Columns 2 and 3 in Table A1 regress FSW characteristics and last sex characteristics on days since last sex, T^{act}, showing a relationship with dependency ratio at the 5% significant level and indicators for widows and both FSWs parents being alive at the 10% significance level.

Next, we test for a relationship between T^{act}, 'days since last sex', and condom use to provide evidence of potential unobserved confounding. Since time itself cannot influence the decision to use a condom, any remaining relationship between time and condom use must be via unobservable confounders and recall bias. Table A2 shows no relationship between T^{act} and condom use. Since T^{act} is a collider, that is, could itself be influenced by Tabaski, we do not include it as a key control variable. We do, however, run versions of our main models, keeping observations where T^{act} below a set number. In our robustness checks, we include T^{act} and dependency ratio as control variables which our main results are robust to.

4.3.3 | Combined

Finally, we combine T^{int} and T^{act} to make T^{D} to examine its relationship (as a continuous variable) with observables in our data (Table A3). Importantly, combining both does not reveal any new relationships, reassuring that combining T^{int} and T^{act} does not introduce new unobserved heterogeneity. Given that some of our estimating equations uses a series of dummy variables to define 'close to' Tabaski, see Section 4.2, we also include results from regressions using definitions $T^D \leq 7$, $T^D \leq 10$ and $T^D \leq 14$.

To conclude this section, the evidence we have presented suggests that T^{int} is exogenous conditional on being 'new to the survey' or having a 'delayed' interview. We include being 'new to the survey' as a key control along with having a 'delayed interview', 'FSW age' as a proxy for experience, and 'risk aversion' as it is strongly associated with risky behaviors.

5 | RESULTS

5.1 | Main results

Our main results are estimated using specification 1 (Equation (6)) with T^D varying incrementally from four to eleven (Table 3). We find a significant reduction in condom use when we define 'close to' as $T^D \leq 6$ to $T^D \leq 9$ inclusive, with a maximum difference in condom use prevalence of 43.1 pp between sex acts within 7 days of Tabaski compared to those 8 days and further from

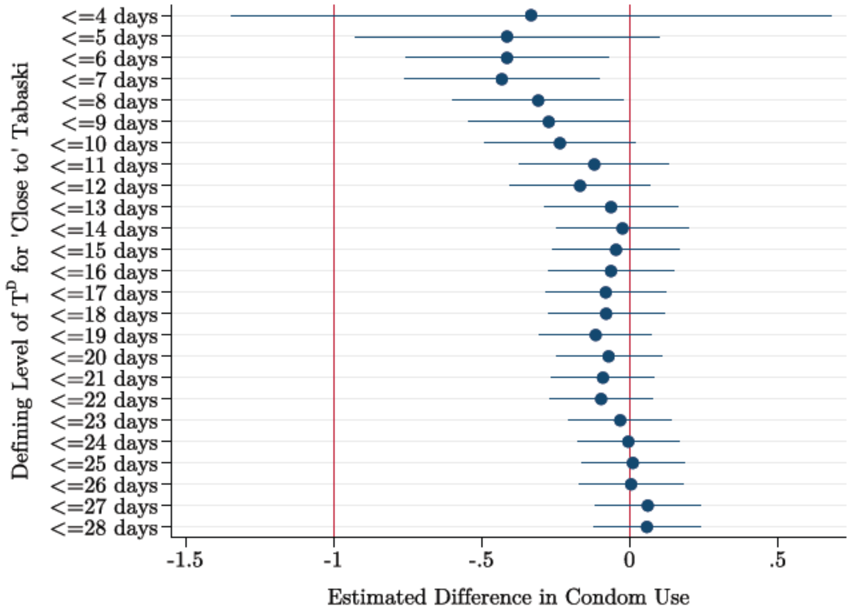
TABLE 3 Effect of Last Sex Act being 'close to' Tabaski on Condom Use Prevalence.

Variables	(1) T^D < = 4 days	(2) T^D < = 5 days	(3) T^D < = 6 days	(4) T^D < = 7 days	(5) T^D < = 8 days	(6) T^D < = 9 days	(7) T^D < = 10 days	(8) T^D < = 11 days
Close to Tabaski * list	−0.332	−0.414	−0.414**	−0.431**	−0.308**	−0.273**	−0.235*	−0.119
	(0.516)	(0.260)	(0.175)	(0.168)	(0.146)	(0.137)	(0.129)	(0.128)
Close to Tabaski	−0.331	0.086	0.178	0.137	0.160	0.093	0.107	0.018
	(0.248)	(0.171)	(0.121)	(0.119)	(0.114)	(0.107)	(0.102)	(0.100)
Sensitive list	0.337	0.369*	0.349	0.353	0.371*	0.359	0.369*	0.355
	(0.222)	(0.221)	(0.219)	(0.219)	(0.220)	(0.219)	(0.220)	(0.220)
Non-sensitive list A	−0.349***	−0.349***	−0.343***	−0.342***	−0.341***	−0.341***	−0.341***	−0.342***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
New * list	−0.101	−0.067	−0.026	−0.018	−0.030	−0.032	−0.040	−0.073
	(0.105)	(0.106)	(0.108)	(0.108)	(0.110)	(0.111)	(0.112)	(0.114)
FSW age * list	0.009*	0.008	0.008*	0.008	0.008	0.008	0.008	0.009*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Risk aversion * list	−0.026	−0.035	−0.014	−0.013	−0.016	−0.019	−0.023	−0.025
	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)
Delayed * list	0.056	0.053	0.066	0.066	0.060	0.066	0.060	0.061
	(0.158)	(0.158)	(0.156)	(0.156)	(0.156)	(0.157)	(0.158)	(0.158)
Constant	2.150***	2.137***	2.135***	2.135***	2.121***	2.132***	2.124***	2.137***
	(0.148)	(0.148)	(0.148)	(0.148)	(0.148)	(0.148)	(0.147)	(0.147)
Observations	824	824	824	824	824	824	824	824
R^2	0.237	0.236	0.237	0.239	0.235	0.235	0.235	0.233
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	412	412	412	412	412	412	412	412
FSWs in 'close to' group	4	17	35	37	48	55	62	68

Note: Robust standard errors in parentheses. Specification 1 (Equation (6)) with the last sex act within T^D days of Tabaski defining 'close to' Tabaski. The top row is the parameter of interest, β_3. Each column is a separate regression. Data of double list experiment with FSW level clustered standard errors. The sample is limited to those who have sex acts within the last 90 days, and regressions include the key controls of FSW age, new FSW to the survey, delayed interview and risk aversion. Covariates without list treatment are included but not reported for brevity. There are no sex acts within 3 days of $T^D <= 11 + days$; the key parameter estimates remain similar and statistically non-significantly different from zero, see Figure 3.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

FIGURE 3 Coefficient Graph of Parameter [β_3] of Models Estimated in Table 3. Includes controls.



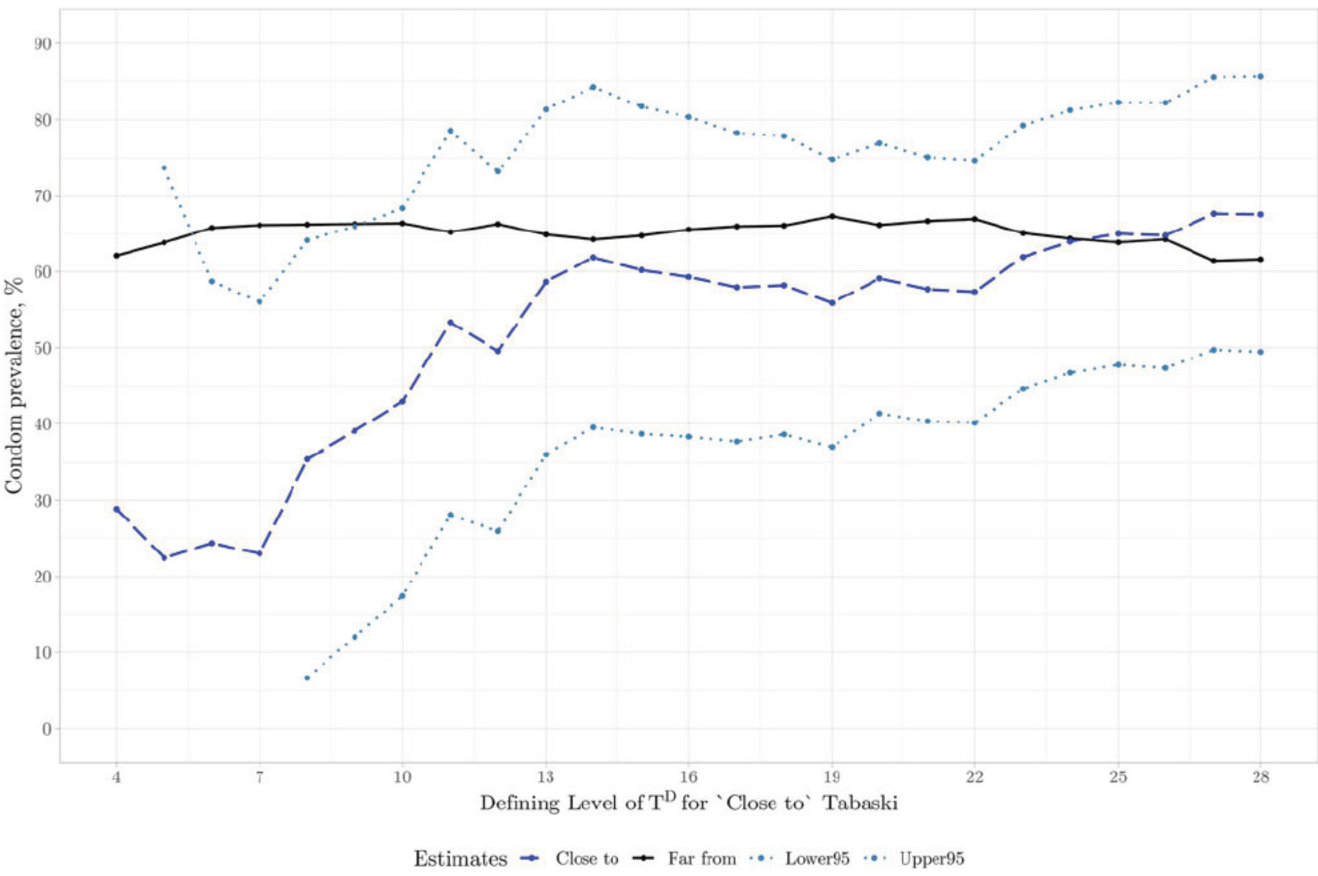


FIGURE 4 Condom Prevalence with Varying Definitions of 'close to' Tabaski. Far from' Tabaski values estimated as the prevalence of those defined as 'far from' Tabaski in specification 1 (Equation (6)) without controls, Table A4. 'Close to' Tabaski values estimated using the key parameters, ***beta***$_3$ in specification 1 (Equation (6)) with controls as well as the 95% confidence intervals.

Tabaski.[22] This implies an approximately 65.5% fall in condom use, to a level of 22.7% for sex acts 'close to' Tabaski.[23] At $T^D = 9$, the difference is a 27.3 pp reduction or a 36.6% fall in condom use. The value of β_3 remains negative but non-significant until $T^D \leq 24$ (see in Figure 3). Figure 4 plots the difference in condom use prevalence across all values of T^D to 28 calculated using specification 1.

We also present the results from Equation (6) without any controls (Figure A2). Tabaski has a negative effect on condom use, with the absolute magnitude increasing the closer the sex act is to Tabaski. Effect estimates show significant differences between groups when we define 'close to' Tabaski as $T^D \leq 5$ to $T^D \leq 12$ inclusive. This implies a maximum difference of 52.2 pp or an 81% drop in condom use when 'close to' Tabaski is defined by $T^D \leq 5$. When $T^D \leq 4$, we still find large negative coefficients, but a lack of observations means statistically significant differences are not found at conventional levels. We would expect the effects to persist up to Tabaski or the animal purchase.

The second part of our main results is estimated using specification 2 (Equation (8)) using sex acts grouped into blocks. Table 4 shows a significant drop in condom use for the first block when blocks are sized seven or four. A limitation

TABLE 4 Effect of Last Sex Act being in Time Blocks on Condom Use Prevalence.

Variables	(1) Block = 7 days	(2) Block = 7 days	(3) Block = 7 days	(4) Block = 4 days	(5) Block = 4 days	(6) Block = 4 days
Block 1 * list	−0.500***	−0.402**	−0.476**	−0.483***	−0.414**	−0.495**
	(0.162)	(0.175)	(0.197)	(0.163)	(0.179)	(0.212)
Block 2 * list	0.099	0.136	0.068	0.121	0.200	0.213
	(0.116)	(0.124)	(0.149)	(0.140)	(0.151)	(0.193)
Block 3 * list	−0.107	−0.127	−0.174	0.048	0.037	−0.040
	(0.109)	(0.109)	(0.139)	(0.159)	(0.161)	(0.191)
Block 4 * list				−0.201	−0.177	−0.195
				(0.146)	(0.150)	(0.196)
Block 5 * list				0.139	0.101	0.142
				(0.128)	(0.134)	(0.170)
Sensitive list	0.663***	0.335	0.524*	0.646***	0.312	0.215
	(0.058)	(0.220)	(0.271)	(0.060)	(0.223)	(0.286)
Non-sensitive list A	−0.334***	−0.342***	−0.383***	−0.343***	−0.352***	−0.386***
	(0.043)	(0.043)	(0.055)	(0.044)	(0.044)	(0.058)
Constant	2.058***	2.131***	2.136***	2.076***	2.121***	2.266***
	(0.043)	(0.145)	(0.181)	(0.044)	(0.146)	(0.201)
Observations	826	826	548	826	826	482
R^2	0.235	0.244	0.248	0.236	0.251	0.249
Prevalence in comparison block	0.663	0.663	0.702	0.649	0.646	0.649
Prevalence in block 1	0.261	0.261	0.226	0.154	0.232	0.154
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	No	Yes	Yes	No	Yes	Yes
Weekend control	No	No	No	No	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	-	Yes	Yes	-
$T^{act} <= 7$ only	No	No	Yes	-	-	-
$T^{act} <= 4$ only	-	-	-	No	No	Yes
Number of FSWs	413	413	274	242	413	242

Note: Robust standard errors in parentheses. Specification 2 (Equation (8)) with blocks of seven and 4 days. Block 1 indicates the block closest to Tabaski and all are in reference to the furthest block. Block 1 starts at $T^D = 1$. There are no observations between $T^D = 1$ and $T^D = 3$. 'Block * list' are our parameters of interest. Data of double list experiment with FSW level clustered standard errors. Models 1 and 3 are limited to sex acts within 90 days. Models 2 and 4 are limited to sex acts the same as the block length, so reference groups are not over weighted by those with less frequent sex acts. All regressions include the key controls of FSW age, new FSW to the survey, delayed interview and risk aversion. Models 5 and 6 include a control for if the sex act took place at the weekend. Controls and their interacted parameters are not reported for brevity. Prevalence of comparison block is the coefficient on the "sensitive list" variable in unreported versions of the models that do not include controls. Prevalence in block 1 is the difference between this number and the estimated effect in block 1.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

with models 2 to five is that the range of values T^{act} can have in each block varies; therefore, at the cost of observations, we limited the observations in the models by $T^{act} \leq block\ length$. We find a reduction in condom use prevalence of 47.6 and 49.5 pp for block sizes of seven and four, respectively, for this first block, but no statistically significant effects for any other blocks. In models 3 and 6, this corresponds to a 68% and 76% drop in condom use to a level of 22.6% and 15.4%, respectively, for sex acts within 7 days of Tabaski compared to our comparison block. To test the extent of potential confounding in these models, we perform the robust version of the Hausman test on models 1 and 2, then models 4 and 5, failing to reject the null in both cases, confirming the coefficients of interest are equivalent (Kaiser, 2015; Pei et al., 2019). Finally we include dependency ratio as a key control in place of *delayed interviews* with similar results, available on request.

Both these specifications suggest a strong effect of Tabaski on condomless sex, concentrated in the 7 days before Tabaski with a maximum effect size of between 47.6 and 49.5 pp.

5.2 | Exploring pathways

5.2.1 | Tabaski exposure

We now examine more closely whether the economic pressure from Tabaski is the driving force behind the reduction in condom use using the sub-group version of specification 1 (Equation (7)). Female sex workers who are financially more exposed to Tabaski, that is, those who have more purchases to make with less support from others and little coping depth, should be more likely to engage in risky behaviors to make up a greater relative amount for Tabaski. First, we construct a dummy variable which takes a value of one if an FSW is celebrating Tabaski and zero if they are not celebrating. As expected, celebrating Tabaski is associated with much lower condom use than non-celebrators (Table 5). There is a statistically significant difference in condom use prevalence of up to 68.7 pp when 'close to' Tabaski is defined as $T^D \leq 5$. The linear combination shows the effect across multiple definitions of 'close to' Tabaski, revealing a stronger effect for those celebrating compared to the full sample with a difference of up to 55.3 pp.[24]

We next define an alternative sub-group that is more exposed to Tabaski's economic pressures. We construct a dummy variable that equals one if an FSW had not yet bought an animal but had indicated they intend to. The comparison group includes those who had already bought their animal (N = 13), plus those who had no intention of buying an animal (N = 168), making it a within 'Tabaski celebrators comparison'. The magnitude of the reduction in condom prevalence between the two groups is large, up to 63.8 pp when we define 'close to' as $T^D \leq 5$, but not statistically significant at conventional levels, see Table 6. The linear combinations suggest a stronger and statistically significant effect of being 'close to' Tabaski for those who have not yet bought an animal up to 73.8 pp reduction in condom prevalence when the definition is $T^D \leq 6$ and persists to $T^D \leq 8$. Given our comparison group's average prevalence at this definition (Table A4, coefficient on the 'sensitive list' variable) is approximately 66%, the effect of having 'not yet bought an animal' brings their prevalence to effectively 0%. We find similar findings when we include those not celebrating in the comparison group ($N = 88$), see Table A8.[25]

The list experiment method is an inherently noisy method of eliciting condom use, and once we begin to perform subgroup analyses, we stretch these data, possibly beyond their useful limit. Another way to measure the effect of having not yet purchased an animal yet on condom use is to not interact T^D with our subgroups but to compare across all sex acts regardless of proximity to Tabaski as per specification 3, Equation (9). Table 7 contains the results of these models. We find a condom use prevalence difference for those yet to purchase an animal of between 3.4 and 7.6 pp. However, this includes many whose last sex act was far from the influence of Tabaski, so in model 3, we estimate on a sub-sample of FSWs whose last sex act was within 1 week of the interview, that is, $T^{act} \leq 7$. We find a statistically significant decrease in condom use prevalence of 23.4 pp in this version.

These results on economic exposure to Tabaski are based on subgroup analyses in which the usual caveats apply. Namely, we acknowledge there is some self-selection into celebrating Tabaski. Variables used to define Tabaski celebrators or animal purchases may be correlated with other characteristics that drive any differences between subgroups, and this means we are careful to apply a causal interpretation to the sub-group results.[26] That said, social and religious pressures mean 83% choose to celebrate, with only 11% excluding themselves for financial reasons and since Tabaski revolves around animal sacrifice, those not purchasing an animal only do so if there are alternatives available. In addition, the results are generally clear-cut and consistent with intuition about the FSWs who are likely to have been acutely exposed to the economic pressures of Tabaski.

TABLE 5 Effect of Last Sex Act being 'close to' Tabaski differentiated by Tabaski Celebrators on Condom Use.

Variables	(1) T^D < = 5 days	(2) T^D < = 6 days	(3) T^D < = 7 days	(4) T^D < = 8 days	(5) T^D < = 9 days	(6) T^D < = 10 days	(7) T^D < = 11 days
Celebrate * close to Tabaski * list	−0.687**	−0.513	−0.520	−0.581**	−0.371	−0.319	−0.277
	(0.305)	(0.325)	(0.317)	(0.277)	(0.266)	(0.260)	(0.255)
Close to Tabaski * list	0.187	−0.027	−0.033	0.136	0.012	0.018	0.103
	(0.120)	(0.261)	(0.261)	(0.235)	(0.229)	(0.229)	(0.226)
Celebrate * list	0.051	0.073	0.079	0.109	0.079	0.076	0.073
	(0.114)	(0.120)	(0.120)	(0.123)	(0.126)	(0.127)	(0.128)
Sensitive list	0.323	0.283	0.282	0.273	0.297	0.311	0.304
	(0.247)	(0.245)	(0.245)	(0.247)	(0.246)	(0.247)	(0.247)
Non-sensitive list A	−0.346***	−0.343***	−0.343***	−0.345***	−0.343***	−0.343***	−0.343***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
FSW age * list	0.008	0.008*	0.008	0.008	0.008	0.008	0.008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
New * list	−0.060	−0.017	−0.009	−0.020	−0.029	−0.039	−0.074
	(0.107)	(0.109)	(0.109)	(0.111)	(0.112)	(0.113)	(0.115)
Delayed * list	0.056	0.073	0.073	0.068	0.072	0.065	0.065
	(0.158)	(0.155)	(0.154)	(0.154)	(0.157)	(0.157)	(0.158)
Risk aversion * list	−0.034	−0.019	−0.017	−0.019	−0.021	−0.026	−0.028
	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)
Constant	2.192***	2.198***	2.194***	2.203***	2.200***	2.194***	2.194***
	(0.169)	(0.170)	(0.170)	(0.171)	(0.171)	(0.170)	(0.170)
Observations	824	824	824	824	824	824	824
R^2	0.237	0.239	0.241	0.238	0.237	0.236	0.234
Effect of Tabaski on celebrators							
Linear combination	−0.5*	−0.54***	−0.553***	−0.445***	−0.358**	−0.301**	−0.174
p-value	0.084	0.01	0.005	0.008	0.025	0.041	0.233
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	412	412	412	412	412	412	412
FSWs celebrarting and in 'close to' group	15	26	28	36	41	48	53

Note: Robust standard errors in parentheses. Specification 1 with sub-groups (Equation (7)) with the last sex act within T^D days of Tabaski defining 'close to' Tabaski interacted with the sub-group of Tabaski Celebrators. The top row is the parameter of interest, β_7. Linear combination is the effect of being 'close to' Tabaski for celebrators. Columns from left to right are separate regressions. Data of double list experiment with FSW level clustered standard errors. The sample is limited to those who have sex acts within the last 90 days, and regressions include the key controls of FSW age, new FSW to the survey, delayed interview and risk aversion. Covariates without list treatment are included but not reported for brevity. There are no sex acts within 4 days for Tabaski for both celebrators and non-celebrators. Beyond $T^D <= 11 + days$; the key parameter estimates remain similar and statistically non-significantly different from zero.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

5.2.2 | Coping strategies and relative poverty

To show whether having a relatively greater ability to cope reduces risky behavior, we estimated the difference in condom use as per specification 3, Equation (9). We use variables to indicate asset-poor, expense-poor and those with available savings[27] in models 1, 3 and 5 (Table 8). We find small point estimates in the direction we expect, that is, poorer FSWs and those without savings are less likely to use condoms. However, counter-intuitively, when we interact the coping strategy term with

TABLE 6 Effect of Last Sex Act being 'close to' Tabaski differentiated by 'Those still to purchase an animal' on Condom Use.

Variables	(1) T^D < = 4 days	(2) T^D < = 5 days	(3) T^D < = 6 days	(4) T^D < = 7 days	(5) T^D < = 8 days	(6) T^D < = 9 days	(7) T^D < = 10 days	(8) T^D < = 11 days
Unbought animal*Days*List	0.033	−0.638	−0.430	−0.336	−0.277	−0.229	−0.049	−0.087
	(0.958)	(0.516)	(0.392)	(0.372)	(0.318)	(0.305)	(0.274)	(0.267)
Close to * list	−0.291	−0.105	−0.307	−0.362	−0.288	−0.236	−0.240	−0.094
	(0.286)	(0.305)	(0.264)	(0.253)	(0.214)	(0.194)	(0.189)	(0.199)
Unbought animal*List	−0.110	−0.081	−0.082	−0.087	−0.090	−0.098	−0.109	−0.099
	(0.100)	(0.100)	(0.102)	(0.102)	(0.104)	(0.106)	(0.107)	(0.108)
List	0.199	0.204	0.200	0.210	0.230	0.224	0.243	0.223
	(0.252)	(0.253)	(0.251)	(0.250)	(0.254)	(0.254)	(0.253)	(0.253)
Non-sensitive list A	−0.347***	−0.344***	−0.338***	−0.337***	−0.338***	−0.339***	−0.339***	−0.340***
	(0.049)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.049)
New * list	−0.109	−0.059	−0.016	−0.007	−0.010	−0.027	−0.045	−0.080
	(0.119)	(0.120)	(0.121)	(0.121)	(0.123)	(0.124)	(0.125)	(0.127)
Delayed * list	0.177	0.175	0.202	0.200	0.192	0.194	0.184	0.185
	(0.176)	(0.176)	(0.171)	(0.171)	(0.172)	(0.173)	(0.174)	(0.176)
FSW age * list	0.014**	0.014**	0.014**	0.014**	0.013**	0.014**	0.013**	0.014**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Risk aversion * list	−0.046	−0.059	−0.041	−0.039	−0.042	−0.046	−0.047	−0.049
	(0.067)	(0.067)	(0.066)	(0.066)	(0.067)	(0.066)	(0.067)	(0.067)
Constant	2.077***	2.074***	2.061***	2.061***	2.034***	2.041***	2.037***	2.057***
	(0.168)	(0.169)	(0.168)	(0.168)	(0.164)	(0.165)	(0.164)	(0.164)
Observations	688	688	688	688	688	688	688	688
R^2	0.246	0.246	0.250	0.250	0.249	0.247	0.244	0.242
Effect of Tabaski on celebrators								
Linear combination	−0.258	−0.742*	−0.738**	−0.698**	−0.565**	−0.465*	−0.289	−0.18
p-value	0.78	0.082	0.015	0.015	0.025	0.065	0.181	0.367
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	344	344	344	344	344	344	344	344

Note: Robust standard errors in parentheses. Specification 1 with sub-groups (Equation (7)) with the last sex act within T^D days of Tabaski defining 'close to' Tabaski interacted with the sub-group of those 'who intend to but have not yet bought an animal' equaling 1 and those who have already bought an animal, those with no intention of equaling 0. Tabaski non-celebrators are excluded making this a within-Tabaski celebrators comparison. The top row is the parameter of interest, β_7. Linear combination is the effect of being 'close to' Tabaski for celebrators. Columns from left to right are separate regressions. Data of double list experiment with FSW level clustered standard errors. The sample is limited to those who have sex acts within the last 90 days and regressions include the key controls of FSW age, new FSW to the survey, delayed interview and risk aversion. Covariates without list treatment are included but not reported for brevity. There are no sex acts within 3 days for both sub-groups. Beyond $T^D <= 13 + days$ the key parameter estimates remain similar and statistically non-significantly different from zero.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

our acute Tabaski exposure variable, models 2, 4 and 6, we see all the signs flip, implying the poorer are more likely to use condoms if they are more exposed to Tabaski or those with savings less likely to use a condom. The counter-intuitive signs persist when we change the savings indicator to include only those with enough savings to cover their full expected Tabaski costs.

Whilst these results do not give us solid evidence, we learn that the influence of wealth and coping depth is not clear cut, and policies would have to be carefully thought through and evaluated to avoid unintended consequences. It could be that any

TABLE 7 Effect of 'Those still to purchase an animal' on Condom Use.

Variables	(1)	(2)	(3)
Unbought animal * list	−0.039	−0.077	−0.238**
	(0.088)	(0.089)	(0.115)
Sensitive list	0.630***	0.375*	0.541*
	(0.060)	(0.221)	(0.321)
List A	−0.339***	−0.345***	−0.365***
	(0.044)	(0.044)	(0.057)
T^D continuous variable * list		0.001	0.005
		(0.002)	(0.007)
New * list		−0.123	−0.143
		(0.101)	(0.144)
FSW age * list		0.008	0.006
		(0.005)	(0.006)
Risk aversion * list		−0.033	−0.087
		(0.060)	(0.077)
Constant	2.038***	2.116***	2.148***
	(0.049)	(0.157)	(0.244)
Observations	810	808	528
R^2	0.226	0.237	0.229
Double list experiment	Yes	Yes	Yes
T^D as control	No	Yes	Yes
Key controls	No	Yes	Yes
$T^{act} < 7$	No	No	Yes
Number of FSWs	405	404	264

Note: Robust standard errors in parentheses. Regression specification 3 (Equation (9)) using the unbought animal as the defining variable of Tabaski economic pressure. The variable is defined as those 'who intend to but have not yet bought an animal' equaling 1 and those who have already bought an animal, those with no intention of and those not celebrating Tabaski equaling 0. The top row is the parameter of interest, β_3. Data of double list experiment with FSW level clustered standard errors. All models include the key controls of FSW age, if an FSW was new to the survey and risk aversion, and interactions with sensitive list treatment plus days between last sex act and Tabaski. Delayed as a control is excluded because it is time dependent and captured in the inclusion of T^D. Covariates without list treatment are included but not reported for brevity. For all models the sample is limited to those who have sex acts within the last 90 days, model 3 includes those with sex acts within 7 days only. The magnitude and statistical significance of β_3 in model 3 is robust for T^{act} values less than 7, 6, 5 and 4.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

economic strengthening intended to reduce the need for condomless sex might increase participation and spending, potentially having the opposite impact on the number of condomless sex acts. Further study of interventions and possible consequences is needed.

5.2.3 | Client type and price

Table 9 shows the results of the changing client types in relation to Tabaski as per specification 4, Equation (10). We find a higher chance of occasional clients the closer the sex act is to Tabaski. On the one hand, this finding is unsurprising as we expect FSWs to seek new clients with an expansion of supply. On the other hand, typically, condomless sex is associated more with regular clients whom FSWs are more familiar with and have more built trust (Ferguson & Morris, 2007; Robinson & Yeh, 2012), suggesting FSWs are not only increasing their risk of infection to HIV and STIs through condomless sex but that these unprotected sex acts are likely to be occasional clients they do not know or trust as well.

TABLE 8 Effect of coping strategies on condom use.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Available savings*List					0.008	0.069
					(0.095)	(0.118)
Savings*Unbought animal*List						−0.087
						(0.144)
Expense poor*List			−0.022	−0.149		
			(0.088)	(0.112)		
Expense poor*Unbought animal*List				0.235*		
				(0.139)		
Asset poor*List	−0.009	−0.054				
	(0.090)	(0.110)				
Asset poor*Unbought animal*List		0.046				
		(0.143)				
Senitive list	0.317	0.398*	0.314	0.462**	0.310	0.356
	(0.215)	(0.223)	(0.214)	(0.222)	(0.219)	(0.226)
List A	−0.346***	−0.346***	−0.345***	−0.342***	−0.346***	−0.346***
	(0.043)	(0.044)	(0.043)	(0.044)	(0.043)	(0.044)
Sex days*List	0.001	0.001	0.001	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
New*List	−0.105	−0.120	−0.103	−0.121	−0.105	−0.125
	(0.100)	(0.102)	(0.101)	(0.102)	(0.101)	(0.101)
FSW age*List	0.009*	0.008	0.009*	0.009*	0.009*	0.008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Risk aversion*List	−0.026	−0.033	−0.025	−0.036	−0.026	−0.031
	(0.059)	(0.060)	(0.059)	(0.060)	(0.058)	(0.060)
Constant	2.260***	2.177***	2.212***	2.114***	2.137***	2.057***
	(0.152)	(0.156)	(0.152)	(0.157)	(0.152)	(0.158)
Observations	822	808	822	808	822	808
R^2	0.248	0.249	0.235	0.241	0.242	0.244
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes
T^D as control	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	Yes	Yes	Yes	Yes	Yes	Yes
$T^{act} < 90$	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	411	404	411	404	411	404

Note: Robust standard errors in parentheses. Regression specification 3 with sub-groups (Equation (9)) using three coping indicator variables as differentiating variables, asset poor - those below median wealth index level, expense poor - those below median 30 days expenses and available savings - those with available savings tomorrow. Columns 1, 3 and 5 indicate association of these with condom use over the whole period. Columns 2, 4 and 6 include an interaction term with our time-invariant Tabaski exposure variable, those 'who intend to but have not yet bought an animal'. Data of double list experiment with FSW level clustered standard errors. All models include the key controls of FSW age, if an FSW was new to the survey and risk aversion, and interactions with list treatment plus days between last sex act and Tabaski. Delayed interviews excluded, because it is an entirely time dependent and captured in the inclusion of T^D. Covariates without list treatment are included but not reported for brevity. For all models the sample is limited to those who have sex acts within the last 90 days. These results are not robust to limiting the sample by $T^{act} < 7$.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

The expected impact of Tabaski on prices is ambiguous. Whilst the premium for unprotected sex typically raises prices, the expected supply expansion and reduced demand due to Tabaski will lower prices. Using data on the last and penultimate sex acts for each FSWs within specification 4, Equation (10), we find no evidence that prices rise or fall depending on when a sex act takes place with respect to Tabaski, see Table A9.[28] This finding suggests that FSWs are only able to maintain their prices whilst agreeing to more condomless sex due to the pressures of Tabaski.

TABLE 9 Effect of Tabaski on likelihood of occasional clients.

Variables	(1) Client type	(2) Client type
T^D	0.002**	0.008***
	(0.001)	(0.002)
Sex act number		−0.046**
		(0.023)
FSW age	0.002	0.003
	(0.002)	(0.002)
New FSW to the survey	−0.041	0.028
	(0.045)	(0.048)
Interview was delayed	0.133*	0.110*
	(0.070)	(0.058)
Risk aversion	0.008	0.017
	(0.026)	(0.024)
Constant	0.676***	0.477***
	(0.096)	(0.110)
Observations	411	689
R^2	0.036	0.055
Key controls	Yes	Yes
Sex-act FE	No	Yes
Number of FSWs	411	365

Note: Standard errors in parentheses. Regression specification 4 (Equation (10)) with dummy variable of being a regular client as dependent variable and the number days between sex act and Tabaski as the continuous shock variable. A continuous type of T^D. The top row contains the parameter of interest β_3 where a positive parameters is interpreted as reduced chance of regular clients as sex acts move closer to Tabaski. Model 1 is cross sectional model of last sex acts only. Model 2, a pooled OLS including both last and penultimate sex acts. Controls used were FSW age, being new to the survey, if the interview was delayed, and risk aversion. The sample was limited to having both sex acts within 28 days. Model 2 errors clustered at the FSW level.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

6 | ROBUSTNESS CHECKS

6.1 | New respondents

As discussed in Section 4.1, new respondents were needed to maintain the cohort size, so the protocol for tracking and interviewing respondents included space for new respondents distributed across the survey. There is, however, a cluster of new respondents in the final stages of data collection, the period closer to Tabaski, see Figure A3. This was unavoidable as research teams prioritized a continuation of the panel. Figure 5 shows how our key shock variable, T^D, is weighted heavily toward new FSWs in the lower values of T^D.

If the characteristics of these new respondents are different from previously interviewed FSWs, it could threaten our identification. Data suggests the new FSWs are different in expected characteristics; that is, they are younger and are more risk-averse (Table A5). We test if there is any relationship between condom use and if an FSW is new to the survey. Since there is a cluster of new FSWs in the survey period proximate to Tabaski, we exclude those sex acts within 14 days[29] (the area where we see an effect of Tabaski). If new FSWs drive our results, we would expect a difference in condom prevalence between new and previously interviewed FSWs in this model. Table A6, shows no difference in condom use between being new to the survey and having been part of a previous wave.

In a further check, we examine the effect of Tabaski amongst new FSWs only using specification 1, Equation (6). Table 10 presents the results for this sub-sample of FSWs. The effect over time found in our main results persists within new FSWs, indicating this sub-sample does not solely drive our findings.

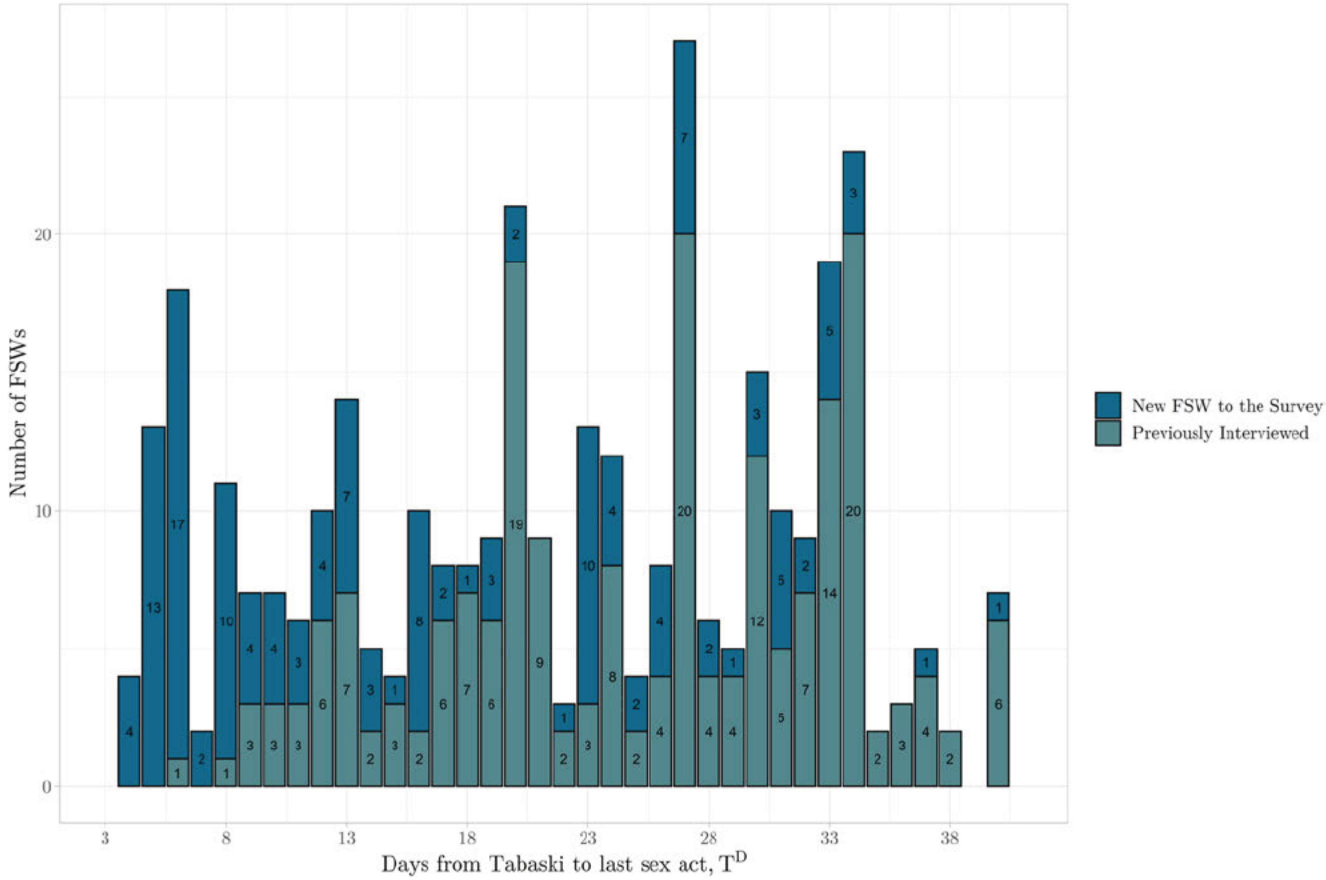


FIGURE 5 Distribution of last sex acts in relation to Tabaski, T^D.

6.2 | Organisation

Those who lack organisational skills or have low availability because of jobs or childcare will be interviewed later in the survey period and, thus, more likely to appear in our 'close to' Tabaski group. Having a delayed interview could have confounding effects on condom use. From scheduling information gathered from interviewers, we determined if an interview was performed the week after it was scheduled. 30% were performed in the assigned week, 22% were performed a week before it was scheduled,[30] and 10% were delayed. The remaining 39% were not applicable, that is, spaces for new FSWs or were not matched between the interview data and the scheduling sheets due to human data input errors.[31] Those who took part in delayed interviews have a higher household dependency ratio, indicating they may be in busier households (Table A5), but no significant difference in condom use (Table A7). Despite not finding a link between delayed interviews and condom use, we included this as a control.

There are limitations to using an indicator for those 'delayed' as a control since we do not have information on scheduling for all interviews; it might not adequately capture the organisation levels of FSWs. We, therefore, test if the key confounding variable related to 'delayed' interviews is related to our treatment variable but find no relation, see Table 1 in the supplementary materials. In addition, as a robustness check, we perform the primary analysis using only FSWs that attended their scheduled interviews on time, supporting our main conclusions and changing our key controls to household dependency ratio, the variable strongly correlated with *delayed* interviews.[32] Our results are robust to all of these tests and checks.

6.3 | Weekend effect

One factor that could explain our results is the effect of the weekend. We ran the time-invariant condom use model, specification 3, with an indicator for sex acts that took place at the weekend.[33] Because the peak of our effect falls around the weekend

TABLE 10 Effect of Last Sex Act being 'close to' Tabaski on Condom Use Prevalence for New female sex workers (FSWs) only.

Variables	(1) T^{act} < = 4 days	(2) T^{act} < = 5 days	(3) T^{act} < = 6 days	(4) T^{act} < = 7 days	(5) T^{act} < = 8 days	(6) T^{act} < = 9 days	(7) T^{act} < = 10 days	(8) T^{act} < = 11 days	(9) T^{act} < = 12 days	(10) T^{act} < = 13 days
Close to Tabaski * list	−0.388	−0.456*	−0.432**	−0.446***	−0.329**	−0.293**	−0.259**	−0.156	−0.192*	−0.096
	(0.501)	(0.254)	(0.167)	(0.160)	(0.137)	(0.127)	(0.119)	(0.117)	(0.111)	(0.105)
Close to Tabaski	−0.274	0.141	0.217*	0.179	0.196*	0.135	0.144	0.065	0.068	0.010
	(0.258)	(0.166)	(0.112)	(0.111)	(0.103)	(0.096)	(0.092)	(0.091)	(0.082)	(0.076)
Sensitive list	0.254	0.323*	0.338*	0.349*	0.360*	0.346*	0.351*	0.313*	0.337*	0.292
	(0.184)	(0.183)	(0.181)	(0.181)	(0.186)	(0.185)	(0.186)	(0.187)	(0.189)	(0.190)
Non-sensitive list A	−0.351***	−0.350***	−0.343***	−0.343***	−0.341***	−0.341***	−0.341***	−0.342***	−0.340***	−0.345***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
FSW age * list	0.010**	0.009**	0.009*	0.008*	0.008*	0.009*	0.009*	0.009**	0.009*	0.010**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Risk aversion * list	−0.038	−0.044	−0.017	−0.015	−0.019	−0.022	−0.028	−0.032	−0.032	−0.036
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Constant	2.244***	2.209***	2.182***	2.187***	2.160***	2.182***	2.169***	2.200***	2.195***	2.226***
	(0.132)	(0.133)	(0.133)	(0.134)	(0.134)	(0.133)	(0.133)	(0.132)	(0.133)	(0.133)
Observations	824	824	824	824	824	824	824	824	824	824
R^2	0.234	0.234	0.236	0.237	0.234	0.234	0.233	0.231	0.232	0.231
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	157	157	157	157	157	157	157	157	157	157
FSWs in the 'close to' group	4	17	35	37	48	55	62	68	78	92

Note: Robust standard errors in parentheses. Specification 1 (Equation (6)) using the sub-sample of new FSWs only with the last sex act within T^D days of Tabaski defining 'close to' Tabaski. The top row is the parameter of interest, β_3. Each column is a separate regression. Data of double list experiment with FSW level clustered standard errors. The sample is limited to those who have sex acts within the last 90 days and regressions include the key controls of FSW age, new FSW to the survey, delayed interview and risk aversion. Covariates without list treatment are included but not reported for brevity. There are no sex acts within 3 days of $T^D <= 13 + days$ the key parameter estimates remain similar and statistically non-significantly different from zero.

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

before Tabaski, we exclude the sex acts within 7 days of Tabaski. Table 5 in the supplementary materials shows no evidence of weekends leading to lower condom use. Our main results are also robust to include a weekend dummy as a covariate.[34]

6.4 | Migration and changing client pool

Another reason to explain our findings is migration or differential attrition due to Tabaski. Migration of FSWs and clients out of the city, or migration in of their families, might change the likelihood of response and, therefore, the pool of FSWs or clients available for interview close to Tabakski in a way related to condom use. For example, FSWs and clients may be unable to solicit clients if their families come to stay. Broadly, migration might be affecting the entire sample such that our sample excludes those who regularly travel out of the city for more prolonged periods around Tabaski. But we know from scheduling information that only a very small portion (1%, $n = 4$)[35] could not take part or delay an interview because of travel. The attrition rates were similar between waves one and two (Wave one was an interview period far from Tabaski and wave two close to Tabaski) and waves two and three (both proximate to Tabaski), implying no differential level of migration influencing the pool of FSWs available for the survey because of Tabaski. Table A1, column 1, in the Appendix, also shows no relationship between FSW characteristics and the interview date.

There are three reasons why we do not think migration within our sample explains our results. First, typical workers in Dakar receive only 2 days off for Tabaski, the day of the celebration and the following day. Because of this, migration into or out of Dakar typically occurs between zero and 4 days before the feast, dependent on individual circumstances. In our dataset, the closest sex act we identify is 4 days before the celebration and the closest interview 3 days before, indicating little chance of significant client or family migration. Second, we do find an increase in the likelihood of occasional clients but find no difference in condom use between regular and occasional clients, see Table 6 in the supplementary materials. In addition, the literature finds occasional clients typically are associated with greater condom use (Ferguson & Morris, 2007; Robinson & Yeh, 2012), implying the increase in occasional clients does not explain our results. Third, if FSWs found it more difficult to seek clients because of family arriving[36] or some other Tabaski-related reason, we would expect the time since the last sex act to be higher for those interviewed closer to the festival. For those interviewed 3 and 4 days ($T^{\text{int}} = 3$ and $T^{\text{int}} = 4$) before the festival, the mean T^{act} is 8.3 and 6.2, respectively. For those interviewed in the first week of interviews ($T^{\text{int}} = 28$ to $T^{\text{int}} = 32$) the mean T^{act} is between 6.4 and 14.3. Unadjusted regression finds no relationship between these T^{act} and T^{int} either.[37]

We test the change in FSW-reported client characteristics to observe changes closer to Tabaski. Our findings show that clients are less likely to be ”as clean” or ”as good-looking” as an FSW's typical client (equally likely to be better or worse) but that the risk of HIV, perceived wealth and age do not differ, Table A10. These findings are consistent with our prediction that the supply of sex increases, but demand falls without a significant change in the pool of clients. Even if non-shock channels drove our results, Tabaski is still strongly associated with large reductions in condom use. To explore the potential other channels, richer data on clients and multiple sex act information before and after Tabaski for FSWs would be needed.

6.5 | Direct questionning

We estimated our results using the answers to the direct question of if a condom was used during the last sex act, where 97% said ‘yes’, and unsurprisingly found no evidence of Tabaski influencing condom use, proving the value of the list experiment. Since we used the double list experiment for our main analysis, we also tested using each side of the list experiment, finding similar results; see Figure 1 in the supplementary materials. Our results were robust to the inclusion of T^{act} and dependency ratio as key controls; see Figures 3 and 2 in the supplementary materials.

7 | DISCUSSION

In this study, we assess the impact of a significant religious festival, Tabaski, on the risky sexual behaviors of FSWs. We identified a significant reduction in condom use in at least the 9 days prior to Tabaski. In the 7 days before the feast, we find up to a 49.5 pp drop in condom use. We find that those who are yet to buy an animal at the time of the interview have a condom prevalence 23.4 pp lower than those who have purchased an animal, with this effect peaking in the final 7 days before Tabaski when it is unlikely any sex acts are protected for this sub-group. We find no difference in price consistent with the idea that any premium associated with condomless sex is cancelled out by decreased demand and increased supply of risky sex. There is also little evidence that savings or wealth protects against changes in behaviors; however, we cannot say for certain due to data and analysis limitations. We show our results are robust to several potential confounders, including days since the FSW's last sex act, those 'new to the survey', those with 'delayed' interviews, sex acts at the weekend, and a number of reasons why migration might threaten our results.

Data collection took place during the COVID pandemic of 2020 and could mean our results are a one-off. Whilst lockdowns and restrictions had largely ceased by the time our data was collected, bars and nightclubs, a key source of clients, remained closed. Cust et al. (2021), find a reduction in clients and earnings, particularly for those who have difficulty borrowing. This is consistent with the idea that COVID is having a depressive effect on the local sex economy such that condomless sex is the only avenue left available, which, as we have seen, does not lead to an overall increase in the prices. A second consequence is that coping strategies (A in our conceptual framework) may have been exhausted coping with COVID such that there is little left to deal with Tabaski, so being underprepared this year is unique. However, debt and savings remained relatively stable between wave two and wave three; households in debt increased 3%, and those with savings fell 4%, but the quantity for those with savings rose 20%, although the quantity might be due to the 2020 data collection period being slightly closer to Tabaski.

The design of our analysis means our results are an internal comparison only. Considering the size of the shock (the expected cost of animals is 121% of typical monthly sex work income), it is plausible that the economic pressure runs across the entire period we collected data, meaning our comparison group is not a good approximation of an FSW's behavior the rest of the year. Should this be the case, our results are likely an underestimation. Further evidence from Treibich and Lépine (2019) using the same longitudinal dataset of FSWs shows there was no significant difference in condom use between data collection in wave one and in wave two (79.6% and 78.2%), with the former being collected at a different time of year (both by calendar and in relation to Tabaski), and the latter being collected at the similar time of year and one week prior (about Tabaski) than wave three in 2020.[38] The consistency of findings between wave one and wave two implies no calendar or seasonal difference and no longer-term Tabaski shock difference in condomless sex.

Our study is relevant for all FSWs in Sub-Saharan Africa that celebrate Tabaski and, more broadly, for economic shocks with similar characteristics. The original sample was not entirely representative, given the requirement for a 50-50 split of registered and unregistered FSWs and the observational nature of the dataset tracking the same FSWs over time. We used respondent-driven sampling methodologies that are best practice for these populations (Magnani et al., 2005) both for the initial FSWs and replacements in subsequent waves meaning the sample naturally cannot drift too far from the underlying population. Indeed, the balance of registered to unregistered has moved from 50% in wave 1%–53%, closer to the 57% previously found (APAPS & IRESSEF, 2014).[39] We, therefore, are confident our findings apply to the wider FSW population in Dakar.

Considering the implications more widely, Senegal's unique legal and contextual frameworks surrounding sex work make direct applications to other countries less straightforward. The inclusion of unregistered FSWs somewhat mimics FSWs in countries where sex work is illegal and where FSWs must take precautions to remain undiscovered, meaning our results do have substantial implications across the continent. A key population not captured here is those who engage in transactional sex but do not identify as sex workers. These women are also exposed to similar premiums and incentives as sex workers but are likely a much larger population than self-identifying sex workers (Luke, 2006; Stoebenau et al., 2016; Wamoyi et al., 2019). Our results suggest further research of anticipated shocks in transactional sex populations is much needed, particularly among adolescent and young women where HIV incidence is greatest.

Our study differs from the economic shocks literature because we study an anticipated economic shock that some theories would predict would be smoothed away. The response we observe is consistent with the effects seen for unanticipated shocks, but our estimates' magnitude is much larger. However, not all economic shock studies find increases in risky behaviors or HIV and STI health outcomes (Cust et al., 2021). Aker et al. (2020) is the only other study to investigate Tabaski, albeit not in a sexual health context. It also finds that Tabaski exerts significant economic pressure on households but that their savings intervention does not help smooth consumption when a shock is anticipated.

Any policy has to be carefully designed and should focus on easing the economic pressure in the final week before Tabaski without increasing intended spending, which could lead to little effect on behaviors.[40] Supplying animals to FSWs free of charge, a voucher system that can be redeemed for a Tabaski animal, or a cash transfer could lessen the risky behavioral responses by smoothing the spike in economic pressure from animal prices. Less costly solutions, such as financial education and savings interventions specifically targeted toward Tabaski, such as Aker et al. (2020), or similar to Jones and Gong (2021) with earmarked accounts could work with special attention given to preventing unintended consequences. From a public health point of view, these policies should be available to all FSWs or vulnerable women at risk of entering the commercial sex market.

However, care should be taken to avoid policies which might increase expected Tabaski spending and inadvertently increase risky sexual behaviors.

Our study has several limitations. The list experiment is inherently noisy and inefficient with low statistical power and has limitations on the type of analysis we could perform, such as calculating risk premiums. It means we cannot draw strong conclusions around the heterogeneous effects of savings and wealth. Surveys asked FSWs to recall their last paid sex acts, which adds potential recall issues. Because we only have a single sex act per FSW our results reflect the propensity for an individual FSW, to use a condom at their last sex act only. We cannot adequately analyze the intensity of condomless sex acts using these data, so we cannot answer the more pertinent public health questions about the total number of condomless sex acts. Future research should focus on directly measuring health impacts, for example, HIV and STIs, following Tabaski or shocks with similar characteristics, plus repeated data collection before, during, and after such events through sex act diaries. There should be a focus on interactions of shocks with coping strategies to inform policies better to protect against such shocks whilst avoiding unintended consequences.

8 | CONCLUSION

How FSWs and women vulnerable to transactional sex respond to economic hardship is vital to aid efforts to improve sexual health and reduce HIV spread in low- and middle-income countries. Our paper seeks to identify if there is a behavioral response of FSWS to anticipated economic shocks similar to the effects found for unanticipated shocks. We found that anticipation and knowledge of upcoming economic shocks do not lead to adequate savings, and its magnitude meets the threshold for a catastrophic health expense. Female sex workers respond by increasing risk-taking in sexual behaviors. We found those with sex acts within 9 days of Tabaski were less likely to use condoms, with a reduction in condom use prevalence of up to 49.5 pp (76%) compared to sex acts furthest from the festival. We show that the economic component of the festival is highly likely to be driving the observed drop in condom use and that those who are yet to buy an animal are unlikely to be using condoms at all in the six to 8 days before the festival. Tabaski has never before been documented as a cause of risky behaviors and has been shown to lead to condomless sex in a key population at high risk of HIV for at least 1 week every year. Our findings have important public health policy implications for FSWs affected by anticipated shocks with limited shock-coping strategies. We highlight the importance of protection against anticipated and unavoidable shocks as well as unanticipated shocks.

CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

Research data are not shared.

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ENDNOTES

[1] See The Strive group's work for detailed discussions of transactional sex and its contribution to HIV (Stoebenau et al., 2016; Wamoyi et al., 2019)

[2] Indeed, those in agriculture make earnings from their harvest last the year (Rosenzweig & Wolpin, 1993), but in general it is more frequent to miss short and long-run savings goals.

[3] Some argue a 'shock' implies it is unexpected and 'economic pressure' may be more suitable. We argue that if a large, anticipated expense is unavoidable and impacts household expenditure, it is a shock. We use shock and pressure interchangeably in this paper.

[4] Also known as 'list randomisation' or 'item count' methods.

[5] Typically FSWs do not receive support from government orNGOs for Tabaski but they do for some other shocks such as free treatment for STIs.

[6] Access to finance, particularly consumption finance, is difficult for vulnerable populations - only 53% of our sample has a mobile banking account or a bank account, and a similar proportion were already in debt. Our measure is not nuanced enough to tell us if household debt indicates access to finance to help with shocks or if the costs of debt are straining household finances further.

[7] Reasons for not celebrating: Non-Muslim: 19%, No Money: 70%, COVID-19: 3%, Other: 7%

[8] All exchange rates calculated at 1 USD = 553.000 XOF 31st July 2020.

[9] Many share the costs as this is a family celebration often with many others contributing.

[10] Looking at actual earnings in the last 30 days makes the cost of animals proportionally higher. However, we are unable to disentangle possible COVID-19 and Tabaski effects on the last 30 days' earnings, hence we compare using the *typical* reported earnings. Kavanagh et al. (2021) provide evidence of possible COVID effects on the earnings of these FSWs.

[11] Due to both farmers investing in transporting them to areas of high demand and because of spikes in demand themselves (Apolloni et al., 2018). Excess supply doesn't necessarily mean lower prices either, as the livestock remains valuable to farms after Tabaski

[12] A mean of 4 days when combining 'those already bought' with those who have and have not yet bought the animal.

[13] Based on the average cost in 2020.

[14] Data collection in 2017 took place at a similar time in relation to Tabaski. Unfortunately, there were no questions about the effects of Tabaski asked, meaning we have limited areas of comparison.

[15] 'Typical' in the survey might have been interpreted as pre-COVID too, although we did not specify, so the difference is hard to attribute to Tabaski alone.

[16] There is debate over the effectiveness of the list experiment in measuring sensitive behaviors. Lensvelt-Mulders et al. (2016) perform a meta-analysis finding it more accurate than direct face-to-face questioning at estimating prevalence, whereas several other studies find issues often derived from the implementation of the method, including whether it is understood by respondents (Haber et al., 2018).

[17] Our main results are robust to using single-sided list experiment analysis, see Figure 1 in the supplementary materials.

[18] The measure of risk aversion is derived from the Gneezy-Potter investment game that determines risk aversion of individuals with values of 0 to 2 (Charness & Gneezy, 2010). All results are robust to the removal of controls and are explored later in the analysis. We do not include all possible controls for the risk of over-fitting.

[19] We do not have enough data for each value of T^D to perform this using each day as a dummy variable. We use larger blocks to give ourselves suitable statistical power to draw conclusions.

[20] Wedo not extend our analysis here to use fixed effects because first differences in the continuous T^D simply represent the difference in time between the last two sex acts of the FSW which does not reflect changes in Tabaski pressure.

[21] We run but do not report the results using the incremental changes in T^D similar to specifications 1 and 2, Equations (6) and (8) for these outcomes too.

[22] These results are robust to the inclusion of T^{act} as an additional control, see Figure 4 in the supplementary materials. It is also robust to incrementally reducing the sample from $T^{act} \leq 90$ to $T^{act} \leq 1$. In other words even including only FSWs who had sex within the last 24 h the results hold. The strongest effect is found when T^{act} is limited to around 1 week, implying our results are not driven by the comparison group containing a high mean of T^{act}, see Figure 5 in the supplementary materials

[23] This is calculated using the value of β_3 when $T^D = 7$, 0.431, from specification 1, Table 3, and the condom prevalence for the comparison group taken from specification 1 without controls, Table A4, 0.658. The controlled specification with the list experiment does not give an accurate figure for the prevalence of the comparison group.

[24] The models without controls are available on request.

[25] Versions of both without controls support our findings and are available on request.

[26] Tabaski celebrators are more likely to be Muslim, in the poorest wealth quintile, be less risk-averse and be a new FSW to the survey. Those yet to buy an animal are more likely to be less risk-averse and typically earn more. See Table 4 in Supplementary Materials.

[27] Asset-poor and expense-poor are dummy variables equaling 1 when an FSW is below the median level of our asset wealth index or the median level of 30-day expenses across the whole sample. Available savings is a dummy variable equaling 1 when an FSW has a non-zero level of savings.

[28] Because we cannot attach condom use to the individual FSWs and given the impossibility to use a variable measured with the list experiment as a right-hand-side variable we cannot investigate how the risk premium changes with Tabaski. We also estimate versions using the definition of 'close to' Tabaski in specifications 1 & 2, Equations (6) and (8) again finding no effect of Tabaski on prices.

[29] Results are consistent reducing the exclusion period down to $T^D <$ five

[30] Enumerators were instructed to move to the next week of their list if they had exhausted their options for that week thus continuing with the randomisation so these interviews do not pose a problem to our identification.

[31] These were aids for the interviewers and were not originally intended for analysis.

[32] Results available in Tables 2 and 3 and Figure 2 in supplementary materials.

[33] We test with three definitions: 1) Saturday & Sunday, 2) Friday & Saturday, 3) Friday, Saturday & Sunday.

[34] Results for the weekend indicator included as a covariate and other definitions of weekend are available on request.

[35] This information is drawn from the scheduling information recorded by interviewers and was not designed for analysis. The information was incomplete

[36] It is worth noting that our interviews took place in private and at a location that does not indicate the respondents' occupation.

[37] Available on request.

[38] Survey 2015: 18th May - 2nd July. Tabaski 2015: Around 23rd - 27th September. Survey 2017: 7th August - 26th August. Tabaski 2017: 2nd September. Survey 2020: June 29th - July 28th Tabaski 2020: 31th July

[39] There have been no substantial changes in the registration policy or local attitudes to FSWs, meaning we believe the true proportion of registered has not differed much from this figure.

[40] An important aspect of Tabaski is sharing of the sacrificial animal with the community, and so with additional wealth FSWs may set their sights higher. There is some evidence that richer FSWs spend more than poorer. For every additional 1 CFAF of typical monthly earnings, an FSW expects to spend 0.16 CFAF more in total on Tabaski.

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APPENDIX A: TABLES AND FIGURES

TABLE A1 Determinants of T^{int} and T^{act}.

Variables	(1) T^{int}	(2) T^{act}	(3) T^{act}
Registered	−0.562	1.054	1.979
	(0.533)	(0.594)	(0.371)
FSW age	−0.003	0.116	−0.050
	(0.956)	(0.340)	(0.750)
Gneezy-Potter risk preference/2	−0.437	−0.288	−0.341
	(0.421)	(0.809)	(0.790)
Time preference	0.481	−3.907*	−3.171
	(0.637)	(0.082)	(0.178)
Number of children	−0.002	−0.385	−0.465
	(0.988)	(0.255)	(0.178)
Dependency ratio	0.029	1.050**	1.011**
	(0.886)	(0.020)	(0.030)

(Continues)

TABLE A1 (Continued)

Variables	(1) T^{int}	(2) T^{act}	(3) T^{act}
New FSW to survey	−8.806***	−1.209	−1.295
	(0.000)	(0.553)	(0.547)
Intensity - typical number of clients in 7 days	−0.038	−0.136	−0.177
	(0.619)	(0.419)	(0.339)
Marital status: Married	−2.877	17.612	17.042
	(0.622)	(0.170)	(0.191)
Marital status: Divorced or separated	−0.871	2.254	2.600
	(0.432)	(0.354)	(0.312)
Marital status: Widowed	−1.734	8.174*	8.280*
	(0.366)	(0.053)	(0.061)
Logged typical earnings (all sources)	−0.637	−2.169	−2.368
	(0.324)	(0.126)	(0.117)
Both parents are alive	−0.742	3.420	3.718
	(0.468)	(0.128)	(0.110)
Both parents are dead	−0.323	−1.997	−1.877
	(0.760)	(0.391)	(0.437)
Constant	30.599***	31.640*	30.964*
	(0.000)	(0.068)	(0.098)
Observations	409	409	398
R^2	0.281	0.097	0.125
FSW Covariates	Yes	Yes	Yes
Wealth covariates	Yes	Yes	Yes
Client/sex-act covariates	No	No	Yes
$T^{act} < 90$ only	Yes	Yes	Yes
Number of FSWs	409	409	398

Note: *p*-values in parentheses. Model 1 is T^{int} regressed on FSW characteristics. Last sex characteristics are not included as these are likely influenced somewhat by Tabaski. Model 2 is T^{act} regressed on FSW characteristics, model 3 includes last sex characteristics (unreported). All unreported variables are not statistically significant at 1% or 5% levels. Marital status reference category - never married. Unreported wealth quintiles, reference category - middle quintile. Unreported education categories, reference category - no education. Other unreported last sex characteristics: age of client, regular or occasional, client risk of HIV, if FSW or client consumed alcohol, negotiation took place, if the sex act took place in public, sex act duration, if fellatio or anal sex took place, if the client was rich, if the FSW stayed the night. All are self-reported by the FSW. The sample is limited to those who have sex acts within the last 90 days. Gneezy-Potter Risk preference is an investment game to determine the risk aversion of individuals with values of 0 to 2 (Charness and Gneezy, 2010). Female sex worker household dependency ratio is the ratio of children and under 65's to adults in the FSWs household. Time preference is a percentage of those who prefer money today instead of twice as much in 1 weeks time.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE A2 Effect of days since last sex Act on condom use prevalence.

Variables	(1) T^{act} continuous	(2) T^{act} continuous	(3) Dummy - $T^{act} <= 3$	(4) Dummy - $T^{act} <= 3$	(5) Dummy - $T^{act} <= 7$	(6) Dummy - $T^{act} <= 7$
T^{act} * List	0.002	0.002	0.032	0.007	0.061	0.042
	(0.002)	(0.002)	(0.061)	(0.063)	(0.063)	(0.064)
Sensitive list	0.594***	0.645***	0.652***	0.688***	0.626***	0.666***
	(0.052)	(0.072)	(0.060)	(0.069)	(0.068)	(0.075)
T^{act}	−0.003**	−0.003**	−0.069	−0.050	−0.013	0.004
	(0.001)	(0.001)	(0.087)	(0.090)	(0.088)	(0.090)
Non-sensitive list A	−0.338***	−0.336***	−0.339***	−0.338***	−0.339***	−0.337***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Intensity * list		−0.007		−0.007		−0.008
		(0.006)		(0.006)		(0.006)
Intensity		0.008*		0.009*		0.009*
		(0.005)		(0.005)		(0.005)
Constant	2.140***	2.080***	2.087***	2.038***	2.063***	2.016***
	(0.043)	(0.055)	(0.048)	(0.055)	(0.054)	(0.059)
Observations	824	824	824	824	824	824
R^2	0.225	0.227	0.222	0.225	0.222	0.225
Intensity control	No	Yes	No	Yes	No	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	412	412	412	412	412	412

Note: Robust standard errors in parentheses. Model 1 & 2 uses T^{act} as a continuous variable, model 3 & 4 a dummy variable equal 1 if $T^{act} <= 3$ and model 5 & 6 equal 1 if $T^{act} <= 7$. Models 2, 4 & 6 include the intensity variable - typical number of clients in 7 days leaving any remaining relationship to recall bias only. The sample is limited to those who have sex acts within the last 90 days. The cut off for the dummy was repeated up to $T^{act} = 21$ at which point there does become a small and statistically significant effect within our sample.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE A3 Determinants of T^D.

Variables	(1) T^D continuous	(2) $T^D <= 7$	(3) $T^D <= 10$	(4) $T^D <= 14$
Registered	−0.410	−0.039	0.003	−0.007
	(0.847)	(0.194)	(0.933)	(0.874)
FSW Age	0.102	−0.001	−0.003	−0.003
	(0.444)	(0.449)	(0.206)	(0.240)
Gneezy-Potter risk preference/2	−0.423	0.033*	0.012	0.000
	(0.746)	(0.073)	(0.598)	(0.987)
Time preference	−3.460	−0.010	−0.005	0.033
	(0.158)	(0.781)	(0.910)	(0.508)
Number of children	−0.269	0.005	−0.000	0.003
	(0.471)	(0.371)	(0.989)	(0.683)
Dependency ratio	0.814	−0.002	−0.004	−0.010
	(0.117)	(0.773)	(0.655)	(0.339)

(Continues)

TABLE A3 (Continued)

Variables	(1) T^D continuous	(2) $T^D <= 7$	(3) $T^D <= 10$	(4) $T^D <= 14$
New FSW to survey	−10.129***	0.210***	0.280***	0.321***
	(0.000)	(0.000)	(0.000)	(0.000)
Intensity - typical number of clients in 7 days	−0.203	0.003	0.003	0.003
	(0.272)	(0.236)	(0.272)	(0.470)
Wealth index continuous	1.208	−0.006	−0.005	−0.016
	(0.195)	(0.673)	(0.750)	(0.396)
Logged typical earnings (all sources)	−2.365	0.014	0.017	0.016
	(0.123)	(0.510)	(0.510)	(0.596)
Both parents are alive	2.706	0.002	0.034	0.038
	(0.270)	(0.955)	(0.420)	(0.452)
Both parents are dead	−1.793	0.017	0.015	0.068
	(0.482)	(0.637)	(0.730)	(0.191)
Constant	58.479***	−0.143	−0.076	−0.002
	(0.002)	(0.582)	(0.811)	(0.997)
Observations	408	409	409	409
R^2	0.135	0.172	0.201	0.179
FSW Covariates	Yes	Yes	Yes	Yes
Coping strategies	Yes	Yes	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes
Number of FSWs	408	409	409	409

Note: *p*-value in parentheses. Model 1 regresses a binary variable equal 1 if $T^D <= 7$, model 2 if $T^D <= 10$, and model 3 $T^D <= 14$. Last sex characteristics are not included as these are likely influenced somewhat by Tabaski. All unreported variables are not statistically significant at 1% or 5% levels. Unreported marital status reference category - never married. Unreported education categories, reference category - no education. The sample is limited to those who have sex acts within the last 90 days. Gneezy-Potter Risk preference is an investment game to determine the risk aversion of individuals with values of 0 to 2 (Charness and Gneezy, 2010). Female sex worker household dependency ratio is the ratio of children and under 65's to adults in the FSWs household. Time preference is a percentage of those who prefer money today instead of twice as much in 1 weeks time.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE A4 Effect of Last Sex Act being 'close to' Tabaski on Condom Use Prevalence without Controls.

Variables	(1) T^D <= 4 days	(2) T^D <= 5 days	(3) T^D <= 6 days	(4) T^D <= 7 days	(5) T^D <= 8 days	(6) T^D <= 9 days	(7) T^D <= 10 days	(8) T^D <= 11 days
Close to Tabaski * list	−0.465	−0.522**	−0.486***	−0.499***	−0.391***	−0.348***	−0.314***	−0.216*
	(0.565)	(0.259)	(0.165)	(0.157)	(0.133)	(0.125)	(0.118)	(0.117)
Close to Tabaski	−0.265	0.161	0.212*	0.176	0.192*	0.135	0.147	0.073
	(0.254)	(0.167)	(0.111)	(0.109)	(0.102)	(0.095)	(0.092)	(0.090)
Sensitive list	0.621***	0.638***	0.658***	0.661***	0.662***	0.663***	0.664***	0.652***
	(0.043)	(0.044)	(0.044)	(0.045)	(0.046)	(0.046)	(0.047)	(0.047)
Non-sensitive list A	−0.344***	−0.343***	−0.336***	−0.336***	−0.334***	−0.334***	−0.334***	−0.332***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Constant	2.109***	2.099***	2.085***	2.087***	2.079***	2.083***	2.079***	2.089***
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.039)	(0.039)	(0.039)
Observations	824	824	824	824	824	824	824	824
R^2	0.226	0.227	0.230	0.231	0.228	0.228	0.227	0.224

TABLE A4 (Continued)

Variables	(1) T^D < = 4 days	(2) T^D < = 5 days	(3) T^D < = 6 days	(4) T^D < = 7 days	(5) T^D < = 8 days	(6) T^D < = 9 days	(7) T^D < = 10 days	(8) T^D < = 11 days
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	412	412	412	412	412	412	412	412
FSWs in 'close to' group	4	17	35	37	48	55	62	68

Note: Robust standard errors in parentheses. Specification 1 (Equation (6)) with the last sex act within T^D days of Tabaski defining 'close to Tabaski'. The top row is the parameter of interest, β_3. Each column is a separate regression. Data of double list experiment with FSW level clustered standard errors. The sample is limited to those who have sex acts within the last 90 days and regressions does not key controls. There are no sex acts within 3 days of Tabaski and $T^D <= 11 + days$ the key parameter estimates remain similar and statistically non-significantly different from zero, see Figure A2.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE A5 Determinants of new female sex workers (FSWs) and delayed interviews.

Variables	(1) New FSWs	(2) Delayed interviews
Registered	0.059	1.052
	(0.248)	(0.595)
FSW Age	−0.016***	0.104
	(0.000)	(0.392)
Gneezy-Potter risk preference/2	0.110***	−0.239
	(0.000)	(0.841)
Time preference	−0.030	−3.879*
	(0.612)	(0.084)
Number of children	−0.012	−0.380
	(0.176)	(0.261)
Dependency ratio	−0.009	1.015**
	(0.466)	(0.024)
Intensity - typical number of clients in 7 days	0.001	−0.158
	(0.838)	(0.347)
Marital status: Married	0.359	17.465
	(0.282)	(0.174)
Marital status: Divorced or separated	−0.071	2.129
	(0.259)	(0.381)
Marital status: Widowed	−0.057	7.946*
	(0.601)	(0.060)
New FSW to survey		−1.828
		(0.351)
Logged typical earnings (all sources)	0.024	−1.932
	(0.514)	(0.169)
Both parents are alive	−0.046	3.658
	(0.427)	(0.102)
Both parents are dead	0.051	−1.694
	(0.397)	(0.464)

(Continues)

TABLE A5 (Continued)

Variables	(1) New FSWs	(2) Delayed interviews
Constant	0.757*	30.000*
	(0.092)	(0.083)
Observations	409	409
R^2	0.176	0.094
FSW Covariates	Yes	Yes
Wealth covariates	Yes	Yes
Client/sex-act covariates	No	No
$T^{act} < 90$ only	Yes	Yes
Number of FSWs	409	409

Note: p-value in parentheses. Model 1 is 'new FSWs to the survey' regressed on FSW characteristics. Last sex characteristics are not included as these are likely influenced somewhat by Tabaski. Model 2 is 'delayed interviews' regressed on FSW characteristics. All unreported variables are not statistically significant at 1% or 5% levels. Marital status reference category - never married. Unreported wealth quintiles, reference category - middle quintile. Unreported those with a second job. Unreported education categories, reference category - no education. The sample is limited to those who have sex acts within the last 90 days. Gneezy-Potter Risk preference is an investment game to determine the risk aversion of individuals with values of 0 to 2 (Charness and Gneezy, 2010). Female sex worker household dependency ratio is the ratio of children and under 65's to adults in the FSWs household. Time preference is a percentage of those who prefer money today instead of twice as much in 1 weeks time.

***p < 0.01, **p < 0.05, *p < 0.1.

TABLE A6 Condom use prevalence of new and previously interviewed female sex workers (FSWs).

Variables	(1)	(2)	(3)	(4)
New FSW*Sensitive list	−0.103	−0.043	−0.044	−0.011
	(0.110)	(0.118)	(0.156)	(0.174)
New FSW to the survey	0.100	0.076	0.080	0.080
	(0.080)	(0.083)	(0.107)	(0.113)
Sensitive list	0.698***	0.304	0.670***	0.558*
	(0.052)	(0.214)	(0.078)	(0.311)
List A	−0.361***	−0.366***	−0.426***	−0.430***
	(0.046)	(0.045)	(0.068)	(0.069)
FSW age * sensitive list		0.010*		0.004
		(0.005)		(0.008)
Risk aversion * sensitive list		−0.003		−0.066
		(0.060)		(0.091)
Constant	2.050***	2.241***	2.150***	2.122***
	(0.041)	(0.144)	(0.061)	(0.213)
Observations	734	734	372	372
R^2	0.268	0.272	0.266	0.268
Double list experiment	Yes	Yes	Yes	Yes
Key controls	No	Yes	No	Yes
$T^D >= 10$	Yes	Yes	Yes	Yes
$T^{act} <= 7$	No	No	Yes	Yes
Number of FSWs	345	345	177	177

Note: Robust standard errors in parentheses. Similar to specification 3 (Equation (9)) looking at the effect of New FSWs on condom use. The top row is the parameter of interest β_3. Data of double list experiment with FSW level clustered standard errors. All models are limited to sex acts more than 10 days from Tabaski. Models 1 & 3 are without controls. Models 2 & 4 includes controls - FSW age, risk aversion. Models 3 & 4 include only sex acts within 7 days of the interview. Covariates without list treatment are included but not reported for brevity.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE A7 Condom use prevalence of female sex workers (FSWs) with delayed interviews.

Variables	(1)	(2)	(3)	(4)
Delayed*Sensitive list	0.027	0.051	0.250	0.259
	(0.137)	(0.139)	(0.220)	(0.228)
Sensitive list	0.672***	0.267	0.641***	0.513*
	(0.048)	(0.197)	(0.071)	(0.276)
List A	−0.358***	−0.365***	−0.424***	−0.430***
	(0.046)	(0.045)	(0.067)	(0.069)
FSW age * sensitive list		0.010**		0.005
		(0.005)		(0.007)
Risk aversion * sensitive list		−0.005		−0.066
		(0.060)		(0.088)
Constant	2.076***	2.303***	2.178***	2.199***
	(0.041)	(0.140)	(0.059)	(0.205)
Observations	734	734	372	372
R^2	0.266	0.271	0.266	0.268
Double list experiment	Yes	Yes	Yes	Yes
Key controls	No	Yes	No	Yes
$T^D >= 10$	Yes	Yes	Yes	Yes
$T^{act} <= 7$	No	No	Yes	Yes
Number of FSWs	345	345	177	177

Note: Robust standard errors in parentheses. Similar to specification 3 (Equation (9)) looking at the effect of FSWs with delayed interviews on condom use. The top row is the parameter of interest β_3. Data of double list experiment with FSW level clustered standard errors. All models are limited to sex acts more than 10 days from Tabaski. Models 1 & 3 are without controls. Models 2 & 4 includes controls - FSW age, risk aversion. Models 3 & 4 include only sex acts within 7 days of the interview. Covariates without list treatment are included but not reported for brevity.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

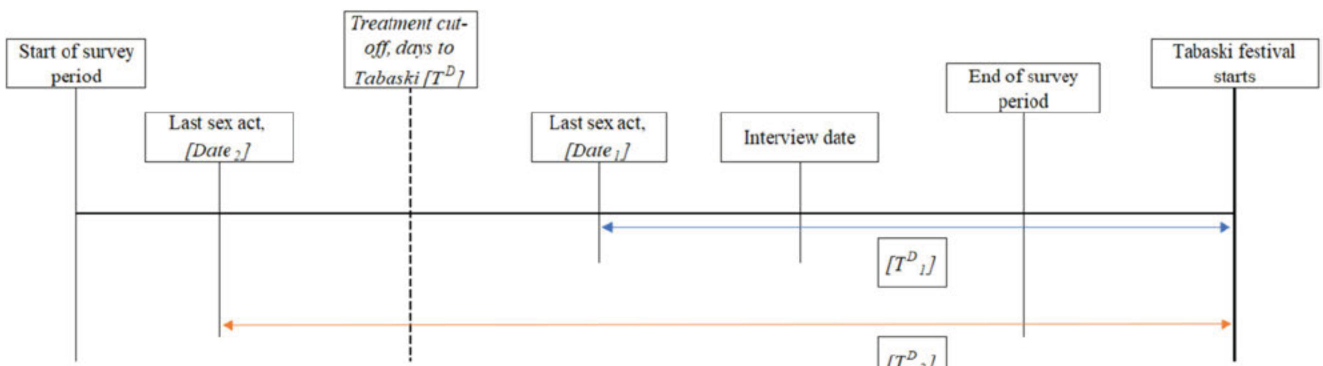

FIGURE A1 Example of T^D Categorized to 'close to' and 'far from' Groups.

Figure 2 illustrates the periods T_{int} and T_{act} in relation to our survey period. In Figure A1 we add an arbitrary cutoff for our 'close to' group at T^D. In the first instance where the respondents last sex act was closer to Tabaski [$Date_1$], T_1^D is included in the 'close to' group. Where the last sex act falls after our cutoff [$Date_2$], T_2^D falls in our control group of sex acts.

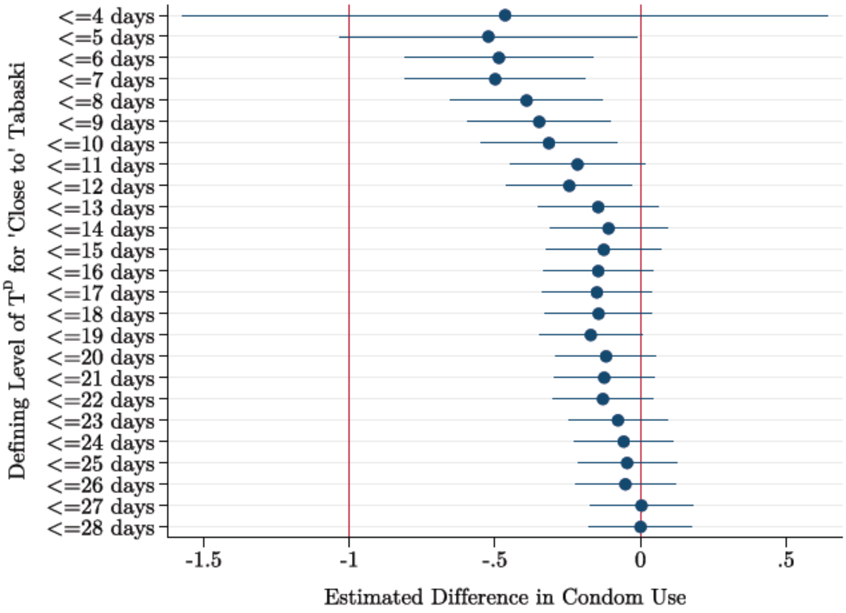

FIGURE A2 Coefficient Graph of Parameter [β_3] of Models Estimated in Table 3 without controls. Results tables for figures are available on request.

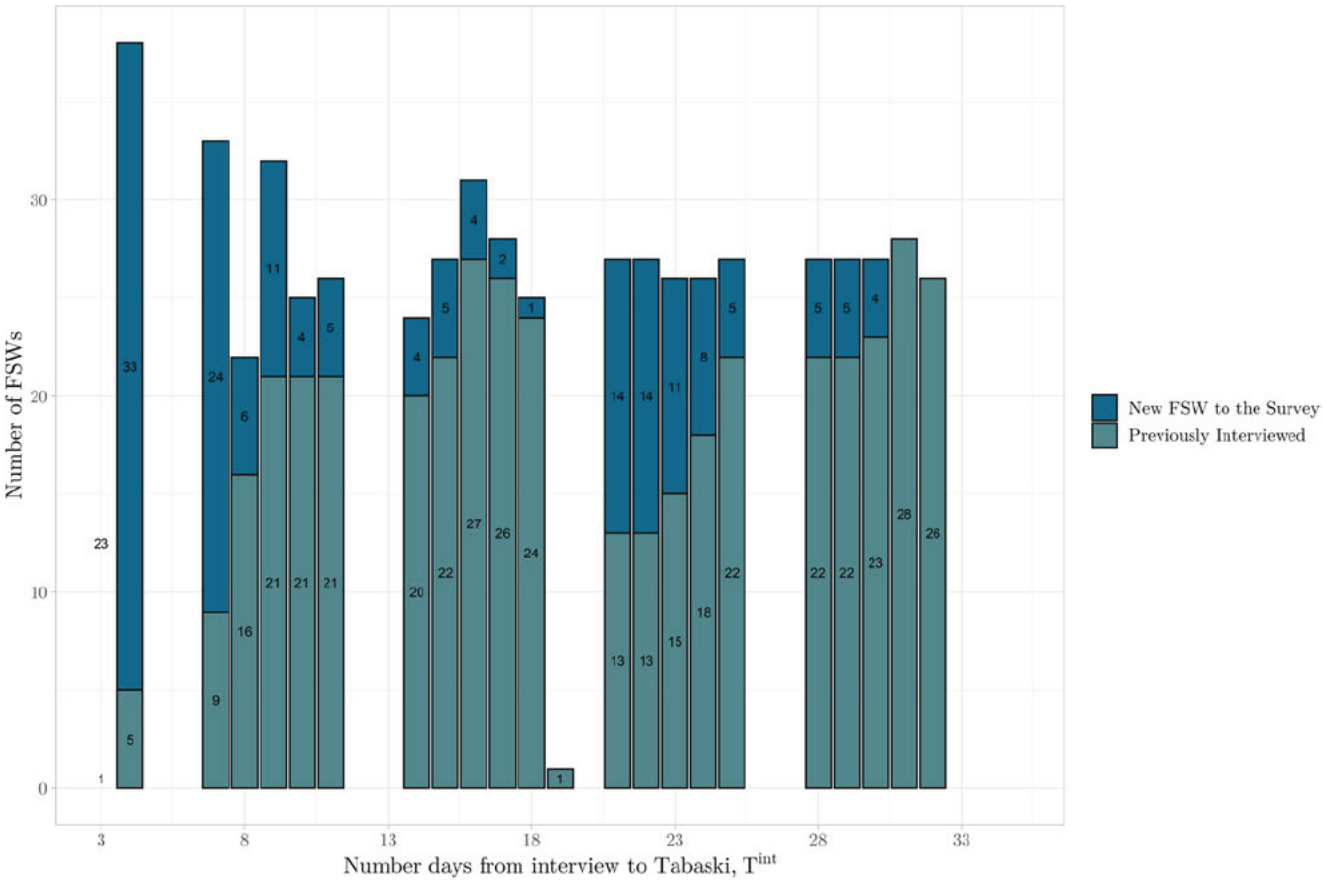

FIGURE A3 Distribution of Interview Date in relation to Tabaski, T^{act}.

TABLE A8 Effect of Last Sex Act being 'close to' Tabaski differentiated by 'Those still to purchase an animal' on Condom Use.

Variables	(1) T^D < = 4 days	(2) T^D < = 5 days	(3) T^D < = 6 days	(4) T^D < = 7 days	(5) T^D < = 8 days	(6) T^D < = 9 days	(7) T^D < = 10 days	(8) T^D < = 11 days
Unbought animal * close to Tabaski * list	0.033	−0.699	−0.539	−0.461	−0.427	−0.316	−0.151	−0.165
	(1.021)	(0.493)	(0.355)	(0.338)	(0.290)	(0.284)	(0.251)	(0.241)
Close to Tabaski * list	−0.333	−0.076	−0.219	−0.259	−0.157	−0.171	−0.172	−0.047
	(0.311)	(0.244)	(0.193)	(0.189)	(0.165)	(0.153)	(0.150)	(0.155)
Unbought animal * list	−0.080	−0.048	−0.044	−0.047	−0.044	−0.058	−0.065	−0.058
	(0.090)	(0.090)	(0.091)	(0.092)	(0.094)	(0.095)	(0.096)	(0.097)
Not yet bought an animal	0.161**	0.140**	0.150**	0.148**	0.158**	0.162**	0.157**	0.156**
	(0.063)	(0.064)	(0.065)	(0.066)	(0.066)	(0.066)	(0.067)	(0.067)
Sensitive list	0.395*	0.397*	0.392*	0.400*	0.411*	0.406*	0.425*	0.410*
	(0.230)	(0.231)	(0.229)	(0.228)	(0.231)	(0.230)	(0.229)	(0.229)
Non-sensitive list A	−0.349***	−0.347***	−0.342***	−0.340***	−0.341***	−0.342***	−0.342***	−0.343***
	(0.044)	(0.044)	(0.043)	(0.044)	(0.043)	(0.043)	(0.044)	(0.044)
New * list	−0.118	−0.075	−0.039	−0.032	−0.039	−0.044	−0.059	−0.093
	(0.106)	(0.107)	(0.109)	(0.109)	(0.111)	(0.113)	(0.113)	(0.115)
Delayed * list	0.057	0.057	0.078	0.076	0.071	0.071	0.061	0.064
	(0.163)	(0.163)	(0.160)	(0.160)	(0.160)	(0.161)	(0.162)	(0.163)
FSW age * list	0.009	0.008	0.008	0.008	0.008	0.008	0.008	0.008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Risk aversion * list	−0.034	−0.045	−0.028	−0.027	−0.034	−0.034	−0.035	−0.037
	(0.060)	(0.060)	(0.059)	(0.059)	(0.060)	(0.059)	(0.060)	(0.060)
Constant	2.051***	2.057***	2.041***	2.040***	2.023***	2.032***	2.027***	2.040***
	(0.152)	(0.153)	(0.152)	(0.152)	(0.151)	(0.151)	(0.150)	(0.150)
Observations	810	810	810	810	810	810	810	810
R^2	0.240	0.241	0.243	0.244	0.242	0.241	0.238	0.237
Effect of Tabaski on celebrators								
Linear combination	−0.299	−0.775*	−0.758**	−0.72**	−0.584**	−0.488*	−0.323	−0.212
p-value	0.76	0.075	0.014	0.013	0.021	0.056	0.136	0.292
Double list experiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$T^{act} < 90$ only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of FSWs	405	405	405	405	405	405	405	405
FSWs 'yet to purchase' and in the 'close to' group	2	8	12	13	16	17	23	26

Note: Robust standard errors in parentheses. Specification 1 with sub-groups (Equation (7)) with the last sex act within T^D days of Tabaski defining 'close to' Tabaski interacted with the sub-group of those 'who intend to but have not yet bought an animal' equaling 1 and those who have already bought an animal, those with no intention of and those not celebrating Tabaski equaling 0. The top row is the parameter of interest, β_7. Linear combination is the effect of being 'close to' Tabaski for celebrators. Columns from left to right are separate regressions. Data of double list experiment with FSW level clustered standard errors. The sample is limited to those who have sex acts within the last 90 days and regressions include the key controls of FSW age, new FSW to the survey, delayed interview and risk aversion. Covariates without list treatment are included but not reported for brevity. There are no sex acts within 3 days for both sub-groups. Beyond $T^D < = 13 + days$ the key parameter estimates remain similar and statistically non-significantly different from zero.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE A9 Effect of Tabaski on log Price of Last Sex Acts.

Variables	(1)	(2) Log price
T^D	0.001	0.000
	(0.004)	(0.003)
Sex act number		0.119***
		(0.036)
FSW age	0.004	0.000
	(0.004)	(0.004)
New FSW to the survey	0.121	0.002
	(0.097)	(0.085)
Interview was delayed	0.290**	0.236*
	(0.146)	(0.136)
Risk aversion	−0.164***	−0.133***
	(0.052)	(0.045)
Constant	9.010***	8.961***
	(0.231)	(0.206)
Observations	345	661
R^2	0.044	0.041
Key controls	Yes	Yes
Sex-act FE	No	Yes
Number of FSWs	345	363

Note: Standard errors in parentheses. Regression specification 4 (Equation (10)) with logged price as dependent variable and the number days between sex act and Tabaski as the continuous shock variable. A continuous type of T^D. The top row contains the parameter of interest β_3. Model 1 is cross sectional model of last sex acts only. Model 2, a pooled OLS including both last and penultimate sex acts. Controls used were FSW age, being new to the survey, if the interview was delayed, risk aversion and a measure for intensity - the typical number of clients seen in 7 days. The sample was limited to having both sex acts within 28 days and the top and bottom 2.5% were dropped. Model 2 errors clustered at the FSW level.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE A10 Effect of Tabaski on the last client's characteristics.

Variables	(1) Risk of HIV	(2) As clean as typical	(3) As rich as typical	(4) Client age
T^D Continuous variable	0.015	0.006**	0.005*	−0.018
	(0.014)	(0.003)	(0.003)	(0.037)
FSW age	−0.005	−0.005	−0.004	0.648***
	(0.016)	(0.003)	(0.003)	(0.042)
Typical number of clients in 7 days	0.052**	0.011**	0.001	−0.000
	(0.024)	(0.004)	(0.005)	(0.064)
New FSW to the survey	−0.418	−0.007	0.043	−0.571
	(0.353)	(0.066)	(0.069)	(0.949)
Interview was delayed	−0.406	0.038	0.133	0.459
	(0.537)	(0.101)	(0.106)	(1.458)
Risk aversion	−0.215	−0.069*	−0.003	0.020
	(0.188)	(0.036)	(0.037)	(0.506)
Last client was a regular	0.444	0.003	−0.147**	0.886
	(0.363)	(0.070)	(0.073)	(0.980)

TABLE A10 (Continued)

Variables	(1) Risk of HIV	(2) As clean as typical	(3) As rich as typical	(4) Client age
Constant	1.154	0.490***	0.556***	18.071***
	(0.869)	(0.167)	(0.175)	(2.337)
Observations	361	349	335	358
R^2	0.034	0.058	0.028	0.448
Key controls	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses. Regression specification 4 (Equation (10)) column title as the dependent variable and the number days between sex act and Tabaski T^D as the continuous shock variable. Risk of HIV is a rating out of 10 that the FSW believes the client has HIV. As clean and as rich is an indicator that the client is different from that FSWs typical client. Client age is in years. The top row contains the parameter of interest β_3. Controls used were FSW age, being new to the survey, if the interview was delayed, risk aversion and a measure for intensity - the typical number of clients seen in 7 days. The sample was limited to having both sex acts within 28 days.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

APPENDIX B: LIST EXPERIMENT VALIDATION

We test the assumptions of the list experiment as per (Lépine et al., 2020; Treibich & Lépine, 2019) and Blair and Imai (2012).

A | Randomization

The randomization for the lists was done during the 2017 wave of the survey and the same lists and randomization was maintained in the 2020 wave. For new entrants to the survey we allocated alternately for each new FSW interviewed by each enumerator. Table B1 shows randomization was successful.

B | Design Effects

Rows 5 and six of Table B2 shows there is no design effects in list A, but there is some evidence of a design effect in Row six of List B because no-one agreed with 0 statements in the control group. The treatment group has only 2 agree with 0 statements and for all other number of statements there is no sign of a design effect. An alternative method for testing the design effects detailed in Chuang et al. (2021) finds there is no significant difference between estimates from the A and B lists. Additionally my own test of design effect by including an interaction term of the list treatment variable and list assignment (list A or list B) in the double list regression which will capture the differential effect of answering the sensitive statement depending on which control list was received. This also gives a non-significant difference suggesting no overall concerns for design effects.

C | Floor and Ceiling Effects

Table B2 summarizes the floor and ceiling effects and the design effects assumptions. Rows 1 to 4 show there is no floor or ceiling effect for List A. The control group have a low number of responses (<10%) for 0 and 3. List B on the other hand, Row 3 of List B shows there is some sign of a ceiling effect (23% for agreement with 3 statements) and so privacy could be compromised for some respondents in this list treatment group. When examining the control statements for list B, we note that COVID could have increased the likelihood of all 3 being agreed with. For the first "*The majority of my clients are Senegalese*.", designed for most to agree with, but with reduced international travel due to COVID, the chance of local clients increases. For the second and third "I usually spend the whole night with my client." & "I usually solicit clients by phone.", COVID has closed bars and clubs throughout the data collection period meaning a common place for finding clients and performing sex acts with clients is closed off potentially pushing solicitation to phones and encourages sex acts to take place at home increasing the chance of overnight stays. However, social desirability bias in our case acts to over-report condom use so a ceiling effect will not influence the FSWs propensity to be dishonest and should not affect our results.

TABLE B1 Test of randomization with descriptive statistics.

Stat.	Means			Diff. A versus *B*
Variable	**All**	**List A**	**List B**	***p-value***
Beauty (mean/10)	5.8	5.8	5.8	0.0
Age (years)	39.0	38.4	39.6	1.2
Risk preference (0-2)	0.8	0.8	0.8	−0.0
Number of children	3.1	3.1	3.0	−0.1
Dependency ratio	1.4	1.5	1.3	−0.2
New FSW to survey (%)	35.8	35.6	36.0	0.4
Marital status: Never married (%)	21.0	20.9	21.1	0.1
Marital status: Married (%)	0.8	0.4	1.1	0.8
Marital status: Divorced or separated (%)	70.4	70.8	70.1	−0.6
Marital status: Widowed (%)	7.8	7.9	7.7	−0.2
Education: No education (%)	51.4	49.4	53.3	3.8
Education: Koranic only (%)	0.8	1.2	0.4	−0.8
Education: Elementary (%)	26.1	26.5	25.7	−0.8
Education: Middle? (%)	13.0	15.0	11.1	−3.9
Education: Secondary (%)	8.6	7.5	9.6	2.1
Education: University (%)	0.2	0.4	0.0	−0.4
Registered (%)	46.9	44.7	49.0	4.4
Has a second job (%)	37.2	34.4	39.8	5.5
Logged typical earnings (all, CFAF)	11.7	11.7	11.7	0.1
Wealth: Poorest (%)	32.5	32.8	32.2	−0.6
Wealth: Poor (%)	10.5	11.9	9.2	−2.7
Wealth: Neither (%)	16.9	16.2	17.6	1.4
Wealth: Rich (%)	21.0	18.2	23.8	5.6
Wealth: Richest (%)	19.1	20.9	17.2	−3.7
Both parents are alive (%)	22.4	21.3	23.4	2.0
Both parents are dead (%)	32.1	29.2	34.9	5.6
Has some available savings (%)	23.5	23.7	23.4	−0.3
Age of last client (years)	43.7	43.0	44.4	1.4*
Last client was a regular client (%)	80.7	84.6	77.0	−7.6**
Likely last client had HIV (%)	4.1	4.7	3.4	−1.3
Client consumed alcohol at last sex (%)	10.4	11.6	9.2	−2.3
Price was negotiated(%)	46.1	45.8	46.4	0.5
Last sex took place outside (%)	7.6	8.3	6.9	−1.4
Duration of last sex (mins)	12.7	13.1	12.4	−0.7
Last sex included fellatio (%)	16.2	15.5	16.9	1.4
Last sex included anal sex (%)	0.6	0.4	0.8	0.4
Stayed the night at last sex-act (%)	7.6	7.6	7.7	0.1
Last client was rich (%)	5.4	4.0	6.9	2.9
Observations	514	253	261	514

TABLE B2 Test of design, floor and ceiling effects.

Estimated Proportions	Source	Number of reported items (y) N	0	1	2	3	4	Sum
Senegal								
List A								
Row 1	Treatment list	261	0.004	0.034	0.544	0.391	0.027	1
Row 2	$\Pr(Y_i \leq y \mid T_i = 1)$		0.004	0.038	0.582	0.973	1	
Row 3	Control list	253	0.0079	0.344	0.565	0.083		
Row 4	$\Pr(Y_i \leq y \mid T_i = 1)$		0.008	0.352	0.917	1.000	1	
Row 5	Row 4 - Row 2 (<0)		0.004	0.313	0.335	0.027		0.679
Row 6	Row 2 - Row 4 ($y - 1$) (<0)		-	0.030	0.231	0.056	0.000	
List B								
Row 1	Treatment list	253	0.008	0.036	0.289	0.577	0.091	1
Row 2	$\Pr(Y_i \leq y \mid T_i = 1)$		0.008	0.043	0.332	0.909	1	
Row 3	Control list	261	0.000	0.149	0.617	0.234		1
Row 4	$\Pr(Y_i \leq y \mid T_i = 1)$		0.000	0.149	0.766	1.000	1	
Row 5	Row 4 - Row 2 (<0)		–0.008	0.106	0.434	0.091		0.623
Row 6	Row 2 - Row 4 ($y - 1$) (<0)		-	0.043	0.183	0.143	0.000	

Chapter 7 – Research Paper 3: The Role of Health Expenses on Condomless Sex Among Female Sex Workers in Urban Senegal

A key gap in the literature surrounding this thesis is the extent to which women at risk of engaging in commercial and transactional sex suffer economic shocks. As seen in Chapter 2 – Literature review, extensive literature is framed around shocks and coping strategies from a poverty point of view, but there is a dearth of evidence on populations engaging in risky behaviours.

This chapter uses primary data from Senegal to examine the breadth and severity of economic shock suffered by FSWs in urban settings, namely Dakar, Senegal. It also analyses the self-reported behavioural response to these shocks before explicitly testing the first hypothesis from Chapter 4. It estimates the impact on condom use from FSWs who suffer the most common economic shock suffered by FSWs, health expense shocks, accounting for endogeneity issues in reporting health shocks and behaviours.

The implications for this thesis are that this chapter generates the first evidence of the frequency of shocks that occur for FSWs. Second, it provides further evidence showing risky behaviours increase as a response to a common economic shock for a key population. Both sections have implications for planning protections against economic shocks and provide empirical evidence in support of the Conceptual Framework.

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Thesis Title	Economic Shocks and Risky Sexual Behaviours		
Primary Supervisor	Timothy Powell-Jackson		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

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Stage of publication	**Not yet submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I was the lead author responsible for the formulation of research questions, all analysis and writing of the research paper. I contributed to the research design and data collection.

SECTION E

Student Signature	[redacted]
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The Role of Health Expenses on Condomless Sex Among Female Sex Workers in Urban Senegal

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Abstract:

Out-of-pocket payments for healthcare present significant economic challenges for many households, especially in low and middle-income countries. In Senegal, a limited number of individuals have access to health insurance, leaving most facing high out-of-pocket costs for medical care. This issue is particularly pronounced for female sex workers who play a crucial role in the ongoing HIV crisis in Africa. Economic pressures can lead these women to engage in riskier behaviours like condomless sex, especially when facing economic shocks. This study investigates the range and severity of economic shocks suffered, and coping strategies used by female sex workers and their behavioural response to health expense shocks. Findings indicate that female sex workers frequently experience economic shocks, with health shocks being the most common. To cope, many increase their involvement in sex work, and some engage in riskier sexual behaviours. We also find there is between a 62% and 72% drop in condom use at the last sex act if someone else in the household is sick at the same time. We highlight the implications for HIV transmission in stigmatized contexts and offer methods for protecting against economic shocks as an HIV prevention method.

1 Introduction

Out-of-pocket payments (OOP) for health care are one of the most common shocks affecting poor households worldwide, with data suggesting the incidence of catastrophic health expenditure is rising throughout LMICs (Wagstaff et al. 2018). Risk-pooling in the form of health insurance is a financial tool limited to the most privileged in LMICs. In Senegal, only around 25-30% of the population is part of formal risk-pooling insurance programmes because they worked in formal public and private sector jobs, meaning the majority of people in Senegal face high OOP to access healthcare (USAID 2016), especially marginalised groups such as FSWs. Whilst HIV prevalence in the general population is <1% in Senegal, among FSWs, the level is estimated to be between 19.9% and 5.9% (Baral et al. 2012; Kane et al. 2009; Wang et al. 2007; Mukandavire et al. 2018) and remains a key population in prolonging the HIV crisis among women in Africa. Sex work is legal in Senegal if FSWs register themselves with authorities. When working, they must carry a *carte sanitaire* which must be signed off each month confirming they are STI-free or adhering to ART, otherwise risking arrest. Whilst the screening and treatment for STIs is free, the *carte sanitaire* is unique and only carried by FSWs putting them at risk of their occupation being discovered by friends and family, resulting in only around half of FSWs register (Ito, Lépine, and Treibich 2018).

Women engaged in commercial and transactional sex are incentivised to engage in condomless sex due to the risk premium attached to it and other risky sexual behaviours that can increase their earnings quickly in the face of economic shocks[1]. Previous literature has shown that health shocks significantly impact the economic well-being of those who suffer, including reduced consumption, reduced labour supply and increased debt (Mohanan 2013; Alam and Mahal 2014). The literature surrounding health shocks and risky behaviours found an increase in condomless and anal sex amongst FSWs following health shocks (Robinson and Yeh 2011) and reductions in transactional sex that were mitigated somewhat by increasing access to and levels of savings (Jones and Gong 2021) – both in Kenya. There is no evidence of health expense shocks leading to risky behaviours in other contexts.

This paper aims to describe the breadth and magnitude of economic shocks suffered by FSWs in urban Sengal, including how they typically cope with such shocks. We then analyse the impact on condomless sex, collected using the list experiment method. We find that health shocks are the

[1] Refer to Chapter 4 for the thorough description of how women engaged in transactional and commercial sex use risk to increase their earnings and the difficult health decisions they have to make.

most common shock suffered by FSWs in the urban environment and that the most common coping strategy to deal with the associated costs is to increase sex work. In response to illness in other household members, we find significant increases in condomless sex, but acknowledging a low number of such events and a noisy analysis associated with list experiment data bring caution to the conclusions.

2 Data and Sample

We use the third wave of the survey of FSW in Dakar, Senegal to test the primary prediction that economic shocks lead to increase HIV risk behaviours. Data collection took place from 29th June until 28th July 2020[2]. The first wave in 2015 recruited 654 FSWs using respondent-driven sampling and represented an estimated 15% of the total FSWs in Dakar at the time (APAPS & IRESSEF 2014). Commercial work is legal in Senegal if FSWs register and attend monthly health visits – although only around 43% of FSWs in the original sample were registered. Registered FSWs were recruited by the midwife in charge of their monthly medical examinations (a registration requirement) from four Dakar sites. Unregistered or clandestine FSWs were recruited from FSW leaders and invited to participate in surveys at the same health centres. Each participant was given up to 3,000 CFAF (around $5) to cover the time of the 90-minute survey and transport costs. In 2020, interviews lasted around 1.5 hours and took place at venues near the health centres, taking measures to minimise COVID transmission. Replacement in waves 2 and 3 in 2017 and 2020 was achieved using the same respondent-driven methodology as in wave 1 in 2015. The original sample required a 50/50 split in registered and unregistered FSWs, but this assumption was relaxed in subsequent waves. Through replacements in waves 2 and 3, the proportion of unregistered FSWs is now over 53%, closer to the natural 57% one would expect.

Table 1 shows the sample descriptive statistics from wave 3 of the survey, those used in the main analysis. These figures show us the majority of FSWs are divorced, separated or widowed, generally poorly educated, with less than 50% having more than primary education. Economically they appear vulnerable, with less than a quarter having any form of savings and 55% of households being in debt.

[2] The London School of Hygiene and Tropical Medicine and national ethics committees in Senegal granted ethical approval for the data collection and analysis.

Table 1: Sample descriptive statistics

	Obs	% /mean	SD
Age, years	514	39.0	9.73
New sex worker to the survey	514	36%	0.48
Registered	514	47%	0.50
Gneezy-Potter risk preference (/2)	514	0.82	0.75
Preference for the present	514	81%	0.39
Nationality			
Senegalese	514	97.9%	0.14
Education			
Primary	514	51.4%	0.50
Secondary primary cycle	514	0.8%	0.09
Secondary second cycle	514	26.1%	0.44
Superior	514	13.0%	0.34
No education	514	8.6%	0.28
Other	514	0.2%	0.04
Marital status			
Never married	514	21.0%	0.41
Married	514	0.8%	0.09
Divorced or Separated	514	70.4%	0.46
Widowed	514	7.8%	0.27
Economic variables			
Number of children	514	3.1	3.3
Dependency ratio	514	1.4	2.2
Earnings last 30 days (CFA)	512	63,520 CFA	86,315 CFA
Expenses last 30 days (CFA)	505	257,010 CFA	178,588 CFA
Has health insurance	514	2%	0.13
Any available savings	514	24%	0.42
Quantity of savings available (CFA)	514	48,989 CFA	397,800 CFA
Has a second job	514	37%	0.48
Earning from second job (CFA)	514	15,929 CFA	37,192 CFA
Is the household in debt	509	55%	0.50

3 Economic Shocks and Coping Strategies

Table 2 summarises the economic shocks suffered in the last 30 days by our sample of FSWs. 112 FSWs (22%) suffered any negative economic shock, with health shocks being the most prevalent, with 92 (18%) of FSW's households suffering a health shock expense. Health shocks are the most prevalent shock among our sample and likely urban households across Senegal. This adds to evidence that agricultural shocks are the most commonly suffered by LMIC households (Christiaensen and Demery 2018). Other negative shocks were uncommon, but the prevalence of job loss and eviction are symptoms of the unstable lives of FSWs. Only 1 FSW registered a positive shock occurring in the form of a new job.

FSWs are a marginalised population in Senegal, despite the legality of their work for those registered, meaning they suffer stigma and are excluded from many formal methods for coping with economic shocks, such as financial instruments or government support. Only nine of 514 FSWs, less than 2% of the sample, have health insurance, and only three of these have insurance covering the entire household. Savings are more readily available, with 24% having at least some savings available at a median savings level of CFA 40000, or around $65[3]. Given poor access to and availability of formal coping strategies, many FSWs are part of *causerie,* an informal group where FSWs meet to discuss their work and lives. Some of these have informal savings clubs where individuals contribute a certain amount that, in certain circumstances, will be distributed to members to aid with economic shocks as a form of informal insurance. These clubs save relatively small amounts and are not readily available when needed. Therefore, FSWs typically face the full cost of healthcare upfront to access it.

Table 2: Economic shocks suffered in the last 30 days & coping strategies

	Obs	n	% /mean	SD
Suffered type of shock				
Any negative shock	514	112	21.8%	0.41
Health OOP	514	92	17.9%	0.38
Eviction	514	5	1.0%	0.10
Theft	514	4	0.8%	0.09
Gift /inheritance*	514	0	0.0%	0.00
Death in the family/household	514	4	0.8%	0.09
Bankruptcy /job loss	514	7	1.4%	0.12
New job /business *	514	1	0.2%	0.04
Decrease in income /increase in expenses	514	2	0.4%	0.06
Another member of the household was sick	512	15	2.9%	0.17
Primary method of coping with a Health OOP shock				
Increase income through sex work	92	54	58.7%	0.50
Earn from non-sex activity	92	13	14.1%	0.35
Donation from household member	92	5	5.4%	0.23
Donation from third party	92	12	13.0%	0.34
Donation from regular client	92	1	1.1%	0.10
Savings	92	3	3.3%	0.18
Sale of asset	92	1	1.1%	0.10
Borrowing	92	1	1.1%	0.10
Other	92	2	2.2%	0.15
How to increase income through sex work				
Increase number of clients	54	12	22.2%	0.2
Increase number of sex acts	54	12	22.2%	0.2
Increase the price per sex act	54	0	0.0%	0.0
How to increase the price				
Stay the night	12	5	41.7%	0.1
Perform additional oral sex acts	12	10	83.3%	0.1
Perform additional anal sex acts	12	0	0.0%	0.0
Engage in unprotected sex	12	0	0.0%	0.0

Note: Shocks reported if they occurred within the last 30 days. All except, "Primary method of coping with shock" are multi-select answers.
* Positive shocks

Further questions about how respondents dealt with health expense shocks were asked - see panel 2 to 4 of Table 2. The majority relied primarily on sex work as their primary method for coping with OOP expense shocks. After that, the next most common option was earning money

[3] Exchange rate at the time of writing

outside of sex work through a second job. Using savings is the closest to a formal type of support available, but only one individual said they would use their saving, the remaining utilising informal strategies involving relying on donations from their networks or selling assets. These findings highlight the lack of support available to FSWs and that the majority must face the full cost of healthcare for themselves and their household without adequate means to pay.

For those whose primary coping method was increasing income through sex work, we wanted to determine how they planned to do this. The third panel of Table 2 shows their answers. The vast majority said they would seek out more clients, but around a fifth also said they would increase the number of sex acts or the price obtained per sex act. The premium attached to risky behaviours is the primary way FSWs increase the price, but when we asked directly, panel 4, none were willing to admit engaging in more stigmatised unprotected sex acts. Whilst these reported behaviours may be true, we believe social desirability bias leads respondents to be unwilling to admit to these activities and treat them with caution. Later we compare condom use at the last sex act using the list experiment and when asked directly, proving misreporting is taking place.

More generally, the fact that around 78% of FSWs are divorced or separated, compared to an average of 18% of women divorced at any one time in the general population (Lambert, van de Walle, and Villar 2018), suggests that sex work is used to cope with the economic challenges of being a female household head. Senegal is a profoundly patriarchal society meaning women face significant economic challenges when they no longer have male partners to rely on for income and protection, particularly those divorced or abandoned by their partners. Typically re-marriage is a quick process taking around a year for widowed women and two years for divorced women meaning they have significant periods to provide for themselves and their remaining families. The high proportion of these types of women in our sample suggests sex work might be one way to cope with these periods whilst not married.

4 Empirical Strategy

Unexpected household health shocks are used in the literature as exogenous shocks to income both through the cost of medical care and through lost working time (Robinson and Yeh 2011; Jones and Gong 2021). Our empirical test of the impact of health shocks on risky sexual behaviours uses a different definition of a health shock and is displayed in the descriptive section of the paper as “another member of the household was sick”, Table 2. The module used in Table 2 concerning OOP health shocks is vulnerable to endogenous decisions to report shocks based on their impacts and might reflect the ability to pay rather than the incidence of suffering a shock. In other words, those with a household illness that required a payment but knew they could not afford it, or were yet to pay it will not have reported that in that section of the survey. We can also not differentiate who the health expense shocks were for.

Therefore, during a module that asked questions about the FSW's last sex act with a client, we also asked *if someone else from the household was sick or injured at the time of this sex act*. We specify *someone else* to avoid the FSW's own health status impacting her decision to use a condom, our outcome measure. Table 3 shows the difference in characteristics between those shocked, i.e. someone else in the household was sick (n=15) during the last sex act, and those that did not (n=497). We find that FSWs suffering health shocks are more risk-loving, are more likely to be widowed and less likely to be divorced. However, when predicting the instance of health shocks from all these covariates, the significance of these variables disappears with the exception of having a significant second job at the 10% level.

Table 3: Balance table of those suffering health shocks and those not

	No illness (n=497)		Illness at last sex act (n=15)		Difference	
	Mean	SD	Mean	SD	Diff	p-val
Age, years	39.02	9.68	39.87	10.85	0.847	0.74
New sex worker to the survey	0.35	0.48	0.47	0.52	0.113	0.371
Registered	0.47	0.50	0.53	0.52	0.069	0.601
Gneezy-Potter risk preference (/2)	0.80	0.75	1.24	0.69	**0.440****	**0.025**
Preference for the present	0.81	0.39	0.80	0.41	-0.009	0.932
Nationality						
Senegalese	0.98	0.14	1.00	0.00	0.02	0.58
Education						
Primary	0.52	0.50	0.47	0.52	-0.048	0.712
Secondary primary cycle	0.01	0.09	0.00	0.00	-0.008	0.728
Secondary second cycle	0.26	0.44	0.33	0.49	0.074	0.523
Superior	0.13	0.34	0.20	0.41	0.071	0.421
No education	0.09	0.28	0.00	0.00	-0.087	0.235
Other	0.00	0.05	0.00	0.00	-0.002	0.862
Marital status						
Never married	0.21	0.41	0.27	0.46	0.059	0.578
Separated	0.01	0.09	0.00	0.00	-0.008	0.728
Divorced	0.71	0.45	0.47	0.52	**-0.246****	**0.04**
Widowed	0.07	0.26	0.27	0.46	**0.194*****	**0.006**
Economic Dependents						
Number of children	3.06	3.34	3.67	2.64	0.604	0.488
Dependency ratio	1.35	2.19	1.88	3.19	0.531	0.362
Earnings last 30 days	64358	87412	44333	36394	-20024	0.377
Expenses last 30 days	256734	178525	226575	167279	-30159	0.547
Has health insurance	0	0	0	0	0	0.621
Any available savings	0.24	0.43	0.07	0.26	-0.173	0.12
Quantity of savings available	49043	403057	400	1549	-48643	0.641
Has a second job	0.38	0.49	0.20	0.41	-0.178	0.16
Earning from second job	16182	37533.42	9667	26354	-6515	0.505
Is the household in debt	0.55	0.50	0.73	0.46	0.187	0.153

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Determinants of suffering a health shock

Characteristics	Someone else in the household was sick Coef	SE
Age, years	-0.001	0.001
New sex worker to the survey	0.009	0.017
Registered	0.018	0.016
Gneezy-Potter risk preference (/2)	0.010	0.010
Preference for the present	0.006	0.019
Nationality		
Senegalese	0.022	0.056
Education		
Primary	Reference	
Secondary primary cycle	-0.040	0.095
Secondary second cycle	0.013	0.018
Superior	0.014	0.023
No education	-0.018	0.029
Other	0.002	0.163
Marital status		
Never married	Reference	
Separated	-0.037	0.085
Divorced	-0.019	0.021
Widowed	0.047	0.034
Economic Dependents		
Number of children	-0.001	0.003
Dependency ratio	0.004	0.004
Earnings last 30 days	0.000	0.000
Expenses last 30 days	0.000	0.000
Has health insurance	-0.020	0.059
Any available savings	-0.015	0.019
Quantity of savings available	0.000	0.000
Has a second job	-0.0321*	0.019
Earning from second job	0.000	0.000
Is the household in debt	0.010	0.015
Constant	0.021	0.068
Observations	496	

Note: 496 observations due to missing covariate observations

4.1 Estimating equation

To determine the impact of health shocks on the likelihood of using a condom collected via the list experiment method, we estimate the following equation:

$$Y_{ik}^{LE} = \beta_0 + \beta_1 LT_{ik} + \beta_2 S_i + \beta_3 S_i * LT_{ik} + \beta_4 List_{ik} + \beta_x X_i + \beta_z X_i * LT_{ik} + u_{ik}$$

where Y indicates the number of statements individual, *i,* agreed with during the list experiment LE included where two separate experiments, k, using two different non-sensitive lists, *list.* LT indicates if the individual received the treatment or control list, S indicates if the FSW had someone else in the household that was sick at the time of the last sex act. Since we are using the validated double list experiment where each individual is asked the list experiment twice, once as a treatment list and once as a control list. X is a list of individual controls, namely, the dependency ratio of the FSWs household, if they are in the bottom half of the wealth distribution, their individual risk preference and if they have a preference for the present. We also include controls for widowed and divorced as a robustness check. For covariates to work as expected, they must be included individually and as interactions with the indicator for the treating or control group, LT_i. Overfitting becomes an issue when we include many of these terms, so we include only key controls detailed in the results tables. u_i is the error term and is assumed to be independent, with normal distribution, zero mean and constant variance.

We estimate robust standard errors clustered at the individual level since each individual appears twice in the model, once for the first instance of the list experiment and once for the second instance. Our parameter of interest, β_3, represents the difference in condom use between the shocked and unshocked groups.

5 Results

We find that the health shock is associated with a 47-percentage point reduction in condom use at the time of the last sex act (Model A, Table 5). This result is robust to the inclusion of a set of covariates that control for potential confounding. An FSW's age, poverty, number of children and dependency ratio could influence the likelihood of a household suffering a health shock to another member and be correlated to condom use. Controlling for these variables yields a difference in the prevalence of 46 percentage points (Model B, Table 5).In model C, we include the additional controls that are the unbalanced characteristics, namely risk aversion, if widowed, if divorced and the number of days since the last sex act from the date of the interview (to control for recall bias). This large and significant estimate shows a 41 percentage point reduction in condom use. The average level of condom use in the non-exposed group is the estimated parameter β_1 , and in Model A is 67.1%. This means our estimates represent a 70%, 68% and 62% fall in condom use in models A, B and C of Table 5, respectively. Unfortunately, the low number of events of the shock variable means further sub-group analysis investigating the impact of coping strategies on risky behaviours is not possible.

Table 5: The impact of illness in another household member on FSWs condom use at last sex act

	A	B	C
Health shock * List treated	-0.470**	-0.432**	-0.428**
	(0.205)	(0.213)	(0.211)
Health shock	0.134	0.182	0.189
	(0.162)	(0.168)	(0.165)
List treated	0.671***	0.612***	0.486***
	(0.0390)	(0.103)	(0.128)
List A	-0.337***	-0.339***	-0.338***
	(0.0383)	(0.0385)	(0.0385)
Dependency ratio * List treated		-0.0207	-0.0204
		(0.0171)	(0.0175)
Below median wealth * List treated		-0.0499	-0.0569
		(0.0781)	(0.0789)
Risk averse * List treated		-0.0654	-0.0651
		(0.0751)	(0.0748)
Preference for present * List treated		0.183*	0.173*
		(0.103)	(0.104)
Divorced * List treated			0.172*
			(0.0991)
Widow * List treated			0.199
			(0.170)
Constant	2.067***	2.207***	2.232***
	(0.0336)	(0.0772)	(0.0906)
Observations	1,024	1,024	1,024
R-squared	0.253	0.281	0.285

Robust stanadard errors clustered by individual in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6 Discussion

We find that health shocks, as measured in the last 30 days, are the most common type of shocks for FSWs in Dakar. We show that protection against such economic shocks is very limited, with very few women having insurance or adequate savings to cover health shocks. We show that if someone else is sick at the same time as an FSW's last sex act, there is between a 62% and 72% drop in condom use at the last sex act. Alongside Chapter 6[4], this analysis provides evidence to support the predictions of the conceptual framework in Chapter 4 that anticipated and unanticipated shocks will increase risky behaviours. It also contributes to the literature on risky behaviour use as a response to health shocks (Robinson and Yeh 2011; Jones and Gong 2021).

Our findings suggest that the most common economic shocks amongst women engaging in commercial sex work are OOP health shocks, and it is likely true for women across LMICs without developed health insurance schemes. The findings add weight to calls that marginalised women

[4] This study uses the same dataset as this study. Our results here are robust to the inclusion of a control for the proximity to Tabaski.

require additional protection against economic shocks, particularly health shocks. Health insurance, other risk-pooling strategies, and savings interventions to increase liquidity show promising signs of protecting against shocks and the associated risky behaviours (Lépine and Szawlowski 2022; Jones and Gong 2021).

The primary limitation of this analysis is the low number of events of the health shock. One might expect the number of health shocks used to assess condomless sex be similar to the health OOP expenses, but the recall periods differ. In the expense shock case, detailed in section 3, there is a 30-day period for a health expense shock to occur, whereas the health shock used in section 4, has no fixed period but is subjective around the last sex act. This period is likely to be a few days to a week. Indeed assuming the reporting is equivalent, the difference between the health expense shocks in the last 30 days, n=92, and the health shock, n=15, suggests the approximate average of a five-day period respondents considered illness acted upon their last sex act. Despite finding large and statistically significant estimates, the consequence of a low number of events is that our findings are underpowered, and we therefore treat them with caution outside of our sample.

A key strength of our findings is the use of the list experiment that minimises potential social desirability bias, where the additional advantages and limitations have been discussed in Chapter 6. However, because of using the list experiment, only a cross-sectional analysis can be performed despite additional data existing. The other literature studying health shocks is able to include individual fixed effects that eliminate time-invariant confounding, whereas ours does not (Robinson and Yeh 2011; Jones and Gong 2021). There are possibly unobserved confounders that we are not adequately controlling for, leading to omitted variable bias. For example, the condition of the household or the natural susceptibility of household members becoming ill are not observed well in our dataset and not controlled for in our regression analysis. Again, we interpret our findings with caution but do not believe that a significant source of confounding is driving our results.

We show that economic shocks are very frequent among FSWs in Dakar with around 22% suffering some kind of significant negative economic shock in the last 30 days. Health shocks again proved to be the most common, with 17% suffering a significant out-of-pocket health expense. We show that both formal and informal support is rarely relied upon for health shocks, suggesting that the marginalisation of FSWs in Senegalese society limits their available support. The majority increase their sex work activity, and 22% indicate they may be engaging in risky sex acts to increase the price obtained.

By isolating those FSWs whose last sex occurred whilst someone else in the household was sick, we estimated the impact of health shocks on risky behaviours. Despite the low event count and other methodological limitations, we find condomless sex is associated with an increase of between 62% and 70% whilst a health shock is taking place, therefore, has significant implications for HIV, particularly in countries where sex work is even more stigmatised and coping strategies more scarce than in Senegal.

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Chapter 8 – Research Paper 4: Weather Shocks and Transactional Sex

This chapter performs the final empirical analysis of this thesis and widens the scope beyond FSWs to incorporate behaviour change in women engaged in transactional sex as well. It uses data from across Africa, making the findings generalisable across the continent where transactional sex is widespread and offers empirical evidence of the link between drought, HIV and transactional sex. This chapter finds that transactional sex does increase on the extensive margin in response to drought to explain a key gap in the literature. The main implication for the thesis of this research is that it completes the empirical testing of the predictions of Chapter 4 – Conceptual Framework by focusing on the expansion of transactional sex. Whilst the findings are robust, there remain questions over potential confounders and the accuracy and consistency of using precipitation data and drought calculations in this analysis and in the wider economic shock literature.

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SECTION A – Student Details

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Thesis Title	Economic Shocks and Risky Sexual Behaviours		
Primary Supervisor	Timothy Powell-Jackson		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

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Where is the work intended to be published?	The Economic Journal
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Stage of publication	**Not yet submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I was the lead author responsible for the formulation of research questions, all analysis and writing of the research paper, including all revisions following co-author comments.

SECTION E

Student Signature	[redacted]
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Supervisor Signature	[redacted]
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Weather Shocks and Transactional Sex

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Keywords: Economic shocks; HIV; Transactional sex; Drought

Summary

Background: HIV disproportionately affects young women in low- and middle-income countries with those aged 15-24 twice as likely to be living with HIV than men of the same age. Transactional sex is thought to be one of the key drivers of this disparity and understanding its causes is key in the fight against HIV. Recent literature suggests droughts in the last 10 years explain up to 20% of cross-country variation in HIV prevalence in sub-Saharan Africa. We show transactional sex is a key mechanism by which droughts lead to increased HIV across Africa where climate change is increasing the frequency and severity of drought.

Methods: This paper uses Demographic and Health Survey (DHS) data collected in eight countries since 2015 across sub-Saharan Africa. We study the impact of drought, as a proxy for unanticipated economic shocks, within these countries on transactional sex and sexually transmitted infections. Droughts are constructed using data from the Global Precipitation Climate Centre and University of Delaware monthly precipitation datasets using the Standardised Precipitation Index and percentile methods with drought periods matched to GPS data included in the DHS surveys.

Results: We find respondents in six of eight countries suffered droughts with large within-country variations in severity and length of drought. We find suggest young women (15-25) suffering

droughts are approximately twice as likely to be engaging in transactional sex in the previous 12 months and the last precipitation season compared to those who did not suffer drought in the preceding rainy season. Men of all ages see an equally large increase in engagement in transactional sex following droughts responding to an increase in the supply of transactional sex in the market. We find important differences between countries implying local context, stigma and the severity and length of drought are important in the behavioural response on the extensive margin to drought. Mediation analysis shows around 6% of the increase in STIs following drought is due to increases in transactional sex.

Discussion: Transactional sex is a risky behaviour and whilst improvements have been made in data collection on the topic, particularly in the DHS, it remains a sensitive behaviour subject to social desirability bias. Our primary outcome measure could be more closely capturing commercial sex workers who are more willing to identify as explicitly having sex for money, rather than users of transactional sex where the exchange is implicit. The samples chosen to answer transactional sex questions also limit the generalisability of our results.

Conclusion: These results suggest that women experiencing economic shocks due to drought use transactional sex as a coping mechanism, increasing their exposure to HIV in the process since increases in supply are matched by increases in the number of men engaged in transactional sex. This paper helps us to understand the importance of transactional sex as a mechanism from economic shocks to HIV and ways in which to protect those most vulnerable.

1 Introduction

In sub-Saharan Africa, six out of seven new HIV infections are among adolescent girls aged 15-19. Those adolescents and young women aged 15-24 acquire 4,200 new infections each week and are twice as likely to be infected with HIV than their male counterparts (UNAIDS 2021). Structural economic gender disparities and social norms mean women are vulnerable to extreme poverty because they lack access to formal employment, face a greater burden of unpaid work and have reduced access to productive assets and financial services, particularly those that sit outside of typical family structures (Wanjala 2021; World Bank 2016; Jayachandran 2021). Women typically face a greater burden of unpaid work, lower education and disadvantages in acquiring well-paid jobs; therefore struggle to build economic resilience. Consequently, many women use sex as a coping strategy that puts them and their families at high risk of HIV and other mental and physical harm. These disadvantages in the face of economic instability are now recognised as leading drivers of HIV, and recent literature has developed conceptual frameworks to understand such structural drivers of HIV in women (Gafos et al. 2020)[1].

Transactional sex is commonly used as an economic coping strategy. It is defined by Stoebenau et al. (2016) and the STRIVE group: "*Non-commercial, non-marital sexual relationships motivated by the implicit assumption that sex will be exchanged for material support or other benefits".* There are three prominent paradigms; first, "sex for basic need" highlights transactional sex as a means of survival and positions women as having lower agency as they use it to fulfil basic needs in the absence of alternatives. "Sex for improved social status" says transactional sex is motivated by women to be "fashionable" or to improve their relative position among their peers using men's wealth. "Sex and material expressions of love" draw attention to the connection between love and money, with men as providers in sexual romantic relationships. The first and second of these paradigms illustrate how economic incentives might change behaviours and economic shocks.

Evidence suggests transactional sex is strongly associated with HIV risk (Dunkle et al. 2004; Kilburn et al. 2018; M Ranganathan et al. 2016) and points to a number of risk factors, including age-disparate relationships (Meghna Ranganathan et al. 2020; Luke 2003; Potgieter et al. 2012; Cockcroft et al. 2010; Luke 2005), violence (Choudhry et al. 2014; Cluver et al. 2011; Jewkes et al. 2006; Okigbo et al. 2014; Zembe et al. 2015), reduced bargaining power (Meghna Ranganathan et al. 2017), multiple concurrent partnerships (Moore, Biddlecom, and Zulu 2007; Steffenson et al. 2011; Phillips-Howard et al. 2015; Okigbo et al. 2014) and inconsistent condom use (Luke 2005;

[1] Including the conceptual framework detailed in Chapter 4 of this thesis.

Luke et al. 2011) among others (Stoebenau et al. 2016). The implicit nature of transactional sexual relationships means gifts or non-material support are exchanged between partners over long periods of time. In comparison, commercial relationships are more explicit with agreed amounts exchanged for specific sex acts at the time. The WHO defines commercial relationships as: “the exchange of money or goods for sexual services” (Overs 2002). Commercial sex workers typically identify themselves as such and refer to their partners as clients whereas those in transactional relationships do not. Women coerced or exploited into engaging in transactional and commercial relationships are not the focus on this research because they are not exposed to the same incentives.

Income volatility, or economic shocks, increases HIV risk through transactional and commercial sex across three margins. Cust et al. (2021) empirically showed that economic shocks are likely to affect both the extensive margin (the number of people engaging in transactional and commercial sex), the intensive margin (the number of sex acts within a relationship) and the degree of riskiness of sexual acts. A strong male preference for unprotected sex and riskier sex acts creates a risk premium that women can use to make up the short-fall in income following shocks (Cunningham and Shah 2011; Gertler, Shah, and Bertozzi 2005; Mac and Smith 2018; UNAIDS and Strive 2018; Rao et al. 2003; Quaife et al. 2019). Unprotected sex acts can be almost twice the price as protected sex within commercial relationships (Islam and Smyth 2012), and there is some evidence of the premium existing in transactional relationships, too (Luke et al. 2011; Robinson and Yeh 2012). In addition, falls in income reduce consumption and can lead to increased susceptibility to HIV through untreated STIs (Oster 2005) and malnutrition (Anabwani and Nfavario 2005). Chapter 4 theoretically demonstrates how the risk premium means economic shocks lead to increases in risky behaviours for women engaged in commercial and transactional sex.

Recent studies have explicitly linked economic shocks to increased risky behaviours and HIV (Cust et al. 2022; Burke, Gong, and Jones 2015; Dinkelman, Lam, and Leibbrandt 2008; Dupas and Robinson 2012; Robinson and Yeh 2012; 2011; Wilson 2012; Tequame and Tenikue 2017; Gong, de Walque, and Dow 2019; de Walque, Dow, and Gong 2014) and research is looking for effective protections against such volatility as an HIV prevention strategy (Jones and Gong 2019; Lépine and Szawlowski 2022). The seminal paper from Burke, Gong, and Jones (2015) previously found that up to 20% of the difference in HIV prevalence between countries in Africa can be explained by droughts. However, they could only speculate upon the possible mechanisms. Treibich et al. (2022) investigate if transactional sex as a key mechanism but only in Malawi and during a particularly severe drought. They find drought doubles the likelihood of engaging in transactional sex with unaffected men (those working outside of agriculture) and increases women's chance of reporting STI symptoms by 50%. Such droughts are not commonplace, and the literature potentially suffers from a publication bias where less severe droughts are less likely to be analysed, find significant results and go on to be published. Our paper aims to expand on this literature by combining meteorological and household data to investigate the relationship between droughts and STI prevalence and the role of transactional sex in mediating this relationship. Our analysis not only covers eight sub-Saharan African countries, but we also examine a range of drought types and severities. Our evidence suggests droughts lead to transactional sex, STIs and HIV and there is suggestive evidence that increases in transactional sex from drought are mediating the relationship.

2 Conceptual Framework

Our study is guided by the conceptual framework laid out by Burke, Gong, and Jones (2015), summarising the effect of droughts on risky behaviours and HIV. They propose the following equation:

$$\frac{\delta HIV}{\delta s} = \frac{\delta HIV}{\delta p}\frac{\delta p}{\delta z}\frac{\delta z}{\delta s}$$

Where HIV is the HIV prevalence rate, s is the measure of drought, p is a measure of sexual risk, and z is income. The direction of the relationships for $\frac{\delta z}{\delta s}$ is negative (i.e., more drought leads to lower income) and $\frac{\delta HIV}{\delta p}$ is positive (i.e., higher sexual risk leads to higher HIV and STIs). The middle term $\frac{\delta p}{\delta z}$ represents the relationship between income and sexual risk and is our main object of interest. Burke, Gong and Jones (2015) investigated this relationship using HIV as the measure of sexual risk but could only speculate as to the potential mechanisms given a lack of risky behaviour data. In this paper, we focus on the role of transactional sex and examine whether there is a behavioural response following drought. Drought reduces disposable income, particularly in rural areas, where a high proportion of income derives from agriculture, but also in urban areas where food prices might rise and reduce demand for agricultural-adjacent industries.

We test three hypotheses based on this conceptual framework and insights in Chapter 4. First, that drought will lead to an increase in the prevalence of transactional sex and an increase in STIs and HIV for young women. We expect women to use transactional sex to cope with income loss across the extensive, intensive, and riskiness margins. Men unaffected or less affected by drought will also increase their prevalence in transactional sex to meet the additional supply from women.

Second, we test if drought affects men and women differently, depending on their location. We hypothesise that women located in rural areas will see a proportionally greater increase in transactional sex prevalence and STIs compared to their urban counterparts. The opposite will be true for men. This is due to the differential impacts of drought on people residing in these two areas.

Third, transactional sex is closely associated with several high-risk sexual behaviours, so we expect some of the increased burden of STIs and HIV in the sample to be caused by increases in transactional sex. Should the first hypothesis be founded, we expect a causal mediation analysis to find the relationship between drought and HIV to be mediated by increases in transactional sex.

3 Data

3.1 Household data on individuals

Since 2015, the Demographic Health Surveys (DHS, version VII or later) have included questions on transactional sex, which we use to investigate our hypotheses (Stoebenau et al. 2018). These surveys took place from around 2015 and there are eight countries included that contain this question and overlap with our precipitation data[2]. Survey clusters are stratified by rural and urban areas within regions and randomly sampled. Then households within clusters are randomly sampled to generate nationally representative samples after the application of sampling weights. Pooled analysis adjusts weights by the proportion of sample size to the estimated country population at the time of the survey meaning each individual in the represented countries has an equal chance of being interviewed. All women in selected households and a third of men were eligible for individual interviews that collected socio-economic and health information. The recommended DHS VII survey contains the required information for our analysis, but individual countries are able to make adjustments based on local preferences leading to some differences in how surveys are conducted and which questions are asked. This is particularly true around the collection of potentially sensitive information. We include all surveys published at the time of data analysis in early 2022 that contain the key transactional sex information. Tanzania is the only country that did not collect information on transactional sex and so was excluded from the

[2] At the time of the analysis in late 2021.

analysis. Uganda did not collect information on STIs but did on transactional sex and so was included in the transactional sex analysis only.

All women aged 15-24 who have ever had sex and were not living with a partner or married were asked, “In the past twelve months have you had sex or been sexually involved with anyone because he gave you or told you he would give you gifts, cash, or anything else”. Men aged 15-54 were asked a similar question: “In the last twelve months, have you given any gifts or other goods in order to have sex or to become sexually involved with anyone”. We do not combine the question “paid anyone in exchange for having sexual intercourse” to limit the influence of clients of female sex workers on our analysis. All men and women were asked if they “has any STD in the last 12 months”. All clusters were categorised as either rural or urban, which was used to differentiate the impact of the droughts. GPS coordinates were available for all clusters, facilitating linkage between these individual data and the drought information. Overall, 10,041 women and 45,845 men were asked if they engaged in transactional sex, whilst 123,400 women and 52,416 men were asked if they had an STI in the last 12 months. In Uganda, the STI question was not asked. Table 1 displays the descriptive statistics of the sample.

The DHS also contains individual-level HIV bio-markers across countries included in this analysis, except Uganda and Benin. Since risky behaviours and STIs are used as a proxy for HIV, it holds a distinct advantage in being used as an outcome. We are limited in the scope of our HIV analysis due to the inherent noise associated with predicting differences in HIV prevalence with a time-limited drought variable. We discuss this further in the empirical strategy but focus our HIV analysis on women aged 15-24.

Table 1: Descriptive statistics

	All		Women		Men	
Variables	Obs	Mean	Obs	Mean	Obs	Mean
Outcome variables						
Engaged in transational sex in the last 12 months (%)	55,886	3.4	10,041	4.35	45,845	3.19
Reported STI symptoms in the last 12 months (%)	175,816	3.07	123,400	3.39	52,416	2.27
Socio-economic variables						
Age (years)	181,318	29.18	123,584	28.54	57,734	30.55
No education (%)	181,318	23.04	123,584	26.21	57,734	16.26
Primary education (%)	181,318	35.01	123,584	33.58	57,734	38.08
Secondary education (%)	181,318	34.45	123,584	33.49	57,734	36.5
Higher education (%)	181,318	7.5	123,584	6.72	57,734	9.16
Live in an urban area (%)	181,318	37.46	123,584	37.69	57,734	36.98
Geographic variables (unweighted)						
Angola	20,063	11.07	14,379	11.64	5,684	9.85
Benin	22,894	12.63	15,499	12.54	7,395	12.81
Burundi	24,737	13.64	17,202	13.92	7,535	13.05
Ethiopia	27,609	15.23	15,242	12.33	12,367	21.42
Malawi	32,040	17.67	24,562	19.87	7,487	12.95
South Africa	12,132	6.69	8,514	6.89	3,618	6.27
Uganda	23,492	12.96	18,231	14.75	5,261	9.11
Zimbabwe	18,351	10.12	9,955	8.06	8,396	14.54

Notes: Weighted to make representative of included countries

3.2 Precipitation and droughts

Precipitation below a certain threshold is commonly used in the literature to proxy an economic shock (Burke, Gong, and Jones 2015; Treibich et al. 2022; Abiona et al. 2022; Corno, Hildebrandt, and Voena 2020). A large portion of many African economies, particularly in rural areas, are still dominated by agriculture. Indeed, it is estimated that 30% of GDP in low-income countries is derived from agriculture (FAO 2017; Davis et al. 2010).

We use data on precipitation to generate various measures of drought. Our primary source of meteorological data is the Global Precipitation Climate Centre (GPCC) (Schneider et al. 2011) monthly precipitation dataset that has a 0.5 x 0.5 degree resolution from 1891-2016 inclusive. We use this data to construct the standardised precipitation index (SPI) that measures the deviation of precipitation to the historic distribution for a given location. It does so by fitting a probability distribution to the monthly precipitation that is then transformed into a normal distribution meaning the mean SPI for the location is zero (World Meteorological Organization, et al. 2012; Edwards and McKee 1997). The SPI generated is equal to the standard deviation of the precipitation using this historic transformed distribution. An advantage of this measure is that the normalisation of the rainfall means wetter and drier climates can be represented and compared in the same way. A timescale is specified during the calculation that is equal to the number of past months aggregated to generate a specific month's deviation from the historic mean. For example, to calculate the SPI for August 2022, using a three-month timescale, the algorithm will use data from June, July and August 2022 and compare to the distribution of historic rainfall from the same months. Different time periods are useful for different reasons. A time period of one to six months is recommended for agricultural droughts (World Meteorological Organization, et al. 2012). We chose the three-month period as the midpoint of these recommendations. We use a historic reference period from 1950 to the period in question, more than the 30-year reference period recommended (Guttman 1999).

Once the timeline of monthly SPI is generated for each location, drought periods are calculated based on McKee et al.'s (1993) classification of drought. They begin when SPI drops below -1.0 and continue until the SPI rises above 0. Since we aim to measure extreme lows in precipitation as a proxy for economic shocks, we map the droughts to the most economically sensitive periods of the year. Harvest is when the majority of income is earnt for the year in agricultural societies and will not always coincide with the most rain-sensitive periods (Hoffman, Kemanian, and Forest 2018; Sacks et al. 2010). The precipitation during the rainy season will influence that year's yields most precisely, so we construct drought for the *last complete precipitation season*. Drought currently being felt or expected to have economic consequences in the future might also change behaviours pre-emptively; therefore, we also investigate drought over the last 12 months.

We believe SPI measurements of droughts are superior to percentile measures used in the literature so far (Burke, Gong, and Jones 2015; Corno, Hildebrandt, and Voena 2020). This is because SPI gives a normalised frequency of drought for a given location over time, has flexible timescales and has a more realistic representation of severity and is thus considered a more robust and versatile way to measure droughts. Its versatility means it can be used to calculate drought which has a scarcely different interpretation when using drought as a proxy for economic shocks. E.g. there is little to tell apart a measure of drought with a three and six-month timescale. However, there can be significant differences in calculations for specific areas between what seem like small adjustments. To the best of our knowledge, there is no analysis mapping the best SPI measure to proxy for an economic shock.

We calculate two primary indicators for this analysis: i) droughts over the last 12 months and ii) drought during the last complete precipitation season, defined as months in which at least 5% of the country's annual rainfall typically falls according to the Climate Change Knowledge Portal (World Bank 2022). An SPI drought of -1.0 corresponds to rainfall below the 16th percentile, equivalent to previous work (Low et al. 2019; Burke, Gong, and Jones 2015; Corno, Hildebrandt, and Voena 2020), which uses the 15th percentile. The 15th percentile measure reflects the greatest damage to maise yields, a staple in sub-Saharan Africa (Burke, Gong, and Jones 2015). We explore the sensitivity of our findings to a wide range of different definitions of drought in the robustness section.

Figure 1 presents a timeline for each country, illustrating how the last precipitation season in the 12 months since the interview lies for each country. The last precipitation season is defined as the last complete rainfall season before the first interview of the DHS survey was undertaken. We chose to use the previous 12 months to define our current drought measure instead of the current precipitation season because it is standardised across countries and does not include precipitation that has not been realised by respondents answering the surveys and is consistent with questions about our outcomes recall period (12 months). We control for different lengths of time between interviews and the last completed precipitation season. Figure 2 &Figure 3 illustrates the proportion of the previous 12 months and last precipitation season that were in drought in the countries covered in our analysis. It is evident that within-country variation exists across both drought periods.

In order to calculate droughts by SPI and percentiles used in the robustness analysis, around 10 million data points across two unique precipitation datasets had to be matched to around 5000 DHS clusters with unique interview dates and precipitation seasons. A total of 120 drought measures were calculated for each cluster, all of which are defensible measures of drought, although not all were used. Table 2 shows drought across countries included in the analysis. Only 34% (unweighted) did not suffer any drought during the last precipitation season and 11% did not suffer any drought in the last 12 months. In Figure 2, the last 12 months are calculated on a cluster-by-cluster basis and therefore, clusters that are close together can represent quite different 12-month periods of rainfall, so the picture looks more mixed than in Figure 3, where the same precipitation season is represented per country.

Table 2: Drought periods across countries

Droughts and countries	Last 12 months Obs	Last 12 months Mean	Last full precipitations season Obs	Last full precipitations season Mean
All				
No drought (%)	153,364	17.6	181,318	23.6
1-81% of period in drought (%)	153,364	80.2	181,318	64.4
81-100% of period in drought (%)	153,364	2.2	181,318	12.0
Average % of period in drought	153,364	33.2	181,318	38.5
Angola				
No drought (%)	20,063	10.8	20,063	38.4
1-81% of period in drought (%)	20,063	88.7	20,063	60.6
81-100% of period in drought (%)	20,063	0.5	20,063	1.0
Benin				
No drought (%)	n/a	-	22,894	100
1-81% of period in drought (%)	n/a	-	22,894	0
81-100% of period in drought (%)	n/a	-	22,894	0
Average % of period in drought	n/a	-	22,894	0
Burundi				
No drought (%)	19,677	76.8	24,737	70.8
1-81% of period in drought (%)	19,677	23.2	24,737	29.2
81-100% of period in drought (%)	19,677	-	24,737	-
Average % of period in drought	19,677	10.0	24,737	6.3
Ethiopia				
No drought (%)	27,609	23.6	27,609	20.8
1-81% of period in drought (%)	27,609	74.7	27,609	76.3
81-100% of period in drought (%)	27,609	1.7	27,609	3.0
Average % of period in drought	27,609	26.6	27,609	30.6
Malawi				
No drought (%)	32,040	1.95	32,040	0.6
1-81% of period in drought (%)	32,040	84.85	32,040	61.8
81-100% of period in drought (%)	32,040	13.2	32,040	37.6
Average % of period in drought	32,040	64.73	32,040	66.7
South Africa				
No drought (%)	12,132	8.21	12,132	6.7
1-81% of period in drought (%)	12,132	89.04	12,132	61.3
81-100% of period in drought (%)	12,132	2.75	12,132	32.0
Average % of period in drought	12,132	38.82	12,132	58.6
Uganda				
No drought (%)	23,492	18.91	23,492	22.9
1-81% of period in drought (%)	23,492	81.09	23,492	63.0
81-100% of period in drought (%)	23,492	0	23,492	14.1
Average % of period in drought	23,492	29.33	23,492	42.2
Zimbabwe				
No drought (%)	18,351	2.11	18,351	13.85
1-81% of period in drought (%)	18,351	97.14	18,351	81.43
81-100% of period in drought (%)	18,351	0.75	18,351	4.72
Average % of period in drought	18,351	36.87	18,351	25.29

Notes: Some Burundi and all Benin DHS surveys took place after the end of our precipitation data range. Means are weighted to be nationally representative and further adjustment by the population sample size ratio was made for pooled figures.

Figure 1: Timelines of interview period and precipitation

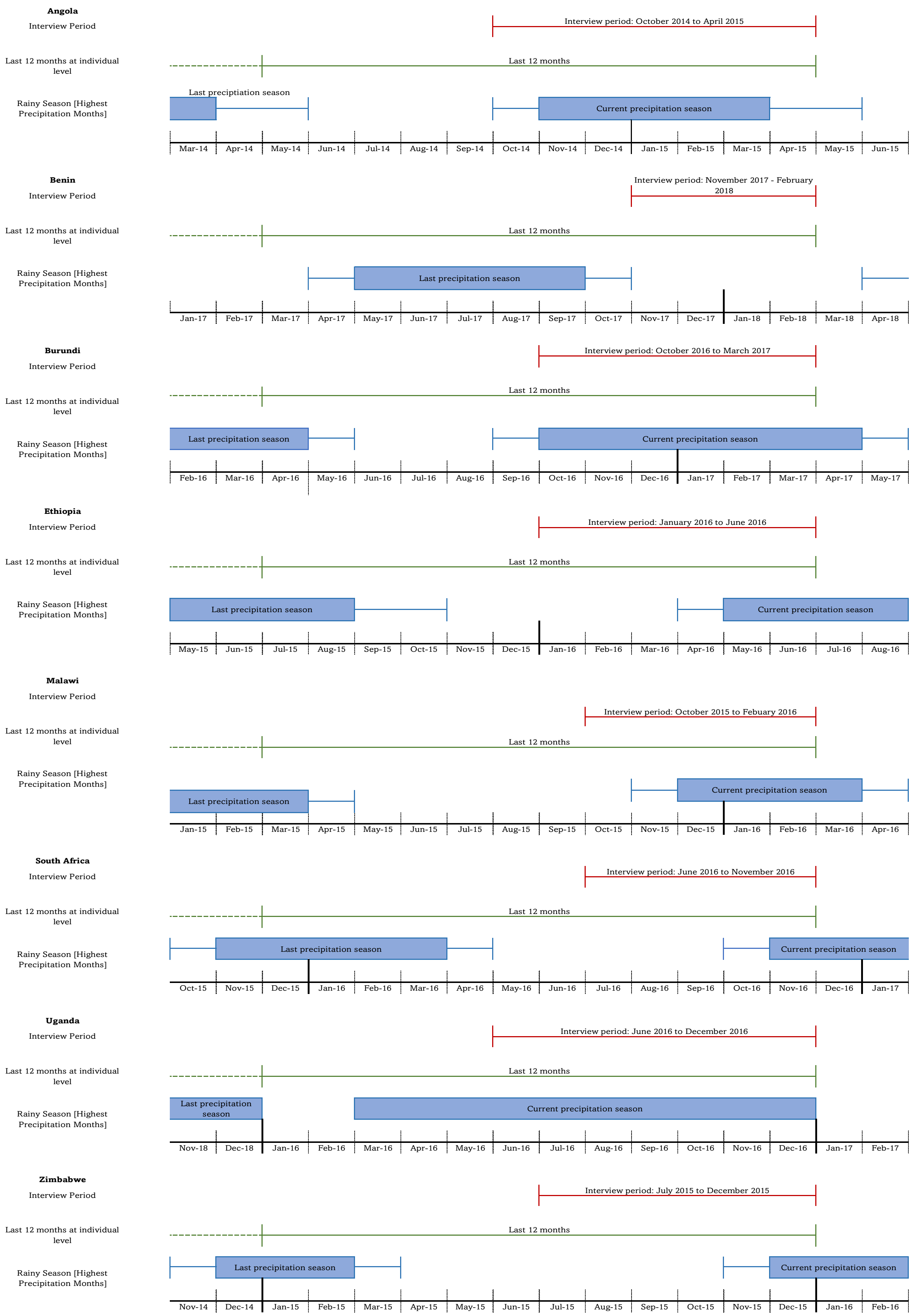

Angola
Interview Period
Interview period: October 2014 to April 2015
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Last precipitation season
Current precipitation season
Mar-14 Apr-14 May-14 Jun-14 Jul-14 Aug-14 Sep-14 Oct-14 Nov-14 Dec-14 Jan-15 Feb-15 Mar-15 Apr-15 May-15 Jun-15
Benin
Interview Period
Interview period: November 2017 - February 2018
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Last precipitation season
Jan-17 Feb-17 Mar-17 Apr-17 May-17 Jun-17 Jul-17 Aug-17 Sep-17 Oct-17 Nov-17 Dec-17 Jan-18 Feb-18 Mar-18 Apr-18
Burundi
Interview Period
Interview period: October 2016 to March 2017
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Last precipitation season
Current precipitation season
Feb-16 Mar-16 Apr-16 May-16 Jun-16 Jul-16 Aug-16 Sep-16 Oct-16 Nov-16 Dec-16 Jan-17 Feb-17 Mar-17 Apr-17 May-17
Ethiopia
Interview Period
Interview period: January 2016 to June 2016
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Last precipitation season
Current precipitation season
May-15 Jun-15 Jul-15 Aug-15 Sep-15 Oct-15 Nov-15 Dec-15 Jan-16 Feb-16 Mar-16 Apr-16 May-16 Jun-16 Jul-16 Aug-16
Malawi
Interview Period
Interview period: October 2015 to Febuary 2016
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Current precipitation season
Last precipitation season
Jan-15 Feb-15 Mar-15 Apr-15 May-15 Jun-15 Jul-15 Aug-15 Sep-15 Oct-15 Nov-15 Dec-15 Jan-16 Feb-16 Mar-16 Apr-16
South Africa
Interview Period
Interview period: June 2016 to November 2016
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Last precipitation season
Current precipitation season
Oct-15 Nov-15 Dec-15 Jan-16 Feb-16 Mar-16 Apr-16 May-16 Jun-16 Jul-16 Aug-16 Sep-16 Oct-16 Nov-16 Dec-16 Jan-17
Uganda
Interview Period
Interview period: June 2016 to December 2016
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Last precipitation season
Current precipitation season
Nov-18 Dec-18 Jan-16 Feb-16 Mar-16 Apr-16 May-16 Jun-16 Jul-16 Aug-16 Sep-16 Oct-16 Nov-16 Dec-16 Jan-17 Feb-17
Zimbabwe
Interview Period
Interview period: July 2015 to December 2015
Last 12 months at individual level
Last 12 months
Rainy Season [Highest Precipitation Months]
Last precipitation season
Current precipitation season
Nov-14 Dec-14 Jan-15 Feb-15 Mar-15 Apr-15 May-15 Jun-15 Jul-15 Aug-15 Sep-15 Oct-15 Nov-15 Dec-15 Jan-16 Feb-16
Last precipitiation season

Figure 2: Proportion of last 12 months in drought by DHS cluster

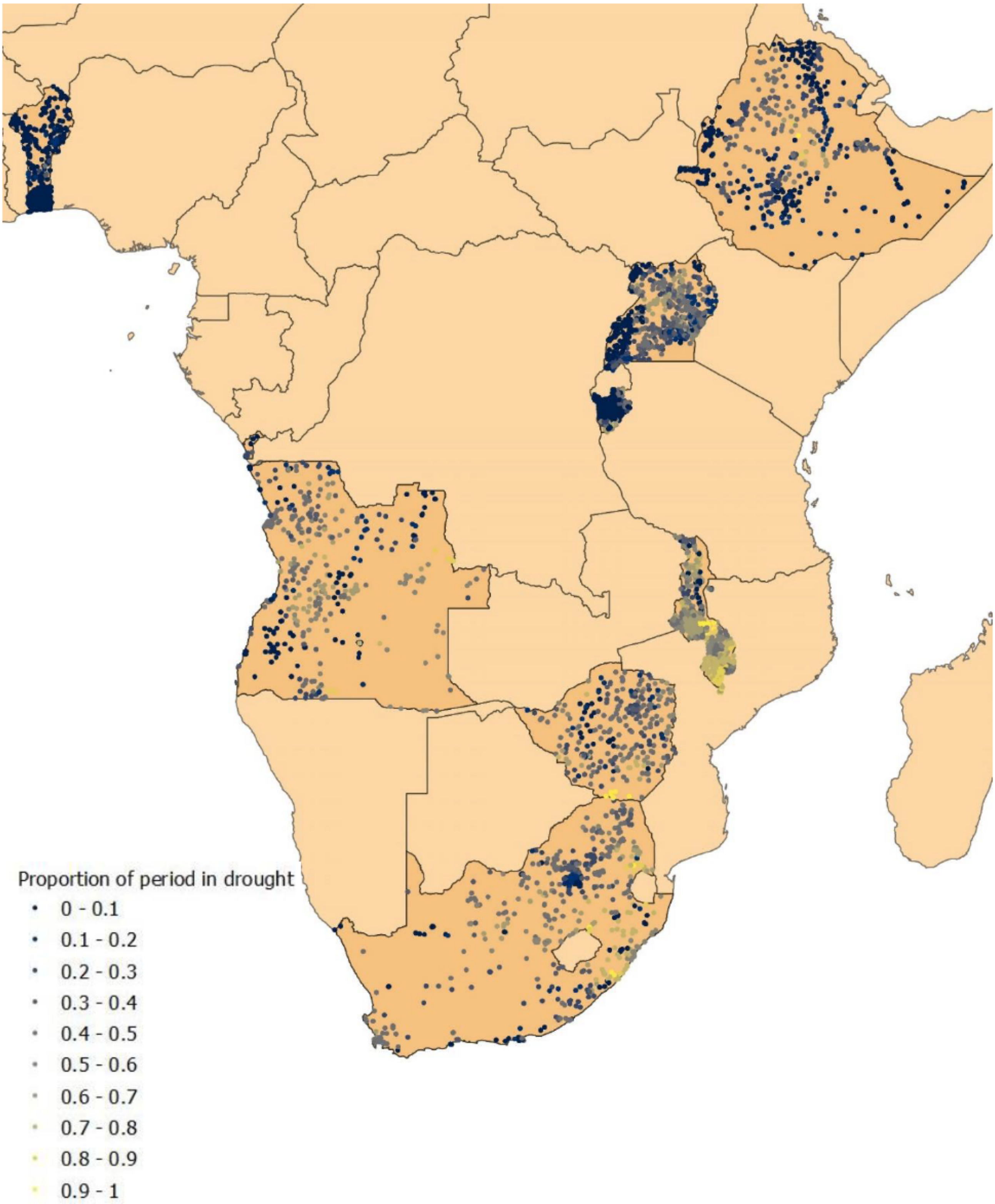
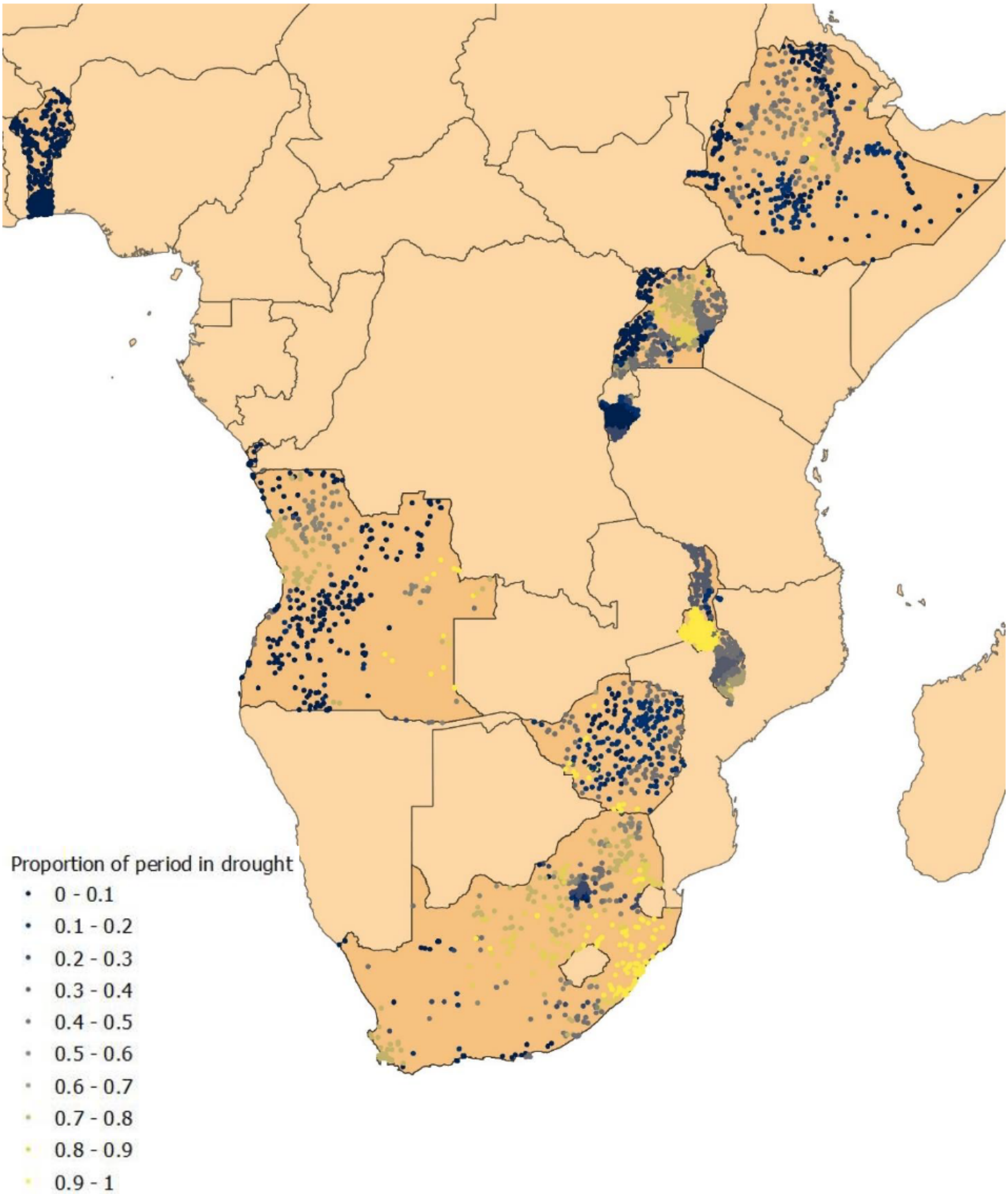


Figure 3: Proportion of last precipitation period in drought by DHS cluster



4 Empirical Strategy

4.1 Effect of drought on transactional sex and STIs

To investigate our first hypothesis that drought will lead to an expansion of transactional sex in women as a coping strategy, we estimate the following equation:

$$Y_{icj} = \beta_1 + \beta_2 S_{icj}^t + \beta_x X_{ic} + \beta_c C_c + \beta_i X_{ic} * C_c + \varepsilon_{icj},$$

where Y and S indicate our outcomes of engaging in transactional sex or having an STI in the last 12 months and our shocks variable respectively, for individual i in DHS cluster c, and in country and survey, j. S is defined in two ways; first, as a continuous variable between 0 to 1 that represents the proportion of the period in drought. The second is a categoric variable that takes the value of 0 if there is no drought in any months of the period in drought, a value of 1 if the cluster has 1-80% of the period in drought and a value of 2 when 81%+ of the period is in drought. This categorisation is consistent with the interpretation that S=1 means a drought is mild and has lasted all but one or two months of the period in question given the last precipitation season is between 5-10 months for all countries. S=2 indicates more severe droughts where all, or all but one months are in drought. S=0 is the reference category where no drought is present.This measure was designed to be consistent with recently published literature by Treibich et al. (2022). $X*C$ indicates a vector of controls interacted with each country to control for age, education, rural or urban location and wealth of individuals and allows these to vary by country. ε indicates a mean zero error term with usual properties. We estimate these separately for men and women.

Second to test if there is a differential effect for those most affected by drought, we estimate the following equation:

$$Y_i = \beta_1 + \beta_2 S_{ic}^t + \beta_2 R_i + \beta_3 S_{ic}^t * R_i + \beta_x X_{ic} + \beta_c C_c + \beta_i X_{ic} * C_c + \varepsilon_i$$

This includes an interaction term between our drought measure and R, representing if the respondent is located in a rural cluster. The coefficient, β_3, represents the differential effect of drought on our outcome between those in rural areas and those not. Intuitively, our hypothesis suggests women in rural areas are more greatly affected by drought and, therefore, more likely to use transactional sex as a coping strategy; the value of this coefficient would be >0, whereas men in rural areas would have less disposable income to engage in transactional sex or risky sex compared to their urban counterparts so we would expect this value to be <0. In other words, we would expect an increase in prevalence in women in rural areas and an increase in prevalence for men in urban areas.

We also estimate the impact of drought on HIV bio-markers. Because our drought treatment variable only measures economic shocks over the last 12-24 months, yet HIV can be acquired over a lifetime, any analysis will be noisy. In other words, the proportion of HIV infections that occur in the last 12-24 months is only a small portion of the overall prevalence, and of that proportion, not all will be due to risky behaviours brought about by transactional sex due to economic shocks. Detecting changes in the HIV prevalence from drought is difficult despite the large sample sizes. To reduce this noise, we focus the analysis on women between 15-24, the same age bracket as the transactional sex question was asked. This also forgoes potential survivability bias since we are capturing HIV that on average, has more recently been acquired. Since this group suffers the disproportionate HIV risk and will most likely contract HIV after becoming sexually active, the drought impacts a relatively larger portion the window of time they could have acquired HIV. For example, if we are estimating the effect of a drought in the last year and the average number of years of being sexually active for this sub-sample is 3, we are capturing 1/3 of the potential drought-induced behaviour that led to HIV infections. For their sexual partners, typically older men, their number of years being sexually active is much higher, and therefore, we are much less likely to pick up an effect.

Our identification strategy relies on the quasi-random nature of rainfall and incidence of drought being external to the use of risky sexual behaviours, which is evident throughout the literature (Treibich et al. 2022; Burke, Gong, and Jones 2015; Corno, Hildebrandt, and Voena 2020). By design, the SPI measure of drought means each cluster has an equal chance of suffering a drought in any given period. It is also a measure that is relative to local conditions meaning areas with differing levels and variability of rainfall can be compared equivalently. This local characterisation of the droughts means it is plausibly reflective of a drought that translates to economic shocks. Crops and systems adapted to different levels of rainfall arguably suffer significant yield losses when hitting a certain deviation from historic rainfall despite the levels.

We estimate linear probability models allowing for correlation of the error term across individuals in the same DHS cluster where drought is applied. To give each individual in the analysis an equal chance of being included across all countries, we use DHS sampling weights that make responses nationally representative and adjust by the country's population-to-sample size ratio. It is worth noting that the transactional sex analysis will capture the increase in the proportion of men and women engaged in transactional sex, or the extensive margin response to drought, whilst STIs encapsulate extensive, intensive and risk margins and act as a proxy HIV that can be within relationships defined as transactional or not.

4.2 Causal mediation analysis

Our second objective is to estimate the proportion of STIs, a proxy for risky sex and HIV, that is brought about through increased engagement in the transactional sex market. To do this, we utilise causal mediation analysis to investigate the proportion of the drought's impact on STIs that can be explained through transactional sex. Following Imai, Keele, and Yamamoto (2010) and Imai, Keele, and Tingley (2010), we estimate the following structural equation models in order to estimate the average causal mediation effect (ACME):

$$M_i = \beta_1 + \beta_2 T_i + \beta_x X_i + \mu_i$$

$$Y_i = \beta_3 + \beta_4 T_i + \beta_5 M_i + \beta_x X_i + \rho_i$$

Y_i indicates the outcome variable, STIs, M_i indicates the mediating variable, in our case, transactional sex, T_i the treatment, in our case the percentage of the period in question in drought, X_i, is a vector of covariates. The product of the estimated coefficients ($\beta_5\beta_2$) is the ACME that can be used to calculate the percentage of the effect between droughts and STIs that can be explained by changes in transactional sex caused by droughts.

5 Results

5.1 Transactional sex

Our main results focus on the two primary measures of drought and our two primary outcomes. Drought in the last precipitation season is associated with a significant increase in transactional sex for women with an increase of 2.3 and 2.2 percentage points for 1-80% and 81-100% of the periods in drought, respectively. This corresponds to a 35% and 34% increase considering the mean level of transactional sex (column 1, Table 3). However, the impact falls and is no longer statistically significant when we measure drought continuously (column 2, Table 3). Inclusion of the rural interaction[3] shows that women in rural areas are more likely to engage in transactional

[3] We report only interaction term coefficients that are interpreted as the difference in changes in our outcome variable between those living in rural and urban clusters. Linear combination terms reveal the impact of drought on rural sub-samples only.

sex, with increases in the rural[4] subsample at 3.7 and 3.6 ppt respectively for the two categories of drought, corresponding to over 50% increase in both cases. The increase in urban areas is not statistically different from zero, and the difference between rural and urban women is not statistically significant (column 3, Table 3). For men, we find an equivalent 1.2 ppt increase (32% increase) but only for droughts 1-80% of the last *precipitation season* (column 5, Table 3). The difference between rural and urban is more pronounced in men, particularly for prolonged droughts. Urban men's response is higher, at 1.9 and 2.8 ppt, with a statistically significant difference between rural and urban men of 3.1 ppt reflected in the continuous measure, representing an increase of over 50% across urban men following droughts (columns 7 & 8, Table 3). Note the magnitude of the difference between rural and urban for women is equivalent to that of men, but because we have a larger sample size the power is sufficient to detect this small difference.

We find droughts in the *last 12 months* have a similar impact but with less evidence of a difference between rural and urban for both men and women. For women, drought in 1-80% of the last 12 months resulted in a 2.2 ppt increase (44% increase) in the likelihood of women engaging in transactional sex[5] (column 1, Table 4). The impact is 3.1 ppt (56% increase) for women located in rural areas, but the difference between rural and urban is not statistically different. Similar results are found using the continuous drought measure (columns 2 & 4, Table 4). We find a smaller response for men, with a smaller difference between rural and urban clusters. A 0.6 ppt increase (16% increase) increasing to a 1.3 ppt increase (33% increase) for urban men only (columns 5 & 7, Table 4). The difference between rural and urban is not statistically different but coefficients are of the expected sign.

5.2 STIs

There is little statistically significant effect of droughts in the *last precipitation season* on self-reported STI symptoms, only severe 81-100% drought eliciting a 0.8 ppt increase in STI symptoms (columns 1-4, Table 5). It is worth noting the large increase in the sample size for women as question restrictions were relaxed for reporting STIs. When limiting the sample size to transactional sex only, we find larger magnitude estimates on our drought measures, but since power is reduced, they are not statistically significant (columns 2 & 4, Table A1). When looking

[4] See linear combination values.

[5] Some interviews took place after we have rainfall data up to hence there are fewer observations for the *last 12 months*

at drought in the *last 12 months,* there is an increase of 1.5 ppt (38% increase) in STIs following droughts of 81-100% compared to no drought. These appear to be concentrated in urban women, where the impact on STIs rises to 3.6 ppt (90% increase compared to average) coupled with a 1.2 ppt increase for rural women (column 3, Table 6). When limiting to the transactional sex sample only, the impact of 81-100% drought is 5.7 ppt (over 200% increase) statistically significant at the 10% level, rising to 8.3 ppt for urban women, although the latter is not statistically significant (Table A1).

For men, where samples asked transactional sex and STI questions are more closely defined, we find strong impacts of drought on STIs across all model formulations. On average, drought increases STIs by 1.0 ppt (50% increase), which rises to 1.2 and 1.8 (57% and 81% increases), respectively, comparing 1-80% and 81-100% to no drought in the *last precipitation season* (columns 5 – 7, Table 5). The continuous measure of drought implies that if 100% of the *last precipitation season* experienced drought it would lead to a 2.4 ppt increase in STIs for urban men (more than 100% increase compared to average STI prevalence in men) and no impact in rural men (columns 6 & 8, Table 5). Droughts over the *last 12 months* purport similar effects, although less statistically strong (columns 4-8, Table 6). This implies large increases in the risky sex of men located in areas less affected by drought.

5.3 HIV

As discussed previously, we focus the HIV analysis on women aged 15-24, the same age range the transactional sex question is asked[6], the group bearing the highest portion of new HIV infections across sub-Saharan Africa. When droughts are measured continuously over the *last precipitation season* and the *last 12 months*, we see HIV prevalence increase by 13.2 ppt and 11.2 ppt (197% and 170% increase), respectively (column 2 & 6, Table 7). The introduction of the rural interaction shows urban women with a slighter larger increase in HIV, but the difference between rural and urban women is not statistically significant. The impact of continuous drought on HIV prevalence is 20.3 and 12.7 ppt for urban women (columns 4 & 8, Table 7). Estimates using the categoric version of the drought measure show HIV impacts are weighted towards more severe droughts (columns, 1, 3, 5, 7, Table 7).

[6] Note the sub-sample is not identical to the transactional sex sub-sample since relationship restrictions did not apply to HIV tests.

For men, we find estimates are much less precise - as expected. Only droughts measured as 81-100% of the last 12 months show statistical differences in HIV prevalence because of drought. The results have magnitude and direction that supports our hypotheses (Table A2).

5.4 Mediation analysis

Table 8 and Table 9 show the results of the causal mediation analysis investigating the portion of the reported increase in STI and HIV from drought that can be apportioned to transactional sex. Note, only the continuous version of the drought measure could be used for the causal mediation analysis. For women, 3.9% of the effect of drought in the last 12 months on STIs can be apportioned to transactional sex (column 2, Table 8) but only 0.8% of the change in HIV (column 1, Table 9) when investigating the *last precipitation season*. For men, only 2.2% of the change in STIs can be apportioned to transactional sex changes due to drought and there is no measurable difference for HIV.

Whilst the proportion of the effect on STIs driven by transactional sex is low, only around 2-4%, Burke, Gong, and Jones (2015) only find drought explains up to 20% of the difference in HIV prevalence. A back-of-the-envelope calculation suggests up to a fifth of the effect attributed to drought in Burke, Gong and Jones (2015) is due to increases in transactional sex on the extensive margin.

Overall the concentration of impacts on transactional sex appears to be on rural women and urban men, as hypothesised; the increase in STIs appears to be focused on urban men and women. These results imply that transactional sex on the extensive margin increases in rural areas in response to drought, but riskiness increases more in urban areas. Both of these are hypothesised transactional sex responses to economic shocks. Whilst we expected HIV estimates to be noisy, the impact of changes in transactional sex from drought on STIs in the mediation analysis for both men and women is small and far from conclusive. Our results could suggest that increases in riskiness within transactional relationships (not directly measured in this paper) play a significant role and is an avenue for future research.

5.5 Country-level analysis

Table A6, in the appendix, shows the results of models estimating the impact of droughts over the last 12 months and the last precipitation cycle on transactional sex and STI prevalence over the last 12 months. These results show that multiple countries are driving our results for different elements of the aggregate findings. We do not report models with rural interaction terms or mediation analysis at the country level, which would make tables cumbersome.

For women, there is a strong increase in transactional sex because of drought in Uganda [the largest estimate is a 5.4 ppt with a relative change of around 35%[7]] and South Africa [up to 1.7 ppt increase or around a 100% increase], with Angola showing a reduction due to drought [a 4.7 ppt reduction, or 160% decrease]. The remaining countries report null estimates. However, Angola shows a strong relationship increase in STIs due to drought [up to a 6.2 ppt or 112% increase], with South Africa also showing an increase [up to 4.1 ppt or 85% increase]. Women in Ethiopia have reduced the prevalence of STI symptoms. Even though point estimates are low, a reduction of 0.4%, given average prevalence is also 0.4%, these results show around a 100% reduction. All other countries report null results.

For men, transactional sex increases following drought in Angola [up to 3.0 ppt, 61%], Burundi [up to 1.9 ppt, 126% increase], Malawi [up to 4.5 ppt increase, 75%, however, includes a 6.9 ppt, 115% reduction considering the last precipitation period drought] and Zimbabwe [up to 4.7 ppt, 110%], with the remaining countries giving null estimates. Burundi [1.9 ppt, 126%], Ethiopia 0.5 ppt, 110% increase], Malawi [2.3 ppt, 120%], South Africa [2.8 ppt, 70%], and Zimbabwe [1.9 ppt, 41%] show a strong increase in STI symptoms following drought. The average prevalence of STI symptoms in men is lower making smaller percentage point increases higher relative changes. Angola reveals mixed results; an increase [1.8 ppt, 47% increase] for mild droughts but a decrease STI symptoms reported for men suffering severe droughts [1.8 ppt, 47% decrease].

Overall, the country-level results support our aggregate results with relationships in men stronger than in women, with notably strong evidence from Malawi and Angola. Whilst Malawi had a severe drought during the period preceding the DHS survey, Burundi and Angola, have more mild droughts implying the severe drought in Malawi does not drive our results. Rural cluster interactions, not reported, are generally null but with magnitudes and signs supporting the

[7] Results interpreted from square brackets follow this style for the remainder of this sub-section.

aggregate results, except for Uganda and Malawi, which do have statistically significant estimates in support of aggregate findings.

Table 3: Effect of drought in the last precipitation season on transactional sex

	Women				Men			
Variables	All		Agricultural interaction		All		Agricultural interaction	
Last rainy season ref: no drought								
1%-80% in drought	**0.023****		0.006		**0.012*****		**0.019****	
	(0.010)		(0.008)		(0.003)		(0.007)	
81%-100% in drought	**0.022***		0.002		0.009		**0.028****	
	(0.012)		(0.014)		(0.006)		(0.012)	
1%-80% in drought & rural			0.031				-0.010	
			(0.020)				(0.008)	
81%-100% in drought & rural			0.034				**-0.031****	
			(0.024)				(0.013)	
% of previous rainy season in drought (continuous)		0.015		-0.003		0.009		**0.022****
		(0.018)		(0.011)		(0.006)		(0.010)
% of previous rainy season in drought & rural				0.037				**-0.023****
				(0.041)				(0.011)
Linear combination 1			**0.0369 ****	0.0337			**0.0088 *****	-0.0011
SE of linear combination 1			[0.0167]	[0.0368]			[0.0032]	[0.0057]
Linear combination 2			**0.0363 ***	-			-0.0024	-
SE of linear combination 2			[0.0187]	-			[0.0066]	-
Mean Y	0.0653	0.0653	0.0653	0.0653	0.0373	0.0373	0.0373	0.0373
Observations	10,041	10,041	10,041	10,041	45,845	45,845	45,845	45,845
R-squared	0.076	0.075	0.077	0.076	0.034	0.034	0.035	0.034

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Effect of drought in the 12 months on transactional sex

	Women				Men			
Variables	All		Agricultural interaction		All		Agricultural interaction	
Month12 - Ref: No drought								
1%-80% in drought	**0.022***		0.006		**0.006****		**0.013****	
	(0.011)		(0.009)		(0.003)		(0.006)	
81%-100% in drought	0.010		0.022		0.002		0.018	
	(0.013)		(0.023)		(0.007)		(0.017)	
1%-80% in drought & rural			0.025				-0.010	
			(0.021)				(0.007)	
81%-100% in drought & rural			-0.008				-0.021	
			(0.028)				(0.019)	
% of previous 12 months in drought (continuous)		0.025		**0.033***		0.003		0.007
		(0.025)		(0.017)		(0.007)		(0.015)
% of previous 12 months & rural				-0.014				-0.007
				(0.045)				(0.017)
Linear combination 1			**0.0312 ***	0.0191			0.0033	0.0005
SE of linear combination 1			[0.0178]	[0.0408]			[0.0034]	[0.0064]
Linear combination 2			0.0138	-			-0.0029	-
SE of linear combination 2			[0.0155]	-			[0.0085]	-
Mean Y	0.0555	0.0555	0.0555	0.0555	0.0394	0.0394	0.0394	0.0394
Observations	8,360	8,360	8,360	8,360	37,468	37,468	37,468	37,468
R-squared	0.078	0.078	0.079	0.078	0.035	0.035	0.036	0.035

Robust standard errors in parentheses. Coeffiecient
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Effect of drought during the last precipitation season on reported STIs

	Women				Men			
Variables	All		Agricultural interaction		All		Agricultural interaction	
Last rainy season ref: no drought								
1%-80% in drought	0.002		0.004		**0.010*** **		**0.012* **	
	(0.002)		(0.005)		(0.003)		(0.006)	
81%-100% in drought	**0.008* **		0.013		0.008		**0.018* **	
	(0.004)		(0.008)		(0.006)		(0.010)	
1%-80% in drought & rural			-0.003				-0.003	
			(0.005)				(0.008)	
81%-100% in drought & rural			-0.009				-0.017	
			(0.009)				(0.013)	
% of previous rainy season in drought (continuous)		0.006		0.010		**0.009* **		**0.024*** **
		(0.004)		(0.007)		(0.006)		(0.008)
% of previous rainy season in drought & rural				-0.007				**-0.026** **
				(0.008)				(0.011)
Linear combination 1			0.0012	0.0032			**0.0085 ** **	-0.0026
SE of linear combination 1			[0.0022]	[0.004]			[0.0042]	[0.0074]
Linear combination 2			0.0042	-			0.0014	-
SE of linear combination 2			[0.0048]	-			[0.0067]	-
Mean Y	0.0377	0.0377	0.0377	0.0377	0.0206	0.0206	0.0206	0.0206
Observations	123,400	123,400	123,400	123,400	52,416	52,416	52,416	52,416
R-squared	0.039	0.039	0.040	0.039	0.010	0.009	0.010	0.010

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Effect of drought in the last 12 months on reported STIs

	Women				Men			
Variables	All		Rural interaction		All		Rural interaction	
Month12 - Ref: No drought								
1%-80% in drought	-0.000		-0.000		0.006		0.002	
	(0.002)		(0.005)		(0.004)		(0.009)	
81%-100% in drought	**0.015****		**0.036****		0.009		0.020	
	(0.007)		(0.018)		(0.008)		(0.018)	
1%-80% in drought & rural			0.000				0.007	
			(0.006)				(0.010)	
81%-100% in drought & rural			-0.025				-0.013	
			(0.020)				(0.020)	
% of previous 12 months in drought (continuous)		0.004		0.009		**0.014***		**0.024***
		(0.005)		(0.010)		(0.008)		(0.014)
% of previous 12 months & rural				-0.007				-0.016
				(0.011)				(0.017)
Linear combination 1			-0.0001	0.0017			0.0083	0.0073
SE of linear combination 1			[0.0023]	[0.0047]			[0.0051]	[0.0097]
Linear combination 2			**0.0115 ***	-			0.0072	-
SE of linear combination 2			[0.0069]	-			[0.0092]	-
Mean Y	0.0401	0.0401	0.0401	0.0401	0.021	0.021	0.021	0.021
Observations	100,690	100,690	100,690	100,690	41,672	41,672	41,672	41,672
R-squared	0.041	0.041	0.041	0.041	0.010	0.010	0.010	0.010

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Effect of drought on HIV prevalence

	Last precipitation season				Last 12 months			
Variables	All		Agricultural interaction		All		Agricultural interaction	
Drought - Ref: No drought								
1%-80% in drought	-0.023		-0.002		0.003		0.002	
	(0.036)		(0.060)		(0.015)		(0.021)	
81%-100% in drought	0.066		0.155		**0.114*** **		**0.148** **	
	(0.082)		(0.173)		(0.036)		(0.060)	
1%-80% in drought & rural			-0.041				-0.003	
			(0.070)				(0.022)	
81%-100% in drought & rural			-0.126				-0.072	
			(0.193)				(0.068)	
% of previous 12 months in drought (continuous)		**0.132** **		**0.203** **		**0.112*** **		**0.127*** **
		(0.054)		(0.082)		(0.036)		(0.048)
% of previous 12 months & rural				-0.158				-0.048
				(0.105)				(0.069)
Linear combination 1			-0.0427	0.045			-0.0013	**0.0793 ***
SE of linear combination 1			[0.0379]	[0.0657]			[0.0059]	[0.0474]
Linear combination 2			0.0294	-			**0.0756 ****	-
SE of linear combination 2			[0.0902]	-			[0.0313]	-
Mean Y	0.0672	0.0672	0.0672	0.0672	0.0656	0.0656	0.0656	0.0656
Observations	3,156	3,156	3,156	3,156	3,279	3,279	3,279	3,279
R-squared	0.122	0.129	0.123	0.132	0.141	0.131	0.143	0.132

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Causal mediation analysis of drought's impact on STIs via transactional sex

	Women		Men	
	Last precipitation season	Last 12 months	Last precipitation season	Last 12 months
Direct effect	0.0043	**0.0212***	**0.0074****	0.0071
Total effect	0.0048	**0.0221****	**0.0075****	0.0073
Average Causal Treatment Effect (ACME) - Difference	0.0005	0.0009	0.0002	0.0002
% of total effect mediated	0.0475	**0.0391****	**0.0226****	0.0224

** if 95% confidence interval does not include 0

Table 9: Causal mediation analysis of drought's impact on HIV prevalence via transactional sex

	Women		Men	
	Last precipitation season	Last 12 months	Last precipitation season	Last 12 months
Direct effect	**0.0639****	0.00336	0.0139	0.0106
Total effect	**0.0644****	0.00425	0.0139	0.0106
Average Causal Treatment Effect (ACME) - Difference	0.00054	0.00089	0.0000	0.00001
% of total effect mediated	**0.0083****	0.01783	0.0006	0.00062

** if 95% confidence interval does not include 0

6 Robustness Checks

Various methods and datasets are used in the literature to calculate or define droughts with varying theoretical and empirical justification. To the best of our knowledge, there is no literature linking different SPI-calculated droughts to economic output in lower- and middle-income countries other than Blanc and Strobl (2013); however, they do not specify the timescale used nor do they compare to economic outcome variables. We, therefore, had to choose between the recommended timescales for agricultural drought without further supporting evidence (World Meteorological Organization, et al. 2012). We re-ran our analysis using the one- and six-month timescales, finding that the one- and six-month drought timescales show null findings for women and transactional sex but similar findings for men. On STIs, there is stronger evidence in both one- and six-month measure of droughts for women and broadly similar estimates for men. Table A3 Table A4 report the impacts for the *last precipitation season* on transactional sex but the droughts over the *last 12 months* tables and STIs are unreported for brevity.

There is a possibility some quirk in the algorithm for generating GPCC's precipitation explains our results. We repeated the generation of droughts and the analysis using data from the University of Delaware (UDEL) (Matsuura and Willmott 2018), the same source used by Burke, Gong, and Jones (2015). This dataset uses the same degree resolution as GPCC but different algorithms to generate the precipitation levels at each coordinate, meaning the calculated SPIs for each DHS cluster are slightly different. In theory, the level of rainfall recorded and the SPI should be very similar between datasets for each location, however, the differing methods could lead to systematic differences across different geographies that follow through to the SPI calculation and thus affect our estimates. With the UDEL data source, we calculated our drought variables finding only 19% of DHS clusters have the identical calculated continuous drought variable. This rises to 58% using the categoric variable, highlighting the sensitivity to the raw precipitation dataset used. Using this second data source and re-ran the regression models finding similar overall results but slightly a stronger impact of drought on men. We include the results for transactional sex using the *last precipitation season* drought measure calculated with the three-month timescale since these results differ from our GPCC droughts (Table A5), excluding the rest for brevity.

We explore several possibilities explaining our results in this next section. Reported STIs are asked to all respondents regardless of age, making the sample for women different for each sub-analysis. The DHS also includes more precise occupation information that we could use to differentiate between those earning predominantly from agriculture. However, the systematic difference between countries' collection of occupation information may bias estimates. We use the more objective rural indicator because it also captures both those directly involved in agriculture and those whose income comes from a complimentary activity. Alternatively, we created and tested an alternative indicator variable that grouped individuals into being directly involved in agriculture if their income or the head of their household occupation was derived from agriculture. We find that our results are largely unchanged in magnitude and statistical strength but, importantly, also no change in our interaction models. In other words, by increasing the precision in our differentiating variable, there is no additional evidence that there is a difference between those deriving their income from agricultural and non-agricultural sources. We do not report the results for brevity.

Finally, Burke, Gong, and Jones (2015) use a different type of drought defined when the previous 12 months of rainfall sits below the 15th percentile of the historic distribution of rainfall for a given location. They provide crop yield evidence to support their method calculation, but their estimates become less statistically strong when varying the percentile level. We re-calculated our drought as a dummy variable, indicating a drought when rainfall drops below the 15th percentile. This method of calculating droughts yields mainly null coefficients for the *last precipitation season* for either transactional sex or STIs. We summarise the key coefficients using both datasets using the 15th percentile measure. Using the *last 12 months,* we find mixed results with UDEL specifications suggesting droughts are protective against transactional sex for men, whereas GPCC droughts support our hypothesis (Table A7). Whilst the SPI calculation is superior to percentile measures, these findings highlight a critical sensitivity of the findings in this paper and in the literature more widely.

Treibich et al. (2022) findings for Malawi are particularly strong, and since their analysis and methods overlap with ours, it could be that Malawi drives our estimates as a strong example of drought leading to transactional sex. We repeat the analysis excluding Malawi. We do not find evidence of Malawi driving our results since the results are consistent with our primary findings for the remaining countries (results available on request). In addition, where Treibich et al. (2022) found a large impact for Malawi we performed a rapid replication varying only my improved calculation for droughts but were unable to replicate the results exactly. We believe this could be due to a significant misalignment of the primary drought measure (November 2015 – April 2016) and the interview schedule (October 2015 – February 2016). In other words, for many respondents in the DHS, the drought in question had not yet happened, implying some of the relationship found is spurious. However, further exploration of this question is beyond the scope of this paper.

Another consideration is migration. Both men and women may move from rural to urban areas following drought, particularly if their households can no longer support them as young adults. This could explain a lack of variation in transactional sex between people interviewed in rural and urban areas. If migration occurs, it will bias the differential results to zero or in the opposite direction if the impact is large enough because those who recently moved to non-drought areas for transactional sex with be observed in these unshocked areas. The DHS includes questions on how long the participant has been at their current residence, so we create an indicator that equals 1 if they have been in their current residence less than 2 years, broadly the same period the drought is measured. This measure is relatively crude since it does not overlap perfectly with the drought period they could have suffered, and we do not know their source location to be able to map their movement directly so we cannot narrow it down to those moving away from drought which would have been more precise.

Table A8 & Table A9 in the appendix, show the results of two tests using both versions of the drought measure. First, we test if our indicator is picking up people moving out of drought areas with a rural interaction. Our framework suggests those who have recently migrated have done so into non-drought areas, and that the impact would be greater in drought-suffering rural areas compared to urban. Models under the "Migration" columns show the opposite to be true. Whilst drought does lead to migration, it is generally into drought areas since there is a positive coefficient on less severe droughts in predicting recent migration. The rural negative rural interaction indicates that those in rural areas are less likely to have recently migrated there if there has also been a drought.

The models under columns "Transactional sex" show results of interacting drought with recent migration split for men and women. Similar to the main analysis, we expect women who have recently migrated will be more likely to engage in transactional sex. If they have moved for drought-related reasons, they will likely be attempting to earn additional income. The opposite will be true for men who have recently migrated because their incomes will be constrained. Across both measures of drought, there is some evidence that droughts lead to increased transactional sex but that it is both for men. The interaction term in moderate droughts in the last precipitation season shows a statistically significant effect for women who have recently migrated to be engaging in transactional sex. Other models have relatively large coefficients but lack statistical precision.

As a final point, running a placebo test using droughts in future was not possible since our precipitation data ends within a year of most countries' DHS survey completion making it.

7 Discussion

7.1 Limitations

Our study suffers from several limitations, primarily in the sample for which the data exists and from social desirability and sensitivity bias. The question was asked to only young, never-married women, not living with a partner and who have had sex before. Whilst we've seen this demographic has a very high risk of HIV in the population, it is a very narrow sample and not representative of those who are most likely to engage in transactional sex. In particular among those engaged for "meeting basic needs" may be engaging whilst older and as well as with a long-term partner. A recent critical review of the definition of transactional sex states the need to include those in marital and extra-marital relationships, among other key characteristics that the DHS surveys do not address adequately (Wamoyi et al. 2019). Descriptive empirical evidence from a recent study in Cameroon suggests the average age of those engaged in transactional sex is 25.1 years, implying the DHS age range does not cover the mean age of women that engage in transactional sex in Cameroon (Lépine and Szawlowski 2022). Consequently, the narrow sample limits the strength of our statistical analysis for transactional sex and add noise to the causal mediation analysis.

Social desirability bias means that we expect stigmatised and other self-reported sensitive behaviours such as transactional sex and STIs to be under-reported compared to reality. Additionally, premarital sex remains stigmatised in Africa (Gyan 2018), meaning fewer women will admit to sexual debut, reducing the sample the transactional sex question is asked to. Whilst some steps were taken in the DHS to make respondents feel comfortable and open with enumerators carrying out interviews, such as ensuring privacy and sex-matching enumerators, these measures are not enough to significantly minimise social desirability and other sensitivity biases.

Together we expect the reported level of transactional sex is far lower than reality. This is likely given other estimates of transactional sex in the literature range from 2.1% to 52% (UNAIDS and Strive 2018; Steffenson et al. 2011; Juma et al. 2013), however, precise methods and definitions vary. The low prevalence of transactional sex could be that the transactional sex question was interpreted as referring to commercial sex work. If we were to interpret the results under the assumption that we are examining FSWs and their clients, our conclusions would be more worrying with a large increase in young women entering or re-entering sex work in response to drought that has a significant impact on STIs and HIV. The reality sits somewhere between the two extreme interpretations.

The recall period of our key outcomes, STI and transactional sex is 12 months and combined with the sensitive nature of the questions means those who do not frequently engage in transactional sex, have not engaged for a number of months, or have left transactional sexual relationships at the time of the survey may be less likely to report it. The further the impact of a drought is from the survey date, the less precisely we will be able to map transactional sex as a response to it. In the *last precipitation season* treatment variable, the drought could sit outside of the survey's recall period of 12 months, see Figure 1, meaning even fully truthful answers might not capture the full behavioural response to droughts.

Recall and social desirability bias lead to attenuation bias and smaller magnitude estimates due to the misclassification of key variables. It is likely there is country by country differences in these biases but our country fixed effects controls account for them. Importantly, there is no reason to believe there is a differential impact of the bias by drought status and, therefore, no influence on the direction of our estimates.

Refusal rates for HIV in DHS surveys can be quite high, up to 30% in some cases. The DHS weighting accounts for refusal but cannot eliminate bias entirely. Previous literature has studied this potential bias when refusal in the DHS has been between 1% and 22%, concluding that although refusals are more likely to be HIV positive, the DHS provides robust HIV prevalence (Mishra et al. 2006).

Given the wide geographic range of the data in this study, differential effects of climate change will not be accounted for in the historic comparisons of rainfall. In other words, if climate change means a specific region is more likely to suffer droughts and people in those regions have already somewhat adapted, the long-term distributions of rainfall will not be accurate reflections of the chance of drought in that area. If these changes are correlated with transactional sex or STIs, it could bias our results. A plausible channel could be that a string of recent droughts may shift farmers to use drought resistant crops, limiting future droughts' economic impact.

7.2 Contribution to the Literature

We find evidence that drought is likely to be leading to entry into transactional sex for adolescent girls and young women, and men. Evidence also suggests transactional sex mediates a very small portion of the increase in STIs coming from droughts. Those in rural clusters are significantly more likely to engage in transactional sex as a response to drought, but the distinction is less clear for STIs. The difference in HIV prevalence between those in drought and non-drought affected areas is large with moderate and severe droughts predicting HIV prevalence to be almost three times higher. There is little distinction between rural and urban residers. This paper succeeds in making the explicit link between drought and transactional sex, providing evidence it is likely playing a key role in explaining HIV in Africa (Burke, Gong, and Jones 2015). It contributes to the wider literature by confirming the impacts of drought on transactional sex found in Malawi extend more widely across African countries in response to both moderate and severe droughts (Treibich et al. 2022). Our findings also support literature investigating other channels in which drought leads to HIV, including IPV (Epstein et al. 2020), child marriage (Corno, Hildebrandt, and Voena 2020) and disruption to health systems that reduce HIV testing (Epstein et al. 2022).

8 Conclusion

To conclude, we find evidence to support the idea that women are utilising transactional sex to cope with the economic consequences of drought across sub-Saharan Africa. Results show the prevalence of transactional sex on the extensive margin increases by around 35%, rising to 50% for those in rural areas suffering droughts. Drought also explains large differences in HIV prevalence. Adolescent girls and young women have three times the HIV prevalence if they suffer drought compared to those that do not. A lack of expected differential impacts between those residing in rural and urban areas could be due to migration which we find is associated with those who recently moved but a lack of precision means we cannot draw firm conclusions and migration remains a limitation. Social desirability bias is likely reducing the magnitude of our estimated impacts. Our findings are sensitive to the source of precipitation data and, to a lesser extent, the type of drought measure calculated, raising questions about the robustness of all literature using droughts as economic shocks. Our findings add to the evidence that police needs to address economic resilience and increase economic protections afforded to adolescent and young women at risk of engaging in transactional sex. It also adds to calls for women engaging in transactional sex to be considered a key population in Africa in the ongoing fight against HIV.

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10 Appendix

Table A1: Effect of drought on reported STIs using the transactional sex sub-sample only

	Last season				Month 12			
Variables	All		Agricultural interaction		All		Agricultural interaction	
Ref: No drought								
1%-80% in drought	-0.004		-0.008		0.007		0.008	
	(0.011)		(0.016)		(0.010)		(0.017)	
81%-100% in drought	0.002		0.015		**0.057***		0.083	
	(0.015)		(0.025)		(0.030)		(0.060)	
1%-80% in drought & agricultural occupation			0.010				-0.003	
			(0.020)				(0.021)	
81%-100% in drought & agricultural occupation			-0.023				-0.035	
			(0.029)				(0.069)	
% of previous 12 months in drought (continuous)		0.014		0.024		0.022		0.029
		(0.015)		(0.021)		(0.019)		(0.030)
% of previous 12 months & agricultural occupation				-0.030				-0.014
				(0.027)				(0.037)
Linear combination 1			0.0014	-0.0053			0.0057	0.0148
SE of linear combination 1			[0.0115]	[0.0163]			[0.0123]	[0.022]
Linear combination 2			-0.008	-			0.0479	-
SE of linear combination 2			[0.0154]	-			[0.0338]	-
Mean Y	0.0518	0.0518	0.0518	0.0518	0.0547	0.0547	0.0547	0.0547
Observations	10,014	10,014	10,014	10,014	8,341	8,341	8,341	8,341
R-squared	0.032	0.032	0.032	0.032	0.033	0.032	0.033	0.032

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2: Impact of Drought (both measures) on HIV for men only

Variables	Last precipitation season: All		Last precipitation season: Agricultural interaction		Last 12 months: All		Last 12 months: Agricultural interaction	
Drought - Ref: No drought								
1%-80% in drought	0.009		**0.041***		0.006		0.011	
	(0.008)		(0.024)		(0.007)		(0.020)	
81%-100% in drought	0.033**		0.040		**0.037****		0.053	
	(0.016)		(0.043)		(0.016)		(0.033)	
1%-80% in drought & rural			**-0.047***				-0.008	
			(0.025)				(0.020)	
81%-100% in drought & rural			-0.016				-0.029	
			(0.046)				(0.035)	
% of previous 12 months in drought (continuous)		0.026		0.047		0.016		0.018
		(0.021)		(0.046)		(0.016)		(0.032)
% of previous 12 months & rural				-0.038				-0.004
				(0.047)				(0.033)
Linear combination 1			-0.0059	0.0097			0.0029	0.0147
SE of linear combination 1			[0.005]	[0.0133]			[0.0027]	[0.0095]
Linear combination 2			0.024	-			**0.0239 ***	-
SE of linear combination 2			[0.016]	-			[0.0131]	-
Mean Y	0.063	0.063	0.063	0.063	0.0592	0.0592	0.0592	0.0592
Observations	28,711	28,711	28,711	28,711	30,938	30,938	30,938	30,938
R-squared	0.124	0.124	0.125	0.124	0.125	0.124	0.125	0.124

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3. One-month timescale: Impact of Drought in the last 12 months on Transactional sex

	Women				Men			
Variables	All		Agricultural interaction		All		Agricultural interaction	
Last rainy season ref: no drought								
1%-80% in drought	0.004		-0.006		**0.006****		**0.015****	
	(0.021)		(0.007)		(0.003)		(0.006)	
81%-100% in drought	0.001		0.001		0.000		0.011	
	(0.021)		(0.017)		(0.007)		(0.011)	
1%-80% in drought & rural			0.015				**-0.011***	
			(0.034)				(0.006)	
81%-100% in drought & rural			-0.005				-0.019	
			(0.037)				(0.013)	
% of previous rainy season in drought (continuous)		-0.011		0.012		**0.020*****		**0.035*****
		(0.023)		(0.013)		(0.007)		(0.012)
% of previous rainy season in drought & rural				-0.043				**-0.027****
				(0.042)				(0.014)
Linear combination 1			0.0099	-0.0317			0.0032	0.0081
SE of linear combination 1			[0.0343]	[0.0414]			[0.0028]	[0.0073]
Linear combination 2			-0.0038	-			-0.0075	-
SE of linear combination 2			[0.0327]	-			[0.0075]	-
Mean Y	0.0653	0.0653	0.0653	0.0653	0.0373	0.0373	0.0373	0.0373
Observations	10,041	10,041	10,041	10,041	45,845	45,845	45,845	45,845
R-squared	0.075	0.075	0.075	0.075	0.034	0.034	0.034	0.035

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4. Six-month timescale: Impact of Drought in the last 12 months on Transactional sex

Variables	Women: All		Women: Agricultural interaction		Men: All		Men: Agricultural interaction	
Last rainy season ref: no drought								
1%-80% in drought	0.005		-0.009		**0.005**		0.010	
	(0.014)		(0.009)		(0.003)		(0.008)	
81%-100% in drought	-0.010		-0.008		0.004		**0.013***	
	(0.009)		(0.008)		(0.004)		(0.008)	
1%-80% in drought & rural			0.023				-0.006	
			(0.024)				(0.009)	
81%-100% in drought & rural			-0.009				**-0.017***	
			(0.016)				(0.009)	
% of previous rainy season in drought (continuous)		-0.013		-0.008		**0.010****		**0.016****
		(0.013)		(0.009)		(0.004)		(0.008)
% of previous rainy season in drought & rural				-0.014				-0.012
				(0.025)				(0.009)
Linear combination 1			0.0134	-0.0212			0.0032	0.0047
SE of linear combination 1			[0.0232]	[0.0266]			[0.0034]	[0.0046]
Linear combination 2			-0.017	-			-0.004	-
SE of linear combination 2			[0.0156]	-			[0.0044]	-
Mean Y	0.0653	0.0653	0.0653	0.0653	0.0373	0.0373	0.0373	0.0373
Observations	10,041	10,041	10,041	10,041	45,845	45,845	45,845	45,845
R-squared	0.075	0.075	0.076	0.075	0.034	0.034	0.034	0.034

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5. UDEL data source: Impact of Drought in the last precipitation season on Transactional sex

	Women				Men			
Variables	All		Agricultural interaction		All		Agricultural interaction	
Last rainy season ref: no drought								
1%-80% in drought	0.002		0.000		**0.011****		**0.025*****	
	(0.020)		(0.015)		(0.005)		(0.006)	
81%-100% in drought	0.014		-0.003		0.006		**0.023*****	
	(0.026)		(0.016)		(0.006)		(0.008)	
1%-80% in drought & rural			0.006				**-0.021****	
			(0.039)				(0.008)	
81%-100% in drought & rural			0.033				**-0.026****	
			(0.049)				(0.011)	
% of previous rainy season in drought (continuous)		-0.005		-0.011		-0.006		-0.004
		(0.038)		(0.015)		(0.007)		(0.013)
% of previous rainy season in drought & rural				0.010				-0.004
				(0.069)				(0.015)
Linear combination 1			0.0057	-0.0012			0.0046	-0.0077
SE of linear combination 1			[0.0363]	[0.0659]			[0.0056]	[0.0073]
Linear combination 2			0.03	-			-0.0027	-
SE of linear combination 2			[0.047]	-			[0.0078]	-
Mean Y	0.0653	0.0653	0.0653	0.0653	0.0373	0.0373	0.0373	0.0373
Observations	10,041	10,041	10,041	10,041	45,845	45,845	45,845	45,845
R-squared	0.075	0.075	0.076	0.075	0.034	0.034	0.034	0.034

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6: Country-level results

	Month12								Last precipitation season							
	Transactional sex				STI				Transactional sex				STI			
Angola	Women		Men		Women		Men		Women		Men		Women		Men	
Ref: No drought																
1%-80% in drought	-0.009		0.013		**0.011***		0.011		0.008		**0.030****		**0.011***		**0.018*****	
	(0.011)		(0.014)		(0.007)		(0.007)		(0.008)		(0.012)		(0.006)		(0.006)	
81%-100% in drought	**-0.047*****		-0.026		**0.062***		**-0.020****		0.024		-0.002		**0.060****		**-0.018*****	
	(0.015)		(0.021)		(0.035)		(0.008)		(0.044)		(0.021)		(0.025)		(0.005)	
% of previous 12 months		-0.005		-0.014		0.018		0.008		0.010		**0.051*****		**0.019****		**0.021****
in drought (continuous)		(0.014)		(0.032)		(0.012)		(0.020)		(0.012)		(0.019)		(0.009)		(0.009)
Mean Y	0.0258	0.0258	0.0487	0.0487	0.0554	0.0554	0.0388	0.0388	0.0258	0.0258	0.0487	0.0487	0.0554	0.0554	0.0388	0.0388
Observations	2,291	2,291	5,170	5,170	14,355	14,355	5,677	5,677	2,291	2,291	5,170	5,170	14,355	14,355	5,677	5,677
R-squared	0.014	0.013	0.013	0.013	0.018	0.018	0.006	0.006	0.014	0.014	0.016	0.017	0.018	0.018	0.008	0.007
Benin - No drought																
Burundi																
Ref: No drought																
1%-80% in drought	0.005		0.006		-0.005		0.008		-0.000		**0.019*****		-0.002		**0.009****	
	(0.055)		(0.005)		(0.004)		(0.005)		(0.036)		**(0.006)**		(0.003)		(0.004)	
81%-100% in drought																
% of previous 12 months		-0.066		0.017		-0.009		0.015		0.042		**0.096*****		-0.004		0.027*
in drought (continuous)		(0.109)		(0.013)		(0.010)		(0.013)		(0.152)		(0.027)		(0.016)		(0.016)
Mean Y	0.1316	0.1316	0.0103	0.0103	0.0214	0.0214	0.0127	0.0127	0.122	0.122	0.015	0.015	0.0219	0.0219	0.0138	0.0138
Observations	228	228	2,913	2,913	9,941	9,941	4,173	4,173	451	451	5,204	5,204	17,197	17,197	7,533	7,533
R-squared	0.084	0.085	0.008	0.008	0.007	0.007	0.006	0.006	0.057	0.058	0.014	0.016	0.006	0.006	0.004	0.004
Ethiopia																
Ref: No drought																
1%-80% in drought	0.038		**0.005***		**-0.002***		**0.011****		0.032		0.003		**-0.003****		**0.011****	
	(0.025)		(0.003)		(0.001)		(0.005)		(0.022)		(0.003)		(0.001)		(0.005)	
81%-100% in drought	0.009		0.014		**-0.003****		0.011		0.005		0.005		**-0.004****		0.000	
	(0.029)		(0.013)		(0.001)		(0.013)		(0.029)		(0.008)		(0.002)		(0.009)	
% of previous 12 months		0.032		0.005										**-0.004****		-0.002
in drought (continuous)		(0.084)		(0.007)										(0.002)		(0.009)
Mean Y	0.035	0.035	0.0128	0.0128	0.0048	0.0048	0.0106	0.0106	0.035	0.035	0.0128	0.0128	0.0048	0.0048	0.0106	0.0106
Observations	343	343	8,846	8,846	15,235	15,235	12,360	12,360	343	343	8,846	8,846	15,235	15,235	12,360	12,360
R-squared	0.054	0.048	0.010	0.010	0.002	0.002	0.008	0.007	0.052	0.048	0.010	0.010	0.002	0.002	0.008	0.006

	Month12								Last precipitation season							
	Transactional sex				STI				Transactional sex				STI			
Malawi	Women		Men		Women		Men		Women		Men		Women		Men	
Ref: No drought																
1%-80% in drought	0.021		**0.039*** **		0.005		0.004		-0.002		**0.045***		0.000		**0.021*** **	
	(0.026)		(0.011)		(0.005)		(0.010)		(0.045)		(0.026)		(0.013)		(0.004)	
81%-100% in drought	0.033		0.016		0.011		0.002		-0.003		-0.002		-0.002		**0.013*** **	
	(0.031)		(0.014)		(0.007)		(0.011)		(0.047)		(0.025)		(0.013)		(0.005)	
% of previous 12 months		0.047		**0.071*** **		**0.013***		-0.005		-0.006		**-0.069*** **		-0.002		-0.012
in drought (continuous)		(0.036)		(0.021)		(0.007)		(0.010)		(0.031)		(0.015)		(0.005)		(0.008)
Mean Y	0.0488	0.0488	0.0604	0.0604	0.024	0.024	0.0204	0.0204	0.0488	0.0488	0.0604	0.0604	0.024	0.024	0.0204	0.0204
Observations	1,863	1,863	6,393	6,393	24,507	24,507	7,456	7,456	1,863	1,863	6,393	6,393	24,507	24,507	7,456	7,456
R-squared	0.017	0.017	0.008	0.009	0.002	0.002	0.006	0.006	0.016	0.016	0.016	0.013	0.002	0.002	0.007	0.007
South Africa																
Ref: No drought																
1%-80% in drought	**0.017*** **		0.002		0.004		-0.016		0.002		0.007		0.016		-0.005	
	(0.005)		(0.010)		(0.011)		(0.019)		(0.013)		(0.011)		(0.010)		(0.016)	
81%-100% in drought	0.003		-0.013		**0.041** **		-0.003		0.008		0.012		**0.023** **		-0.000	
	(0.006)		(0.013)		(0.020)		(0.027)		(0.016)		(0.012)		(0.011)		(0.017)	
% of previous 12 months										0.011		0.002		0.016		**0.023***
in drought (continuous)										(0.015)		(0.012)		(0.010)		(0.013)
Mean Y	0.0181	0.0181	0.0207	0.0207	0.0486	0.0486	0.0387	0.0387	0.0181	0.0181	0.0207	0.0207	0.0486	0.0486	0.0387	0.0387
Observations	1,489	1,489	3,185	3,185	8,505	8,505	3,616	3,616	1,489	1,489	3,185	3,185	8,505	8,505	3,616	3,616
R-squared	0.019	0.022	0.003	0.003	0.004	0.004	0.008	0.008	0.018	0.018	0.003	0.003	0.004	0.004	0.007	0.008
Uganda																
Ref: No drought																
1%-80% in drought	0.019		0.006		-0.001				**0.054** **		0.012		0.000			
	(0.027)		(0.011)		(0.009)				(0.023)		(0.011)		(0.008)			
81%-100% in drought									0.048		0.025		0.007			
									(0.035)		(0.021)		(0.012)			
% of previous 12 months		0.047		-0.005		-0.004				0.041		0.007		0.003		
in drought (continuous)		(0.053)		(0.020)		(0.016)				(0.037)		(0.018)		(0.013)		
Mean Y	0.1405	0.1405	0.0708	0.0708	0.0964	0.0964			0.1405	0.1405	0.0708	0.0708	0.0964	0.0964		
Observations	1,573	1,573	4,407	4,407	18,207	18,207			1,573	1,573	4,407	4,407	18,207	18,207		
R-squared	0.044	0.044	0.034	0.034	0.007	0.007			0.047	0.044	0.035	0.034	0.007	0.007		

	Month12								Last precipitation season							
	Transactional sex				STI				Transactional sex				STI			
Zimbabwe	Women		Men		Women		Men		Women		Men		Women		Men	
Ref: No drought																
1%-80% in drought	-0.039		-0.010		**-0.027*** **		-0.009		0.010		0.006		-0.001		-0.002	
	(0.051)		(0.012)		(0.009)		(0.015)		(0.021)		(0.008)		(0.005)		(0.005)	
81%-100% in drought	0.126		**0.106** **		-0.021		0.040		0.021		**0.047*** **		-0.000		**0.017***	
	(0.110)		(0.044)		(0.014)		(0.027)		(0.026)		(0.016)		(0.006)		(0.009)	
% of previous 12 months						0.004		0.011						0.005		**0.014***
in drought (continuous)						(0.009)		(0.011)						(0.006)		(0.008)
Mean Y	0.0419	0.0419	0.0484	0.0484	0.0202	0.0202	0.0215	0.0215	0.0419	0.0419	0.0484	0.0484	0.0202	0.0202	0.0215	0.0215
Observations	573	573	6,554	6,554	9,940	9,940	8,390	8,390	573	573	6,554	6,554	9,940	9,940	8,390	8,390
R-squared	0.028	0.015	0.005	0.003	0.004	0.003	0.005	0.004	0.015	0.015	0.005	0.004	0.003	0.003	0.005	0.004

Table A7: Droughts as below 15th percentile impact on transactional sex

Variables	Women				Men			
	All		Rural interaction		All		Rural interaction	
	GPCC	UDEL	GPCC	UDEL	GPCC	UDEL	GPCC	UDEL
Month12 - Ref: No drought								
Below the 15th percentile	0.000		0.009		0.004		**0.020****	
	(0.018)		(0.009)		(0.004)		(0.009)	
Below the 15th percentile		**-0.012***		-0.003		**-0.013*****		**-0.013***
		(0.006)		(0.006)		(0.004)		(0.007)
Below the 15th percentile & Rural interaction			-0.015	-0.016			**-0.023****	-0.000
			(0.033)	(0.011)			(0.010)	(0.008)
Linear combination 1			-0.0059	**-0.0196 ****			-0.0031	**-0.0133 *****
SE of linear combination 1			[0.0298]	[0.0096]			[0.0035]	[0.0042]
Mean Y	0.0555	0.0602	0.0555	0.0602	0.0394	0.0379	0.0394	0.0379
Observations	8,360	9,203	8,360	9,203	37,468	42,691	37,468	42,691
R-squared	0.077	0.076	0.077	0.076	0.035	0.035	0.036	0.035

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A8: Impact of drought on migration and migration on transactional sex using the previous 12 months measure

	Migration			Transactional sex			
Variables			Variables	Women		Men	
Month12 - Ref: No drought			Month12 - Ref: No drought				
1%-80% in drought		**0.016*** **	1%-80% in drought		0.014		**0.011*** **
		(0.006)			(0.010)		(0.003)
81%-100% in drought		0.010	81%-100% in drought		0.019		-0.001
		(0.019)			(0.019)		(0.009)
1%-80% in drought & rural		-0.009	1%-80% in drought & recently migrated		0.010		0.004
		(0.006)			(0.027)		(0.016)
81%-100% in drought & rural		-0.022	81%-100% in drought & recently migrated		0.054		**0.089***
		(0.021)			(0.066)		(0.047)
% of previous 12 months in drought (continuous)	0.010		% of previous 12 months in drought (continuous)	**0.026***		**0.016****	
	(0.011)			(0.014)		(0.007)	
% of previous 12 months & rural	-0.002		% of previous 12 months & recently migrated	0.066		0.023	
	(0.013)			(0.041)		(0.024)	
Observations	181,318	181,318	Observations	10,041	10,041	45,845	45,845
R-squared	0.070	0.070	R-squared	0.067	0.066	0.025	0.025

Robust standard errors in parentheses. Coeffiecient
*** p<0.01, ** p<0.05, * p<0.1

Table A9: Impact of drought on migration and migration on transactional sex using the last precipitation season measure

Variables	Migration	
Last season - Ref: No drought		
1%-80% in drought		**0.023*** **
		(0.006)
81%-100% in drought		0.017
		(0.011)
1%-80% in drought & rural		**-0.014** **
		(0.007)
81%-100% in drought & rural		0.007
		(0.012)
% of previous 12 months in drought (continuous)	0.013	
	(0.008)	
% of previous 12 months & rural	0.002	
	(0.011)	
Observations	181,318	181,318
R-squared	0.070	0.071

Variables	Transactional sex: Women		Transactional sex: Men	
Last season - Ref: No drought				
1%-80% in drought		0.010		**0.016*** **
		(0.008)		(0.003)
81%-100% in drought		0.012		-0.002
		(0.013)		(0.006)
1%-80% in drought & recently migrated		**0.057** **		-0.001
		(0.024)		(0.016)
81%-100% in drought & recently migrated		0.049		0.020
		(0.032)		(0.027)
% of previous 12 months in drought (continuous)	0.005		0.006	
	(0.011)		(0.006)	
% of previous 12 months & recently migrated	0.042		0.017	
	(0.031)		(0.022)	
Observations	10,041	10,041	45,845	45,845
R-squared	0.066	0.067	0.024	0.026

Robust standard errors in parentheses. Coeffiecient
*** p<0.01, ** p<0.05, * p<0.1

Chapter 9 – Discussion and Conclusion

9.1 Introduction

Today HIV remains a main global health challenge, with 38.4 million [33.9 million–43.8 million] people globally living with HIV in 2021 – 20.6 million of those live in Eastern and Southern Africa (53%) (UNAIDS 2021). The recent focus of the fight against HIV has been on identification, treatment and ongoing surveillance, but efforts to prevent new infection remain a priority given vast gender inequalities. Adolescent and young women (15-24) face three times the odds of acquiring HIV than their male counterparts in SSA, where half of all new infections are amongst the general population (i.e. not *key populations)* compared to 6% in the rest of the world (UNAIDS 2022). FSWs, a *key population* of predominantly women, make up 15% of new infections. A better understanding of how to prevent HIV is vital in correcting this imbalance, and to do so would be associated with vast positive externalities. Each HIV infection forgone benefits the individual and those around her. Additional positive externalities exist to the health systems of forgone spending on lifetime treatment support for new infections.

This thesis examines the economic incentives FSWs face that drive risky behaviours to help us understand the mechanisms by which adolescents and young women are at disproportionate risk of HIV. It generates new evidence on the role of economic shocks in leading to risky sexual behaviours through anticipated economic shocks and health shocks. It also generates compelling evidence that drought leads to transactional sex and HIV and is vital in explaining the unequal risk of adolescent girls and young women. This chapter summarises the key findings from the research, describes the contributions to the wider literature, discusses the limitations of the research, and offers policy implications before concluding. This chapter takes the perspective of the entire body of research within the thesis and attempts to minimise repetition from within research papers and chapters.

9.2 Key findings

This thesis aimed *to generate new evidence on the role of economic shocks in driving risky sexual behaviours and their contribution to unequal HIV transmission in Africa*. This section summarises the key findings against the five research objectives set out in the introduction, referring to specific results within the Chapters and work in the appendix.

Research objective 1: To conduct a systematic literature review examining the effects of economic shocks on risky sexual behaviours, STIs and HIV in low- and middle-income countries.

Chapter 3 systematically reviewed the literature examining the link between economic shocks as treatment or exposure and risky sexual behaviours and health outcomes. A novel framework to classify shocks was developed and applied, with domains including *direction, scale, magnitude* and *expectation*. Outcomes were evaluated across the *extensive, intensive* and *riskiness* margins.

Of 35 papers included, we found 42 unique shocks and over 320 different definitions of measures of risky sexual behaviour and health outcomes. The literature employed a variety of quasi-experimental and randomised methods to ascertain the impact of shocks on behaviours leading to varying study quality. Meta-analysis and in-depth quality assessment were impossible because of the heterogeneity, so evidence maps were used to summarise results.

In summary, persistent and covariate negative shocks are the combination that consistently drives increased risky behaviours in women. Temporary negative shocks impact the riskiness margin for those already engaged in transactional or commercial sex but less so for more samples more representative of the general population. A key finding from this research is that the types of shocks, particularly the *expectation* of how long they are expected to last, provide a meaningful way to understand risky behaviour responses.

Positive shocks were included but were limited to unconditional cash transfers, lotteries and natural economic uplift. Conditional cash transfers were excluded because they change the opportunity cost of engaging in risky behaviours in ways other than changing the individual's economic circumstances. By including only cash transfers that affect the income pathway alone, the findings are comparable to negative shocks, albeit in the opposite direction.

Positive shocks confirmed the theory that greater spending power increases risky behaviours in men; there was little evidence for a protective effect for women when receiving cash alone, possibly because amounts were too little. Despite this, our findings are consistent with other recent reviews that cash transfers can be effective, but that conditionality is key to that (Richterman and Thirumurthy 2022). Lessons from this systematic review were used directly to inform the role of risky behaviours as a consumption smoothing strategy in Chapter 4 and the rest of the thesis.

Research objective 2: To generate a conceptual framework that explains the role of the risk premium in creating an environment for women to use risky sexual behaviours within commercial and transactional sexual relationships to cope with economic shocks.

Chapter 4 outlines a conceptual framework that focuses on the role of the risk premium from unprotected sex and other risky sexual activities in explaining why women may engage in commercial and transactional sex. Its primary aim is to take lessons from the literature and guide the empirical portion of the thesis by generating testable hypotheses. The primary hypothesis generated is that economic shocks will lead to increases in risky behaviours because of both increases in commercial and transactional sex on the extensive margin and increases in risky behaviours within these relationships. The framework suggests both unanticipated and anticipated shocks will elicit similar responses in contexts where the anticipated shock is unavoidable or worth the pain. Accounting for the findings in Chapter 3, shocks affect women through two channels: directly through reduced income or consumption; and, in the case of covariate shocks, through reduced access to alternative forms of income or support. This allows us to understand the greater impact of covariate shocks that influence both channels compared to idiosyncratic shocks that affect only the income channel. The framework helps explain previous work that has conflated transactional and commercial sexual relationships. It provides a more nuanced understanding of risky behaviours in such relationships and how economic shocks contribute to HIV in young women across SSA. This chapter successfully guides the empirical work of Chapter 6 to Chapter 8, including Research Papers 2, 3 and 4, and provides a narrative structure to the rest of the thesis.

Several additional pieces of work contribute to the first research objective. The literature reviews (Chapter 2 Chapter 3) and a paper written on the economic drivers of HIV infection inequality in sub-Saharan Africa, accepted and forthcoming in the Oxford Research Encyclopedia of Economics and Finance (Appendix 10.1), were all key to addressing this research objective and vital to the construction of the conceptual framework. They highlight the role of economics in explaining the vast gender inequalities in new HIV infections. By consolidating the theoretical and empirical evidence, they show that women face reduced access to economic opportunities and institutions, particularly those in a-typical family structures, putting them at greater risk of HIV through the use of commercial and transactional sex. In particular, the paper in Appendix 1 argues that those engaging in, or at risk of engaging in, transactional sex should be considered a *key population*, as categorised by UNAIDS, alongside more formalised FSWs.

Research objective 3: To empirically determine the effect of an anticipated economic shock on risky behaviours amongst FSWs in Senegal.

Chapter 6 tests the prediction that an anticipated negative economic shock will also lead to a risky behavioural response similar to unanticipated shocks found in Chapter 3. The study design uses the time to Tabaski as an exogenous source of exposure to economic pressure to generate plausible causal estimates of its effect on condom use prior to Tabaski in Senegal. There is a significant reduction in condom use leading up to the festival, with estimates in the range of 76% for the most robust specifications. The heterogeneity analysis provides compelling evidence that the festival's economic component drives risky behaviours. Those most exposed to the festival – i.e. those intending but yet to purchase an animal, the largest acute spending of the festival – were found almost to cease using condoms entirely in the week before the festival. Unexpected poverty estimates are likely due to heterogenous perceived or real social costs of participants. Unfortunately, low power in the sample and the noisy nature of the list experiment (used to measure our key outcome) meant that further examinations of alternative income and wealth forms could not be performed robustly.

Research objective 4: To empirically determine the association between an unanticipated illness shock and risky sexual behaviours amongst FSWs in Senegal.

Chapter 7 examines the relationship between health shocks suffered by FSWs and risky sexual behaviours using the same dataset as used in Chapter 6. It describes the range and breadth of economic shocks suffered by FSWs in an urban setting and tests the prediction from the conceptual framework that unanticipated shocks will lead to increased risky behaviours. It shows health expense shocks are the most common shocks suffered and that coping strategies for FSWs are very thin, if non-existent, meaning more than half rely on increasing their sex work earnings to pay the costs. When testing the behavioural response to another being sick in the household, FSWs who experience a health shock are 47 percentage points (70 per cent) less like to use a condom during their last sex act.

Research objective 5: To examine whether drought-induced economic shocks lead to greater transactional sex in sub-Saharan Africa.

Chapter 8 utilises data on transactional sex and self-reported STI symptoms in the DHS to test if transactional sex changes on the extensive margin following drought. It then attempts to find if the increase in transactional sex is responsible for the rise in self-reported STI symptoms and HIV bio-markers using a causal mediation analysis. It shows that drought during the last precipitation season is associated with an increase of around 35% in transactional sex in adolescent girls and young women, rising to 50% for those in rural areas suffering drought. Among this same group, HIV prevalence was around three times higher if the entire previous precipitation season was in drought. For men, we find a similar increase with more precision, but part of this is because the pool of respondents is much larger. For STIs, there is little effect of drought found for women but a 100% increase in reported STI symptoms in men if the previous period was in drought. Results from the causal mediation analysis suggest only a small proportion of the increase in HIV or self-reported STIs comes from increases in transactional sex on the extensive margin. The small magnitude of these estimates is still relevant but imply the intensity and riskiness of sex acts may play an important role. Overall, Chapter 8 successfully addresses our research aim, finding that transactional sex is also responsive to drought and is likely a key component in the causal pathway from drought to HIV.

9.3 Strengths and Contributions

The strength of this thesis and its contributions to the wider literature can be summarised under the following areas:

9.3.1 Consolidating the literature on the effect of economic shocks and risky sexual behaviours.

Chapter 3 consolidates the existing evidence of economic shocks and risky behaviours, a topic only tackled once previously in the literature in a book chapter (LoPiccalo, Robinson, and Yeh 2016). By systematically reviewing the literature, all papers from all fields of academic research are included, as well as grey literature. This research takes the range of shocks and considers that their framing does not preclude their exogeneity and strength of inference. For example, droughts are studied in both economic and public health literature as a cause of risky behaviours and STIs and conclusions are treated equally meaningful, all else equal. Using the novel framework of inspecting shocks by *magnitude, scale*, and *expectation* allows us to understand the particular vulnerability of women to persistent covariate shocks. Such shocks impact their network of people to provide support or income, i.e., potential clients or transactional sex partners but impact the availability of their pool of alternative coping strategies. In the absence of a meta-analysis, infeasible given the heterogeneity of studies, results are presented using evidence maps to effectively portray the review's conclusions. Another contribution is the conceptualisation of the impact of shocks on risky behaviours, and the findings of this paper contributed to the development of the conceptual framework in Chapter 4.

Whilst Chapter 3 finds little consistent impact of unconditional cash transfers in improving HIV outcomes, we acknowledge the beneficial impacts of cash transfers found when conditions are included in the post-script to Chapter 3. The size of cash in unconditional transfers programmes is likely too low to protect against negative shocks and rarely continues long enough for significant cash buffers to be saved. Combining this with other more pressing short-run uses for sudden cash injections, it makes sense that unconditional cash transfers do not address the economic variability in the short-run and therefore have limited impacts on risky behaviours. Conditionality is important because they often change the opportunity cost of engaging in behaviours that unconditionality does not, and it appears this is key to their benefit. Discounting for a moment the other beneficial impacts of cash transfers and conditioned cash, for unconditional cash transfers to be more effective at preventing HIV, they should be targeted to reduce the swings in economic variability, i.e., targeting shocks. For example, an insurance-type product, or subsidies for known shocks such as Tabaski or an upcoming drought, would make the same amount of cash further prevent HIV transmission.

9.3.2 Producing an evidence-informed conceptual framework for understanding the role of incentives from risk premiums in transactional and commercial relationships.

There are few previous theoretical contributions to sex work and the role of risky behaviours in consumption smoothing. Notable examples include Edlund and Korn (2002) describing the commercial sex market and examining the risk premium alone with commercial sex (Gertler, Shah, and Bertozzi 2005). Past literature often conflates transactional and commercial relationships, particularly in economics, but there is growing debate around the complexities of the relationships and similarities in their structural drivers (McMillan, Worth, and Rawstorne 2018; Crankshaw and Freedman 2023; Freedman, Rakotoarindrasata, and de Dieu Randrianasolorivo 2021; Stoebenau et al. 2016). Following a "revisiting" of transactional sex by Stoebenau et al.

(2016), Chapter 4 outlines a conceptual model that draws on the common incentive structures felt by those engaged in commercial and transactional relationships whilst successfully articulating the differences where apparent.

Whilst the primary purpose is to generate testable hypotheses to shape the empirical work of this thesis, it makes an original contribution in its own right. This is the research to theoretically link transactional and commercial sex through the common economic incentives felt to engage in risky behaviours for consumption smoothing. A significant implication of this study is its comprehensive description of the underlying factors contributing to the substantial HIV inequalities between young men and women. The framework explains the overall findings described in Chapter 3 but can also be applied retrospectively to many of the relationships within this review's specific papers. The hypotheses generated are explicitly tested in this thesis, with the empirical findings in Chapter 6 Chapter 8 legitimising the framework and providing clear avenues for future research.

Ideas and lessons from the framework have been utilised outside of this thesis from dissemination and work undertaken outside of the PhD. Specifically, the POWER project in Cameroon is currently testing the impact of health insurance as a protection against economic shocks for women engaged in commercial and transactional sex independently (Szawlowski et al. 2022).

9.3.3 Finding causal evidence that anticipated economic shocks lead to an increase in risky sexual behaviours to aid in consumption smoothing.

Chapter 6 contributes to the small but growing literature on the effect of religious celebrations as an economic shock and is the first to link them to risky sexual behaviours (Banerjee and Duflo 2007; Aker et al. 2020). More broadly, it is the first to show a behavioural response to anticipated shocks, similar to the findings of unexpected shocks (Robinson and Yeh 2011; Jones and Gong 2021; Burke, Gong, and Jones 2015; Gong, de Walque, and Dow 2019). This behavioural response stems from two factors. First, economic opportunities are lacking for female sex workers, so they cannot ex-ante build up the required personal safety nets. Second, there is strong social pressure to participate in the festival, meaning their ability to back out or reduce spending is difficult without being ostracised. An additional but more general factor impacting people worldwide is the behavioural bias for the present, meaning savings for future expenses are inadequate (O'Donoghue and Rabin 1999).

The size of the effect found has important implications for understanding the spread of HIV through economic shocks. The vast majority of people in sub-Saharan Africa are either Muslim celebrating Tabaski-like celebrations or Christian celebrating Christmas, a celebration that shares several important characteristics with Tabaski, namely lavish spending and is either very difficult to avoid or provides benefits that outweigh potential costs. We find a troubling unintended consequence that vulnerable individuals are willing to take these risks to participate.

Another implication of this research is reconsidering the most common shocks suffered by the poor and vulnerable. Previously agricultural shocks were deemed the most frequent and impactful shocks affecting households in Africa (Christiaensen and Demery 2018) or health shocks that were more relevant in urban contexts (Wagstaff and Lindelow 2014; Wagstaff et al. 2018). The evidence from Chapter 6 suggests that Tabaski and other annual religious celebrations may be causing risky behaviours, making them the most frequent economic shocks to trigger risky behaviours.

9.3.4 Use of the list experiment in natural experiment and quasi-experimental study designs.

Chapter 6 Chapter 7 use risky sex as an outcome collected via the list experiment in a natural experiment study design. Previous literature attempts to minimise social desirability bias with non-statistical methods such as self-completed diaries or weekly SMS surveys that remove both the risk of discovery from being overheard and issues of trust when speaking to an enumerator (Robinson and Yeh 2012; Jones and Gong 2021). The DHS takes a relatively light touch and only ensures interviews are private, threatening to terminate them if this privacy is breached. Privacy is very difficult to ensure in these interviews, and even if it passes the enumerator's acceptability, the respondent could still fear being overheard if the interview is taking place in their home with others around. This fear of being overheard could change the answers they will give to the fieldworker.

In Chapter 6 Chapter 7, the primary outcome is collected via the list experiment to provide a statistical method to minimise social desirability bias. As discussed extensively throughout the thesis, this method gives sample-level prevalence estimates on sensitive behaviours whilst ensuring respondents answer sensitive questions without revealing their answers to the enumerator. To the best of my knowledge, Chapter 6 &Chapter 7 are the first research papers to utilise the list experiment in a natural experiment study design exploiting the ability to estimate prevalence difference between defined sub-samples. These papers demonstrate the feasibility of including list experiments for sensitive topics and that, despite the statistical limitations[6], can give more truthful estimates of risky behaviours. Future surveys and data collection surrounding sensitive topics should recognise the importance of social desirability bias and the potential for the list experiment to reduce bias in studies. For example, the DHS asks sensitive questions surrounding sexual behaviours and health that would yield more accurate answers if steps were taken to reduce social desirability.

9.3.5 Novel evidence on the role of transactional sex in mediating the relationship between economic shocks and HIV in sub-Saharan Africa.

A seminal paper in the literature on HIV and economic shocks by Burke, Gong, and Jones (2015) shows up to 20% of the difference in HIV prevalence across SSA is due to droughts over the last ten years using DHS datasets. The analysis was based on individual HIV tests from large representative samples of people across the continent. Transactional sex is generally considered to be a critical transmission channel but was not explicitly tested since the improved transactional sex questions were not introduced into the DHS until 2015. Alongside the work by Treibich et al. (2022), Chapter 8 contributes to the literature by bridging the gap between drought and transactional sex. It shows that transactional sex is responsive to drought, and increases in transactional sex drive a small but significant increase in HIV from drought. It also contributes to the debate around similarities in the structural drivers of transactional and commercial sex and how these translate into HIV risk (McMillan, Worth, and Rawstorne 2018; Crankshaw and Freedman 2023; Freedman, Rakotoarindrasata, and de Dieu Randrianasolorivo 2021).

This analysis's key strength and important contribution lies in the extensive representative data used. The analysis is representative of the countries involved, and since there is a large geographic spread across Africa and there was no discrimination in choosing countries to analyse, likely applicable to the rest of the continent. Inequality in new HIV infections towards young women is likely driven by those engaged in transactional sex, and this paper provides strong evidence for that. Increased incidence of climate-change-induced droughts means utilisation of transactional sex and risky behaviours within transactional sex relationships will only increase. These results

[6] Namely that esitmates are sample-level and have reduced statistical power.

provide additional evidence that HIV policy must broaden to include those engaged in these transactional relationships.

9.4 Limitations of the Research

9.4.1 Theoretical limitations

Chapter 4 presents a conceptual framework to structure our thinking on how economic shocks may influence risky sexual behaviour and to provide testable hypotheses for this thesis. While it serves this purpose well, it has limitations that mean it may not provide a true reflection of reality. The strength of the paper lies in its identification of the common incentive structures facing commercial and users of transactional sex whilst appreciating the nuance and distinct differences between both groups.

A weakness of the framework is the treatment of economic alternatives, the term A. A is a simple sum of all economic elements external to the risky sex act decision. Whilst the broad definition serves the purposes of this thesis well, it does not reflect the economic gender inequalities present in sub-Saharan African countries. To represent reality better, the framework would need to model the contextual factors, make more dynamic predictions about changes in the extensive and intensive margins when facing economic shocks, and provide more nuanced predictions by having flexible external factors.

Adjacent influences on the decision to engage in risky behaviours that are not economically driven is another factor not adequately covered. For example, research has shown self-esteem and empowerment among sex workers, increasing their self-perceived value and improving positive health and economic behaviours, thus effectively reducing risky behaviours (Ghosal et al. 2022). These factors will also be vital for young women vulnerable to entering risky transactional relationships and ideally would be included in the framework.

9.4.2 Analytical Limitations

9.4.2.1 Exogeneity

In addition to the specific analytical limitations discussed within each empirical chapter, a main thematic limitation lies in studying naturally occurring economic shocks. The exogeneity of shocks is key to identifying their effects, but potential endogeneity remains a potential limitation throughout this thesis. Negative shocks typically cannot be studied in a laboratory or purely randomised setting because imposing an economic loss to investigate if that leads to health loss is unethical. Consequently, the empirical analysis of the wider literature relies on quasi-experimental and natural experiment study designs. Studies attempting to causally link negative shocks to risky behaviours, as in this thesis, are potentially subject to confounding due to unobservable variables. For example, droughts or food insecurity also lead to nutritional deficiencies that impact HIV susceptibility through channels distinct from the behaviour change channel.

This research meticulously considers potential endogeneity in using Tabaski, illness and droughts as exogenous economic shocks using robust study design and careful interpretation of estimates when translating them into findings. However, not being studied under randomised conditions means confounding cannot be entirely ruled out. There are some lingering potential sources of confounding present in these analyses. Primarily, social pressures make it difficult, but not impossible, to avoid the celebration of Tabaski, meaning a portion of our estimated effects could be due to differences in those who select in and out of the shock. Equally, climate change is changing the way we view the weather. Differential impacts of climate change may mean people are differentially prepared for extreme changes in weather, and some of the effect in risky behaviours might be due to differences in the people that choose to, or not to, live in places recently more prone to drought. Ill health as an economic shocks could be endogenous because they might be confounded by wealth through an FSWs ability to pay and living conditions that contribute both to likelihood of illness and influences economically incentivised risky sexual behaviours.

Another implication of this type of research is the wider literature might suffer from bias and overstate the impact of negative economic shocks. Whilst negative shocks are typically used as proxies for a loss of income, only those negative shocks that meet the strict econometric requirements for exogeneity are studied and published in the literature. For example, Andrabi, Daniels, and Das (2023) study of the Pakistan earthquake ticks all the econometric boxes but, as they state, is a freak in terms of destruction and impact on people affected, making it hardly representative of a household's typical economic shock. Responses to such shocks might not be representative of all sudden changes in income loss; therefore, over or understate certain behaviour changes found.

In relation to this thesis, Chapter 6 studies Tabaski, which, among other reasons, has its key high-spending event at a similar time for all people making our identification strategy plausible. However, Christmas, a similar Christian religious festival, might cost the same amount but spread over a longer period. All else the same, should it have been Christmas, the behavioural response may have been different, but publishing that study is difficult.

9.4.2.2 Observational data

In Chapter 6 Chapter 7, the statistical power and design of the sample meant only changes in the riskiness outcomes could be studied. How Tabaski and health shocks impact temporary or permanent entry or exit to commercial sex work and intensive margin outcomes would have complemented the analysis well but were not feasible due to the observational study design. i.e. the sample was existing sex workers, so by definition, the data only captures exit between rounds of data collection that cannot be linked to the shocks studied. In contrast, Chapter 8 allows analysis of the extensive margin, but analysis of changes in risky behaviours or the intensive margin were not possible. Whilst both of these analyses are informative, to better design policy to protect against the economic elements of Tabaski, illness and droughts, evidence on all behaviours that put women at risk of HIV is needed.

9.4.2.3 Migration

Finally, the role of migration remains a challenge both within the thesis and in the wider literature. It is documented that mobile and transient populations (e.g. miners, migrant workers, truckers, travellers, servicepeople, traders) spend extended periods away from families and long-term partners and are more likely to engage in risky sexual behaviours (Rao et al. 1999; Orubuloye, Caldwell, and Caldwell 1993; Meekers 2000; Lippman et al. 2007; Lagarde et al. 2003; Isdory, Mureithi, and Sumpter 2015). Earlier in the HIV epidemic, areas closer to the road were found to have higher HIV incidence where there was greater contact with transient populations, and it was easier to move around (Djemai 2018). A typical response to economic shocks, particularly covariate and aggregate shocks, is moving to unaffected areas. Those who move away in response may be similar to those who choose to be transient and share unobservable characteristics associated with their HIV risk. Those left behind to cope with the shock are therefore not representative, and increases in risky behaviours maybe reflect a change in the population rather than a change in individual behaviours. The specific threats from migration to the research in the thesis are discussed within the respective Research Papers, but future research should focus on answering questions on the migratory impacts on this literature.

9.4.3 COVID-19

The COVID-19 pandemic, with its associated lockdown and travel restrictions, limited the ability to conduct primary research globally, particularly those doing research abroad and in LMICs. The containment measures enacted by states worldwide have led to huge reductions in research activity, with domestic and international travel restrictions impacting social science research in LMICs particularly badly (Redden 2020; Abramo, D'Angelo, and Mele 2022). Recent figures from the Global Challenges Research Fund in the UK found that the majority of all research funding was negatively impacted by COVID-19 (Vogel et al. 2023).

The COVID-19 pandemic led to two limitations in my thesis. First, the travel restrictions affected the ability for quality control and direct monitoring of data collection activities in Senegal, which had been part of my original plan. I understand I am lucky that my research was primarily focused on secondary data, so only relatively minor adjustments needed to be made to my research activities. My role in the third wave of the Senegal observational study after COVID-19 were desk-based, namely updating the questionnaire, contributing to the field protocols, and remotely monitoring and cleaning data as it was collected. The changes did not require significant additional training of fieldworkers; therefore, as discussed in Chapter 5, they were handled by the teams already based in Dakar. Despite that, we had to be careful with changes knowing we could not perform training on-site. Without being able to view and monitor fieldwork, I was unable to observe interviews and perform on-the-ground quality checks on the new data that was being collected and that field protocols were being followed. Additional checks were put in place to monitor data as soon as it was collected to try to guard against suspected issues. Whilst there was no evidence of problems that have significant implications on my research and no further problems were found during the analysis, I cannot rule out misunderstandings and issues that have introduced noise into the analysis, particularly around new Tabaski questions.

In addition, the data used in Chapter 8 is collected and distributed by the DHS. There is a typical lead time of several years between data collection and public availability. COVID-19 slowed this process, meaning further datasets could have been available when the analysis took place.

More directly, COVID lockdowns have been one of the largest global economic shocks to strike in recent years. The amplifying effect of the economic downturn due to COVID could have impacted the findings in Chapter 6 Chapter 7 but happened too late to impact droughts in Chapter 8. These downturns have likely led to large increases in women engaged in risky behaviours to cope with the aggregate shocks; indeed, work I contribute to outside of this thesis shows a likely drop in condom use due to COVID-19 (Toh et al. 2020) and reductions in the propensity for condom use among FSWs (Machingura et al. 2021; Silhol et al. 2021). In the coming years, the true extent of the impacts of COVID-19 will become apparent.

9.4.4 Measurement of key outcomes and mediators.

9.4.4.1 Sensitivity and social desirability bias

Sensitivity and social desirability bias and the list experiment have been a theme within this thesis since it primarily investigates sensitive outcomes. This bias plagues the wider literature, and whilst we make successful efforts to minimise the impact of social desirability bias in Chapter 6, it is a limitation in Chapter 8 and impossible to eliminate entirely throughout the thesis. It therefore deserves additional discussion. The primary factors influencing how likely respondents are to give accurate answers are:

1) The potential consequence of being discovered, i.e. the underlying attitudes towards the sensitive topic being asked about.
2) The risk of being discovered. This is determined by the context in which the questions are asked or the perceived level of anonymity the respondent will feel to their answers. For example, a survey in a public location is going to mean a respondent feels overheard and far less likely to report sensitive behaviours. Whereas an online survey that does not include their name or contact details might feel far safer reporting such behaviours because the chance of matching answers to the individual is low.
3) The level of trust between the respondent and the interviewer. In large-scale quantitative face-to-face interviews, such as the DHS, respondents and enumerators are typically strangers so rapport and trust are difficult to establish consistently. Respondents can feel more comfortable if enumerators share common characteristics or are from the same culture and social groups. Equally, familiarity might make people less likely to report truthful answers and more comfortable telling strangers.

In the case of condomless sex, a primary outcome in Chapter 6 and Chapter 7, minimising social desirability and sensitivity bias, is critical to generating accurate, unbiased results. Even when the list experiment is used, a respondent is not guaranteed to be truthful for two reasons. First, they may not understand the method and trust its anonymity, and second, they may have no intention of telling the truth anyway. This results in systematic measurement error, albeit less than when asked directly. Therefore, addressing these three factors were important during data collection in Senegal. Fieldworkers were re-hired from the previous waves of the survey, and the majority of the respondents were interviewed previously, meaning a level of trust was built. Interviews take place at a common location in each wave, away from family members and the general public, to minimise fears of being overheard. Despite these steps, evidence within Chapter 6 shows that without the list experiment, no impact of Tabaski would have been possible to detect, justifying our use of it and highlighting its strengths.

In Chapter 8, using the DHS data, transactional sex, the key outcome, and mediating variable is self-reported and is likely to have been influenced by social desirability bias; hence we consider our results a lower bound. Despite improvements made in the collection of transactional sex questions in the DHS that made the analysis possible in the first place, it is possible that it only captures women engaging more openly in sex work.

9.4.4.2 Rainfall

For the analysis in Chapter 8, the rainfall data I had the code and capability to use at the time of the analysis was only available until the end of 2017. These datasets did not extend beyond this relatively arbitrary date but were chosen also because they were the same datasets used in the literature allowing for verification of my drought calculations and assistance in their construction to take place. However, this prevented placebo tests being run which would have been a key robustness check for this analysis. Any surveys after mid-2017 could not be included since we use the current precipitation period as a key drought calculation. This precluded inclusion of surveys from Cameroon, Ethiopia, Gambia, Guinea, Liberia, Madagascar, Mali, Mauritania, Nigeria, Rwanda, Sierra Leone, and Zambia[7], which all took place after 2018, many of which were not available at the time of analysis with COVID related delays.

Whilst different sources of rainfall data that extend closer to the present could have been sought, the costs were felt to exceed the benefits. New datasets have different interpolation

[7] These are simply datasets that have been made available since I began this analysis. They may not contain the required information to be included in the analysis.

methodologies, and significant time commitments are required to reconstruct the droughts and analyse the new data.

Recent literature has shown that drought calculated using interpolated data from weather stations in Africa can have very different results in econometric analyses (Michler et al. 2022). Through cross-tabulations of droughts assigned from different rainfall datasets for DHS clusters Table 5.3 in Chapter 5, these same inconsistencies begin to emerge. Extending the analysis performed in Chapter 8 to use more current rainfall data and additional DHS surveys are priorities for future research but also further investigation to determine the most effective drought measures to use in the African context.

9.5 Policy Implications

There are a series of useful policy implications in this thesis. First, the framework for analysing shocks presented in Chapter 3 allows policymakers to understand better and predict the impact of economic shocks on HIV risk behaviours. The conceptual framework in Chapter 4, whilst more abstract, allows a clearer understanding of the mechanisms by which shocks lead to risky behaviours and will help in policies relating to sex work and policies targeting women engaged in transactional sex.

The main lesson from this thesis, however, is that policy should focus on smoothing the economic variability faced by vulnerable women in Africa. Evidence from this thesis on the impact of anticipated shocks means that knowing when certain shocks strike makes policy to protect against them easier to target but not necessarily to design. For Tabaski, any subsidy could increase individuals' net spending because they maintain their private spending (with associated behaviour change), so it must be carefully designed to avoid such unintended consequences. To deal with health shocks in Senegal, healthcare provision through subsidised or free health insurance has shown to be effective at preventing HIV in Cameroon (Lépine and Szawlowski 2022). Since registration already includes a portion of free healthcare, it is a policy that fits with the current policy environment. Therefore, policies to improve saving and financial inclusion for FSWs that improve levels of secure liquid savings and improve access to formal credit may be more effective than direct subsidies.

Our findings from Chapter 8 highlight the importance of considering how the changing climate will impact health and HIV in LMICs. By highlighting the use of transactional sex as a consumption-smoothing coping strategy, it is likely that as droughts and weather-related natural disasters become more frequent transactional sex will increase in response. We contribute evidence that policy needs to include women who engage in transactional sex as a key HIV population is needed in the ongoing fight against HIV.

More broadly, HIV policy aimed at prevention should renew focus on economic shocks, paying close attention to anticipated shocks and inclusion of women engaged in transactional sex. By targeting support to specific causes of economic variability i.e. insurance to pool costs across people and time, or targetting cash support during time of hardship, interventions might prove more effective. Other policies that help reduce economic uncertainty such as improved financial inclusion, particularly targeting women, will help HIV prevention efforts. Access to financial services act in two ways to help consumption smoothing. First, by increasing access to credit, consumption smoothing can take place through borrowing from formal institutions. Second, by having access to bank accounts and savings products, personal savings can be built and controlled more securely. Increasing access to mobile money has been shown to improve coping with shocks (Abiona et al. 2022) and savings interventions have been shown to increase protection against shocks (Aker et al. 2020) and risky behaviours in response to economic shocks (Jones and Gong 2021).

By increasing economic resilience, such policies not only aid in the prevention of HIV but improve economic empowerment and macroeconomic outcomes that are equally important in improving the lives of people in LMICs.

9.6 Future Research

There are two strands of future research this thesis points to. First is the direct next steps leading from the research in this thesis. Second, it focuses more broadly on improving our understanding of the role of shocks in driving risky behaviours, particularly for women, and how to protect against them. Third, understanding the potential differential impacts of climate change on the health behaviours of men and women surrounding HIV, and how climate adaptation can be designed to reach those most in need.

Direct research stemming from this thesis includes empirically testing the hypotheses from the conceptual framework in Chapter 4 using data on women exclusively engaged in transactional sex. Transactional sex is vital in explaining why adolescent girls and young women are at high risk of HIV. This thesis lays the groundwork for investigating adolescent girls and young women who engage in exclusively transactional sex in more detail. Our findings suggest they are a key population in fighting HIV, so more research not the economic drivers behind transactional sex and its use as a consumption smoothing strategy is warranted. Further research into anticipated shocks to confirm the findings of Chapter 6. From Chapter 8, there remain questions over the quality of datasets and choices made when using droughts as shocks that warrant further investigation that could have implications more widely in research using droughts as an economic shock.

The research of this thesis demonstrates the feasibility of conducting list experiments within observational and cross-sectional surveys to be analysed using quasi-experimental methods. Future research is needed into the benefits of using the list experiment in large publically available datasets such as the DHS. The potential benefits to HIV policy and research of having more accurate estimates for the prevalence of sensitive behaviours, such as transactional sex, must be weighed against the cost of implementation and statistical limitations. In other words, estimates might be more accurate but less precise. List experiment outcomes cannot be analysed with the typical advantages associated with panel data, although the DHS as a repeat cross-section survey, does not have to worry about this.

Finally, this thesis points to a more general research agenda to deepen our understanding of the differential consequences of economic shocks by gender beyond that of health. Climate change-induced economic uncertainty is already increasing in Africa. For the next few decades, development and health research will focus on how to best mitigate against the economic impacts associated with climate change for the world's poorest. Our research already points to an important behavioural and health consequence that differs by gender; therefore, future research is needed into how men and women respond and what best ensures the poorest can lead healthy and fulfilled lives.

9.7 Conclusion

Growing evidence shows that economic variability is a crucial driver of HIV in Africa. Economic shocks lead women to engage in risky commercial and transactional sex and are incentivised to have other risky types of sex within these relationships as a means of consumption smoothing, putting themselves and their sexual partners at increased risk of HIV. This thesis sets out to and succeeds in expanding knowledge of the role of economic shocks in driving HIV. It described the range of shocks FSWs are exposed to in urban settings and identified anticipated shocks, in the form of the religious festival Tabaski, as a new type of shock, significantly increasing HIV risk alongside health expense shocks. It also quantified the role of transactional sex in explaining the relationship between droughts and increased HIV in sub-Saharan Africa. This thesis highlights the need to expand efforts to protect FSWs and vulnerable young women against economic shocks as key in the ongoing fight against HIV.

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Chapter 10 Appendix

10.1 Appendix 1 – Drivers of HIV

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Surname/Family Name	Cust		
Thesis Title	Economic Shocks and Risky Sexual Behaviours		
Primary Supervisor	Timothy Powell-Jackson		

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Stage of publication	**Undergoing revision**

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What drives HIV in Africa? Addressing economic gender inequalities to close the HIV gender gap

Aurélia Lépine, Henry Cust, and Carole Treibich

The draft version of the article that will be published on the Oxford Research Encyclopaedia of Economics and Finance

Summary

Initially perceived as a disease affecting gay men, HIV currently disproportionately affects young women in Africa. Current strategies to prevent HIV mostly rely on using biomedical interventions to reduce the risk of infection during risky sex and to address biological inequality of women in HIV infection. Current policies and strategies to end the AIDS epidemic in Africa are likely to fail if implemented alone, given that they omit that the main reason why vulnerable women engage in risky sexual behaviours is economic. We review the literature on the drivers of risky sexual behaviours and present new evidence from our most recent research in this area. We propose a new explanation for the HIV gender gap using a gender inequality lens by documenting the role of poverty and economic shocks on risky sexual behaviours of women. We then discuss new promising approaches to reduce HIV acquisition and transmission in Africa and to break the pattern of inequality in HIV against women.

Keywords: HIV epidemic, gender inequality, economic shocks, sex work, transactional sex, risky sexual behaviours, condom use.

1 The HIV epidemic in Africa

1.1 HIV is still one of the biggest killers

Early 21st century HIV is still a main global health challenge: 38.4 million [33.9 million–43.8 million] people globally were living with HIV in 2021 – 20.6 millions living in Eastern and southern Africa (53%) (UNAIDS 2021a). The HIV/AIDS epidemic has seen dramatic shifts since the first cases described in the beginning of the 1980's. In the 90's there was no treatment available and HIV prevalence in some cities in some sub-Saharan countries reached 30%. At this time, HIV became the largest cause of death in the region (UNAIDS 2002; Danforth et al. 2017). Antiretroviral treatment (ART) became available in 1996, reducing mortality to those in treatment. However, at this time treatment was too expensive for most African people ($15,000 per year) and mortality and infections continued to soar reversing many health benefits from the social and economic advances of the previous decades (The Observer 1999). Over the 2000's costs fell to $129–$568 USD per person per year because of political pressure and increased accountability of pharmaceutical companies (Bendavid et al. 2010; Menzies, Berruti, and Blandford 2012; McNeil 2019; Walensky et al. 2013; 'Access to Medicine Foundation' n.d.). Between 2005 and 2007 in sub-Saharan Africa, ART coverage rose from 2% to 10% (World Bank 2020) with over 17 million receiving treatment in 2015. In high-income countries, those with HIV/AIDs were able to achieve near-normal life expectancy and clinical focus shifted to managing chronic illness from treating a fatal infectious disease.

More recently surveillance of infections has taken centre stage in ending HIV as a public health threat by 2030. It is estimated that 87% of people living with HIV know their HIV status, between 76% and 83% are on ART, and 90% of those are virally suppressed in pursuit of the 90-90-90 target (Cornell et al. 2021; World Bank 2020; Doshi et al. 2018). Recently there has been strong attention given to antiretroviral-based prevention strategies, such as pre-exposure prophylaxis (PrEP), available in most high-income countries to high-risk individuals but lacking in most African countries. Notable exceptions are Kenya, Nigeria, South Africa, Uganda, Zambia, and early trials in Senegal and Cameroon.

Outside of sub-Saharan Africa, 93% of new infections are among 'key populations' and their sexual partners, namely female sex workers (FSWs) and their clients, people who inject drugs, men who have sex with men (MSM), prisoners and transgender people (UNAIDS 2021b). Access to ART, pre-exposure prophylaxis (PrEP) for those not infected but with the high risk of infection, HIV activism advocating for patient-driven care, and expanding funding for both HIV care and research has meant the risk to the general population has fallen dramatically outside of key populations. Sub-Saharan Africa remains the region with the highest HIV prevalence outside of key populations. It is estimated that around 25 million people in Africa were living with HIV in 2020 and the region is responsible for around 60%of the global HIV infections (UNAIDS 2021a). Of these new infections, only 39% are among key populations, compared to 93% outside sub-Saharan Africa. Southern and Eastern Africa, where prevalence and new infections are highest in the world, is estimated to have 670,000 new infections each year and 310,000 AIDS related deaths, around half the global deaths (UNAIDS 2021a).

While recent advances have been made to fight HIV/AIDS with the development of new HIV prevention technologies such as PrEP, HIV cannot be addressed by biomedical interventions alone, particularly in low-resource settings. As a result, a better understanding of reasons why women engage in risky sexual behaviours is required to optimise HIV prevention methods.

1.2 The changing face of HIV: the HIV gender gap

Initially perceived as a disease among gay men, HIV is disproportionately affecting young women in Africa. Within sub-Saharan Africa six of seven new infections amongst adolescents aged 15-19 are among girls (UNAIDS 2021a). Those adolescents and young women aged 15-24 suffer 4,200 new infections each week and are twice as likely to be infected with HIV than their male counterparts and accounted for 63% of all new HIV infections in 2021 (UNAIDS 2021a) . We observe that, HIV prevalence among young women is at least twice larger than HIV prevalence among men in more than 20 African countries as shown in Figure 1. As a result, HIV is the biggest killer among women between 15-24 years old in Africa. UNAIDS recognise gender inequality as a key issue in Africa to address in future for both young men and women (UNAIDS 2021b). Whilst prevalence is higher in Eastern and Southern Africa, the risk to young women is also higher with 5.9 and 3.2 times higher HIV incidence for girls than boys between 2005-2015 respectively (Birdthistle et al. 2019). Urban adolescents consistently have around twice the prevalence of their rural counterparts, both for girls and boys (Maulide Cane et al. 2021).

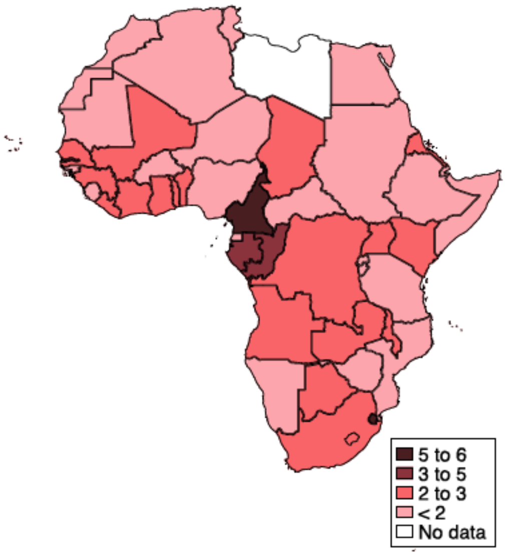

Figure 1: Female to male HIV prevalence (15-24 years)

Structural gender inequalities are likely to be the primary driver of the deeply unequal distribution of new infections to young women and girls. Societies in Africa are largely patriarchal meaning the economic and social odds are stacked against women (Stichter and Parpart 2019). Many women lack access to formal, well-paid, secure jobs and productive assets and therefore do not have the same ability to earn a secure income. Women who sit outside the typical family structures, such as divorced, abandoned or simply those without a committed partner, are particularly vulnerable to engaging in transactional or commercial sex to satisfy their basic needs and support themselves and their families.

Transactional and commercial sex is strongly associated with HIV in young women leading to high numbers of older sexual partners and strong economic incentives attached to risky sexual behaviours. There exists a fuzzy boundary between transactional sexual relationships and commercial sexual relationships in sub-Saharan Africa; while they are distinct they are often conflated. Stoebenau et al. (2016) define transactional sex as: *"non-commercial, non-marital sexual relationships motivated by the implicit assumption that sex will be exchanged for material support or other benefits"*. It has three paradigms: *"sex for basic need"* positions girls as using transactional sex to meet the basic needs for themselves and families, *"sex for improved social status"* positions women as agents engaging in transactional sex aspirationally, and finally *"sex and material expressions of love"* highlights men as providers in a loving relationship. The implicit nature of transactional sexual relationships sets them apart from the explicit nature of commercial relationships defined by the WHO as: *"the exchange of money or goods for sexual services"* (Overs 2002). Both types of relationships are consensual, differentiating them from sexual exploitation or trafficking that is not (UNAIDS 2009). Whilst trafficking and sexual exploitation are serious problems, often economically driven, they involve relatively small numbers (UNODC 2022) and do not contribute significantly to HIV in Africa.

Commercial sex workers are considered a key population in the fight against HIV and globally have 26 times the odds of contracting HIV than the general population, up from 13 times in 2017 (UNAIDS 2018; 2021a). Transactional sex is uniquely widespread in sub-Saharan Africa, particularly in southern and eastern Africa (UNAIDS and Strive 2018), where HIV incidence remains stubbornly high. Epidemiologically, transactional sex is associated with HIV risk behaviours such as alcohol use, sexual or physical violence, inconsistent condom use, age-disparate relationships and multiple partners (Stoebenau et al. 2016). A wealth of studies show that entry to sex work is driven by economic insecurity (McClarty et al. 2014; Scorgie et al. 2012). Estimates for the number of young women engaged in transactional sex collated by UNAIDS & Strive (2018) range from 2.1% (Steffenson et al. 2011) to 52% (Juma et al. 2013). For young women and girls between 14-19 with more than one sexual partner, the prevalence of transactional sex was estimated to be as high as 81% in Malawi (Moore, Biddlecom, and Zulu 2007).

There is evidence that women engaging in commercial sex face a positive premium for unprotected sex (Cunningham and Shah 2022; Gertler, Shah, and Bertozzi 2005; Mac and Smith 2018; UNAIDS and Strive 2018; V. Rao et al. 2003; Quaife et al. 2019) and that men are willing to pay up to 81% more for condomless sex acts in India compared to protected sex acts (Islam and Smyth 2012), see Figure 2. There is limited direct quantitative evidence (Luke et al. 2011; Robinson and Yeh 2012) of whether such a premium also exists in the transactional sex market, given the difficulty in quantitatively estimating the price charged for sex since transactional sex acts exchange is implicit. Some evidence from the public health literature highlights a strong link between poverty and inconsistent condom use in transactional sex relationships (Davidoff-Gore, Luke, and Wawire 2011).

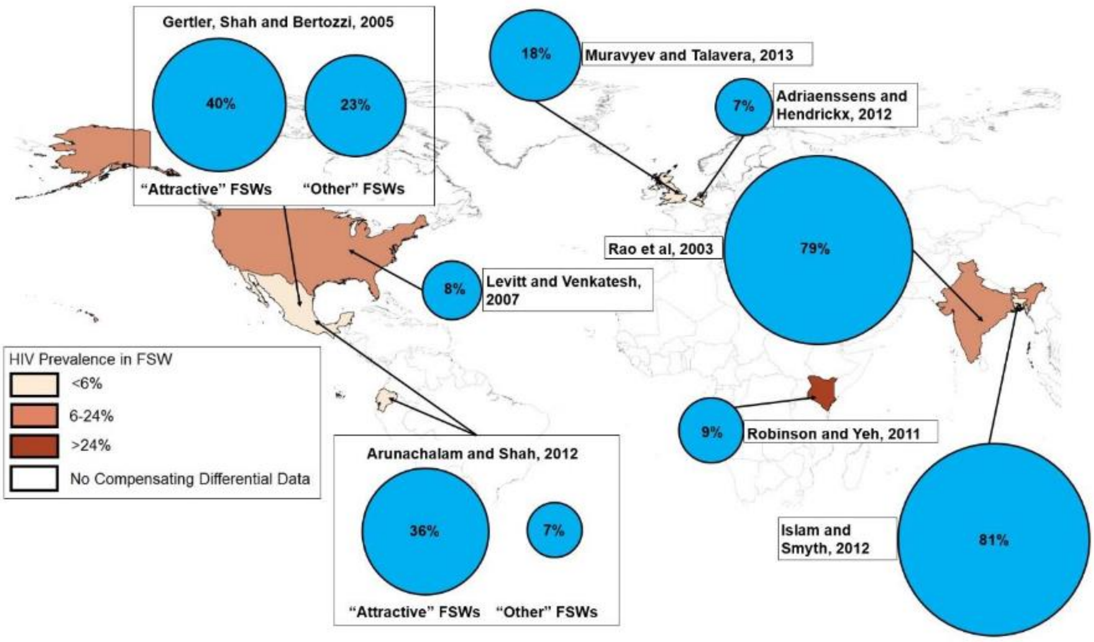

Figure 2: Premium for unprotected sex (Quaife 2018)

2 Economic activity and development

Paradoxically, both relative wealth and poverty have been hypothesised and found to be determinants of HIV (Gillespie, Kadiyala, and Greener 2007; Hajizadeh et al. 2014; Shelton, Cassell, and Adetunji 2005). Recent work has confirmed that a positive relationship between wealth and HIV infection is waning, but that odds of being a woman infected with HIV compared to men is rising, consistent with the gender inequalities present in Africa currently (Andrus et al. 2021). As with many other studies of HIV prevalence and wealth, to say HIV is concentrated in the wealthy is too simplistic because of key confounders (e.g. education, survivability and social network), which are also strongly associated with wealth.

A better explanation that introduces poverty as a determinant of HIV is the relationship found between economic activity and HIV, which operates primarily through mobility and income channels, but that partially highlights how poverty is a significant risk factor in the HIV story. Oster (2012) presents evidence of the positive relationship between economic activity and HIV incidence in Africa. By doubling exports, she finds that HIV incidence increases between 10% and 70%. This is positively related to the underlying HIV prevalence in a country. She shows that the incidence following export changes is related to underlying prevalence. Unequal economic opportunity and traditional attitudes to such occupations mean the benefits of such economic expansion disproportionately go to men. Because of such increases in income, men can economically provide for women in transactional or commercial relationships. Dangerous occupations, like mining, both attract workers with high-risk preferences, increasing the propensity for risky sexual behaviours alongside their day-to-day jobs. Oster proposed these as mechanisms, assuming risky sex is a normal good and increased income raises the amount of risky sex and thus HIV incidence, and that exports increase the share of the population engaged in export-related and high-risk and high-mobility activities such as miner and truckers within and between countries. Female populations, including FSWs and women engaged in transactional sex, are attracted to these areas, e.g. mines, ports, and truck stops, because of the increased economic activity and supply of relatively wealthy sexual partners (Clift et al. 2003).

In addition, it was documented that mobile and transient populations (e.g. miners, migrant workers, truckers, travellers, servicepeople, traders) spend extended periods away from families and long-term partners and are more likely to engage in risky sexual behaviours (Rao et al. 1999; Orubuloye, Caldwell, and Caldwell 1993; Meekers 2000; Lippman et al. 2007; Lagarde et al. 2003; Isdory, Mureithi, and Sumpter 2015). Ports and military bases share similar characteristics to mines attracting high-risk populations (Brodeur, Lekfuangfu, and Zylberberg 2018; Nwokoji and Ajuwon 2004). Fish-for-sex is an area that has received a lot of research attention, albeit exaggerated, compared to sex in exchange for access to other natural resources (Fiorella et al. 2019). Fishing communities, primarily in the countries bordering Lake Victoria, share many characteristics of mobile populations and risky jobs, but this highlights the use of sex for women to access natural resources themselves rather than the income and protection of wealthier men. HIV transmission affects the communities visited and when these populations return home, spreading HIV to their long-term partners and families.

The evidence suggests income alone is unlikely to be the driver of risky behaviours in the longer term, particularly in the absence of mobile or transient populations. Wilson (2012) finds protective effects to risky sexual behaviours in cities around copper mines when the incomes and wealth rose following a rise in the copper price. The study includes a broader population of not just high-risk mine workers and associated high-risk people but locals alongside the more risk-averse general population. He found that initial HIV prevalence was higher in mining cities, consistent with greater risky behaviours and attraction of HIV-positive and risky populations. Mining and high-risk jobs are crucial drivers of HIV, but net, these activities have positive spillovers for those indirectly affected by the uplift in the economy.

Raised incomes in conjunction with mobility or mobile and transient jobs alone appear to be a strong driver of HIV in isolated populations that can spread. Djemai (2018) find evidence to support her hypothesis that communities close to roads have high-risk people coming into contact with their communities more often. This implies a greater opportunity for HIV transmission compared to communities far from roads with lower in- and out-migration, in which HIV incidence is observed to be lower and more stable. She also notes that roads might also provide a protective effect through better access to information, contraceptives and treatment. However, since the mid-2000s, HIV knowledge has been high (Ukaegbu et al. 2022) so any remaining increases are likely due to the high throughflow of high-risk populations.

3 Economic shocks

Whilst economic activity and wealth play important roles in attracting vulnerable young women into activities like commercial and transactional sex, there is growing evidence that income variability, economic shocks, and poverty are more significant in driving HIV through unsafe sexual behaviours. The concepts and evidence presented in this section suggest that the risky sexual behaviours adopted to cope with economic shocks are a significant missing piece of the gender-unequal HIV puzzle in sub-Saharan Africa.

Africa is vulnerable to a wide range of economic shocks (Christiaensen and Demery 2018); under-developed health and financial systems mean illnesses and diseases are more prevalent and often lead to catastrophic health expenses, disproportionately affecting the poorest people globally (Wagstaff et al. 2018). Climate change increases the risk and realisation of droughts and other agricultural shocks affecting large portions of the poorer rural population (Devereux and Edwards 2004; B. F. Jones and Olken 2010). Political instability and conflicts remain a problem in many regions of low and middle-income countries. More recently, macro elements from the recovery from the COVID-19 pandemic, including food and energy shortages plus increased debt financing costs for governments due to inflation in high-income countries, mean shocks are likely to become yet more prelevant in African countries.

Structural economic gender disparities and a lack of formal safety nets, a characteristic of sub-Saharan Africa (Banerjee & Duflo, 2007; Dercon, 2002), mean women rely on transactional or commercial sex to cope with economic uncertainty and shocks. Without alternatives, these young and economically vulnerable women engage in transactional or commercial sex to satisfy their basic needs and support themselves and their families in times of economic shocks by building sexual networks and exploiting risk premiums available for risky sex. This provides a more compelling explanation of why risky sexual behaviours and HIV incidence concentrate so intensely amongst young and vulnerable girls and women.

Cust et al. (2021) categorise economic shocks in the HIV literature primarily by their scale and expectation. Each is categorised across three strata; the scale can be *idiosyncratic*, shocks that affect the individual or household; *covariate*, shocks that affect a larger group of individuals or households, typically a community, village or town; and *aggregate*, those that affect whole economies, countries, regions or the world. The expectation is the amount of time a shock is expected to last once it has been realised – *temporary*, those shocks that are expected to be shortlived and require only a single payment or loss of income, *persistent*, shocks expected to last a number of months or years with multiple periods of increased expenses or lost income, and *permanent,* shocks expected to be very long-lasting over several years with permanent changes to household expenses or income. After systematically reviewing this literature, Cust et al. (2021) found that temporary and persistent negative shocks consistently increased HIV, STI and risky sexual behaviours, see Figure 3. However, their review shows that positive economic shocks (e.g.

unconditional cash transfers) had limited effect on HIV, with only large and persistent positive economic shocks showing any signs of reduced behaviours or HIV. Variability in income appears to fill a significant void in the poverty HIV nexus. The findings regarding the effect of negative economic shocks on HIV are crucial in explaining why transactional and commercial relationships are associated with risky sexual behaviours and, considering the estimated extent of transactional sex, in explaining why young women face higher HIV incidence than their male counterparts.

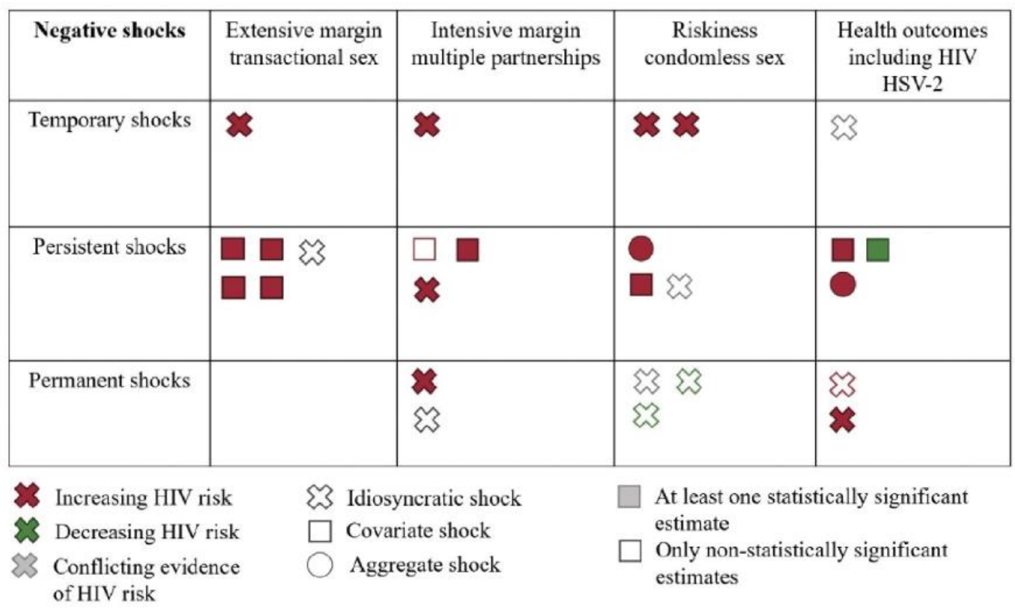

Figure 3: Evidence map of negative economic shocks and risky sex and health outcomes (Cust et al. 2021)

Health shocks

Health shocks are commonly studied in the literature since illness has a significant random element. Robinson and Yeh (2011) estimate illness of a family member led to an increase of 21 per cent in unprotected sex among? sex workers in Kenya, directly observing increases in risky behaviours. Jones and Gong (2021) find health expense shocks linked to increased transactional sex and STI symptoms in their RCT in which they implement an intervention to boost saving levels. They found that savings dampened the increase in unprotected sex in response to these health shocks. As well as savings to help pay for out-of-pocket payments, health insurance is being tested as a protection against heath shocks to vulnerable women and their economic dependents. The results of an upcoming RCT aiming at insuring vulnerable women and their economic dependents against illness shock suggest that protecting against unexpected and unaffordable health expenditures leads to a reduction in HIV infections among women engaging in transactional sex (Lépine and Szawlowski 2022).

Weather shocks

Burke, Gong, and Jones (2015) used cross-sectional DHS data from 19 African countries and found that droughts explained up to 20 per cent of the variation in cross-country HIV prevalence. They found a 0.3 percentage point (ppt) increase or 7.3 per cent increase in HIV prevalence in drought-affected rural areas, given a mean HIV prevalence of 4.1 per cent. Gong, de Walque, and Dow (2019) found that food insecurity led to an increase in STI incidence in women. More recently, Treibich et al. (2022) provided evidence that one channel through which drought may increase HIV was the increase in transactional sex. Using DHS data combient with precipitation data, they found that during the severe drought that affected Malawi in 2015-2016, women employed in agriculture affected by a six-month drought were twice as much more likely to engage in transactional sex than those working in other sectors?. These results are mirrored when the analysis is expanded to multiple sub-Saharan African countries (Cust 2022). Corno, Hildebrandt, and Voena (2020) found that economic incentives of receiving a bride price mean girls marry younger following droughts to cope with the economic shock. Politics, culture and celebrations bring about periods of increased economic pressure leading to increased risky behaviours and HIV both when shocks are anticipated and unanticipated. So far there is no consensus on the best economic interventions to protect young women from engaging in risky sexual practices following systemic climate shocks.

Religious celebrations

New evidence from a sample of FSWs in Senegal highlighted that Tabaski, a religious festival celebrated in Muslim West Africa, led to significant drops in condom use amongst FSWs. Overall there was a 76% drop in condom use and for those most exposed to the economic pressures stopped using condoms altogether for the two weeks before the festival (Cust et al. 2022).

Political shocks

Violent fallout from political unrest and the economic consequences have been shown to lead to increases in the riskiness of sex acts but to no change in the quantity of risky behaviour in Kenya (Dupas and Robinson 2012) and was associated with increased HIV infections in Cote d'Ivoire (Tequame and Tenikue 2017).

COVID-19

COVID-19 has presented one of the most severe and long-lasting economic shocks experienced in recent history. Once the realities of the lockdown and social distancing were realised, there was concern that progress in fighting HIV would be put in jeopardy, through a lack of access to testing hindering chances of achieving UNAIDS 90-90-90 targets and through reduced access to vital medication resulting in excess deaths (Jewell et al. 2020; Jiang, Zhou, and Tang 2020). COVID-19-related lockdowns and restrictions led to a decline in HIV testing of 41% and reduced referrals for diagnosis and treatment by 37% during the first COVID-19 lockdowns in 2020, compared with the same period in 2019 in Africa and Asia (UNAIDS 2021a). As well as the economic aspect, those living with HIV have higher comorbidities related to COVID-19 in comparison to people who were not infected with HIV, but by July 2021, less than 3% of Africans had received a COVID-19 vaccination (UNAIDS 2021a). Comparatively, little was written about the potential structural economic impact of reduced incomes and opportunities that will drive inequalities, particularly in economically vulnerable populations, that cause risky behaviours and increase HIV incidence, with the exception of FSWs (Adebisi et al. 2020).

FSWs are at particular risk due to their work's high and close contact nature. Reduced contact and closure of businesses have made their job of finding and meeting with clients safely harder. Evidence supports that FSWs are disproportionately affected by COVID-19 lockdowns and economic downturns due to the relative collapse of their industry, meaning they cannot afford some basic needs (Kimani et al. 2020). Early reports showed FSWs were excluded from government support and safety nets compounding their vulnerability (BBC 2020; Dube 2020). Toh et al. (2020) provide some of the first robust economic evidence of the impact of COVID-19 on the sexual behaviours of FSWs. They found that the number of clients fell by 70%; earnings fell by 50.3%, comparing a sample of FSWs in 2015, 2017 and 2020 mirrored by a drop in condom use of 16.8% supporting the idea the condom premium is used to compensate for the lost clients. At the height of lockdown and uncertainty in the summer of 2020, similar data was collected in Kenya amongst women who earn money from transactional or commercial sex, finding similar results – a reduction in economic outcomes and reduced quantity of risky behaviours but increases in the price of sexual contacts (Richterman et al. 2022).

The short-term evidence suggests potential HIV protection effects from social distancing with severe economic cost to those who rely on sex for their livelihood. There is already evidence of deepening inequalities and increases in risk factors associated with HIV, including violence (UNAIDS 2021b). The long-term effects from economies yet to recover from COVID-19 include health service re-orientation away from HIV to COVID-19, reallocated or stretched donor support, indirect impacts from reduced education, particularly for women, and the erosion of human rights surrounding key populations and access to services are likely to show their consequences in the coming years (Iversen et al. 2020; Global HIV Prevention Coalition 2020). On top of this, food and energy shortages following COVID-19 and inflation causing sudden increases in debt financing requirements for African countries will exacerbate poverty through reduced public services for already vulnerable individuals.

Positive shocks

The majority of evidence on negative economic shocks comes from naturally occurring events, which lend themselves to quasi-experimental analysis but tend to be larger in scale and choice of analysis takes place after the fact (Cust et al. 2021). There is a body of literature on positive economic shocks, mainly cash transfers, often conditional on other positive social behaviours. A recent literature review (Richterman and Thirumurthy 2022) and other evidence suggests cash transfers can be effective in reducing the incidence of negative health outcomes (Baird et al. 2012; Pettifor et al. 2016), for reducing transactional sex behaviours (Wagner et al. 2017; Rosenberg et al. 2014; Handa et al. 2014), but for risky behaviours, evidence suggests an increase in unprotected sex for men who win a lottery (Wagner et al. 2017). The final finding is consistent with the idea a premium exists for men to pay for engaging in riskier sex acts. Larger scale and magnitude positive shocks appear to have a consistent reduction in HIV risk behaviours, implying reversals brought about by negative shocks require more significant positive shocks over some time to reverse consistently (Wilson 2012).

4 Challenges in targeting key populations

4.1 Criminalisation

UNAIDS identifies FSWs (and their clients) and men who have sex with men as key populations because of their increased risk of HIV infection and their potential as a vector of HIV transmission. However, sex work and same-sex relationships are illegal in many African countries. The reason for this prohibition lies in moral concerns and the idea that legalisation could increase deviant behaviours. Senegal is currently the only African country where sex work is regulated by a public health policy. Free health care and protection against authorities whilst working are offered, but around half of FSWs do not officially register for these benefits because the policies do not protect against stigma (Ito, Lépine, and Treibich 2018; Foley 2017). The criminalisation of sex work leads women to enter dangerous situations for their physical and sexual health to meet their basic needs. There is strong causal evidence through the unexpected criminalisation of sex work in Indonesia that, in the short run, there might be protective effects to HIV through a shrinking of the sex market, offset somewhat by increased STI transmission in those that remain. However, in the long run, the size of markets returns to pre-criminalisation levels but with reduced access to condoms and services to protect and support the health of sex workers and their clients unable to operate (Cameron, Seager, and Shah 2020). A systematic literature review backs up these findings, albeit reviewing non-causal studies, adding that sex work criminalisation is associated with increased violence, reduced access to justice and reduced negotiating power (Platt et al. 2018). The evidence implies that in the long run, the size of a sex market is not determined by the legal status but that criminalisation reduces protections against physical and sexual harms from the state, NGOs and even peers. Since most African countries criminalise commercial sex work, they perpetuate the HIV crisis by reducing the services and protections available to high-risk individuals. Reducing stigma against sex work and changing beliefs that decriminalisation will not increase sex work, in the long run, are vital barriers to shifting policy.

4.2 Stigma

Self-perception in marginalised groups, driven by external stigma, plays an important role in explaining sub-optimal behaviours and acts as a barrier to HIV prevention. On top of the adverse impacts directly suffered by some key populations, such as FSWs and men who have sex with men, internalised stigma keeps such groups from accessing health services and engaging in HIV prevention behaviours. There are multiple pathways in which self-image adversely affects behaviour. It can limit the set of choices one feels is suitable to choose from (Akerlof and Kranton 2000), and it can lead to poverty traps from sub-optimal choices and “self-fulfilling pessimism about returns to effort for certain activities” (Loury 2000).

Senegal, again is an excellent example to understand how stigma prevents FSWs from contacting health services, as detailed in Foley (2017). Sex workers who hold a registration card suffer from greater social stigma and as a result have worse mental health outcomes (Ito, Lépine, and Treibich 2018). They find it challenging to access basic needs and be accepted in society, and so they need to hide their sex workers’ registration card (“*carnet sanitaire”*) to their relatives. This desired anonymity, for many, outweighs the socio-medical benefits registration brings. To make an adequate living, they must expose themselves to the public and state, and through the distribution of “*carnet sanitaire”* upon registration, they must carry a label of their profession with them or leave it at home to be discovered by family and friends. Evidence is promising that interventions to improve self-esteem and the image of sex work leads to more optimistic health and economic outlooks through increased savings, increased preventative health behaviours, increased doctors visits, and increased happiness, all persisting for at least 21 months post-intervention (Ghosal et al. 2022)

5 The PrEP promise and pitfalls

FSWs are now eligible to PrEP in many African countries. PrEP consists of giving a low dose of antiretroviral to HIV-negative individuals at high risk of being infected with HIV (Donnell et al., 2010; Grant et al., 2010; Q.A. Karim et al., 2010). Introducing new HIV prevention strategies such as PrEP could help eradicate HIV/AIDS epidemics in low-incidence contexts by targeting high-risk group populations to stop the spread of HIV transmission. In fact, recent trials have found a strong impact of oral PrEP (Baeten et al., 2012; Thigpen et al., 2012; Van Damme et al., 2012) and microbicide (Quarraisha Abdool Karim et al., 2010). Daily oral PrEP is currently recommended by the World Health Organization (WHO) as an additional prevention choice for all population groups at substantial risk of HIV infection, i.e. with an HIV incidence of about 3 per 100 person-years or higher (WHO, 2015).

However, there are two key issues with PrEP that limit its effectiveness: poor adherence in real life in Africa (i.e. outside of clinical trials) and behaviour changes brought about by reduced risk of HIV and the combination of the two. In addition, non-economic factors may impair access to PrEP for vulnerable women (Bozzani et al. 2022). Whilst PrEP appears efficacious in reducing HIV incidence, the recent results of the VOICE trial have highlighted the important role of adherence in the overall effectiveness of PrEP. Daily oral tablets are required for PrEP to work effectively, but among FSWs, adherence has been observed to be as low as 23% after one year, reducing PrEP effectiveness (Karim and Baxter 2021). After running for three years, the trial found that none of the PrEP products (oral and vaginal) were effective in preventing HIV because of poor adherence after detecting the drug in less than one-quarter of participants in the treatment group. More importantly, the characteristics of the non-adherent participants appeared to be riskier: adherence was poorer among women under 25 years and unmarried women.

On the other hand, for those that even partially adhere, there are other benefits, such as increased contact with health systems for more regular testing and treatment of STIs, a particular problem with stigmatised groups who often avoid contact with health services. This appears to somewhat counteract fears that PrEP will wipe out decades of progress from condom promotion among high-risk groups. A recent randomised controlled trial among FSWs in Senegal concluded that PrEP led to an increase in condom use of 0.108 percentage points ($p=0.041$), representing a 16.0% increase with respect to the control arm (Toh, Lépine, and Treibich 2022)

Risk compensation, or risk disinhibition, is the increase in risky behaviours resulting from interventions that reduce the perceived risk of infection. In other words, if an FSW's risk tolerance is unchanged, then reducing the riskiness of a sex act will mean they can engage in more of it and maintain the same cumulative amount of risk. There are concerns that risk disinhibition will negate the impact of PrEP interventions despite its efficacy (Cassell et al. 2006; Eaton and Kalichman 2007), particularly when considering that risk compensation will not only negate the impact of PrEP, but also of condom use(Quaife et al. 2021). PrEP does not offer protection against STIs, while the presence of any STI increases HIV transmission between HIV-negative and HIV-positive people in both directions. Although behavioural disinhibition will only increase HIV transmission for interventions with low efficacy, there is strong evidence that poor adherence strongly mitigates PrEP efficacy, explaining the disappointing results obtained from VOICE and FEM PrEP trials in Africa (Cottrell et al. 2014).

Despite this, the WHO recommendation for oral PrEP states that 'no evidence for risk compensation in sexual practices, such as decreased condom use or more sexual partners has emerged' in PrEP trials (WHO 2015). Indeed, there appeared to be no change in syphilis incidence among the treatment group in the iPrEx trial, in which subjects received blinded medication or placebo and no change in self-reported sexual practices (Marcus et al. 2013). However, one should be cautious regarding this conclusion. First because the assessment of the extent of risk compensation is complicated in the context of a clinical trial. In fact, all open-label and randomised PrEP trials have provided and emphasised the use of condoms and HIV testing. Hence, risk compensation following PrEP roll-out may differ from what was observed in clinical trials. Second, there is evidence that sensitive behaviours such as condom use are often over-reported. Previous studies that have used an indirect elicitation method called list experiment, among sex workers in Dakar to indirectly elicit their condom use showed that on average, they over-report their condom use by 20 percentage points in surveys (Treibich and Lépine 2019) and more worrying is the fact that over-reporting is much higher among sex workers at higher risk of HIV (Lépine et al. 2020). Third, there could also be a behavioural response of non-PrEP users who are aware of the benefit of PrEP, and the efficiency of PrEP could then be mitigated by risk compensation of non-PrEP users. Modelling economic conditions within FSWs taking PREP suggests condom substitution could reduce the impact of PREP by 55% and greater frequency of commercial sex in response to reduced price of unprotected sex could entirely cancel out the benefits of PREP (Quaife et al. 2021). Some qualitative evidence suggests there is little change in behaviours (Guest et al. 2008), and forthcoming evidence from a trial of FSWs in Senegal suggests risk behaviours fall for those taking PrEP, suggesting the benefits of increased contact with health services outweigh any temptation for increased risk behaviours (Toh, Lépine, and Treibich 2022). This study is somewhat limited by two-sided non-compliance and self-reported risk behaviours. However, risk compensation has been documented more widely among MSM following PrEP uptake (Nguyen et al. 2018; Kojima, Davey, and Klausner 2016).

More evidence around behavioural impacts of PrEP outside of clinical trials for FSWs focussing on economic conditions and potential externalities due to antimicrobial resistance to determine the impact and cost-effectiveness of PrEP on HIV and other health outcomes is needed before understanding its true potential. First, the epidemiological effects given economic incentives to have unprotected sex might increase non-HIV STIs, in turn increasing susceptibility to HIV.. Second, impact on other high-risk groups such as adolescents and young women and those practising transactional sex to assess the feasibility of rolling out to large numbers of people. Third, understanding community dynamics and how users and non-users of PrEP might behave differently within the community. Finally, understanding how perception and stigma interact with all these previous elements. For example, for young girls at risk, their risk perceptions, their parents' attitudes, school effects, and increased cost of STI given fertility comorbidities need to be further understood.

6 Tackling HIV in Africa in the 2020's

6.1 The role of international aid

Historically funding for HIV treatment prevention has come from external donors such as the Bill and Melinda Gates Foundation, The Global fund and high-income government overseas development aid. Of all development assistance for health in 2017, around 24.2% ($9.1 billion) was distributed for HIV/AIDS (Dieleman et al. 2018). According to UNAIDS (2021a), at the end of 2020, US$ 21.5 billion was available for the AIDS response in low- and middle-income countries, with around 61% from domestic sources. They suggest a further $29 billion is required in LMICs to end HIV/AIDS as a public health threat. Spending peaked in 2013 and has plateaued since then, with contributions via development assistance falling in total and as a share of total available spending (Dieleman et al. 2018). Recent development cuts due to the recovery from the COVID-19 pandemic and the current energy crisis in high-income countries will likely drive further reductions in development assistance available.

Since around 2010, the conversation on financing has progressed to the capabilities of LMICs to meet HIV funding domestically. Mathematical modelling studies investigating this shift to domestic financing suggest that poorer countries will not be able to meet their funding requirements directly. However, there is potential for some upper-middle-income countries to become self-reliant in the next decade, while lower-middle-income and low-income countries will require large proportions of their funding to come from external sources for the foreseeable future, particularly those with high HIV positive populations to maintain (Hecht et al. 2010; Resch, Ryckman, and Hecht 2015; Remme et al. 2016). The forecast reductions in aid from high-income countries could see progress falter, prolonging the HIV crisis on young women.

6.2 Structural Interventions to prevent HIV

Education has been the focus of structural interventions to address inequalities in girls' education, focusing on improving health outcomes. Combined with cash support, it increases the opportunity cost of skipping school while simultaneously directly alleviating poverty. Not only do these interventions provide economic support directly to families to remove one pathway to risky sex, but they also increase the skills and opportunities for young women in the economy to protect them in the present and in future. Baird et al.'s (2012) cash transfer programme gave cash conditionally and unconditionally to girls in Malawi with promising results in reducing HIV and HSV-2 incidence. This intervention works through the combined effect of removing the need for girls to seek external support through transactional sex with direct cash and increasing future prospects through encouraging school attendance. However, once the program stopped, sexual health benefits vanished, but welfare, education, reduced early marriage and fertility benefits still exist. However, these benefits did not translate into labour market or empowerment outcomes for women who received the intervention five years later (Baird, McIntosh, and Özler 2019). Other structural interventions found similar results (Pronyk et al. 2006). Conditioning the cash on education appears to make such interventions more effective (Baird, Mcintosh, and Özler 2011). Duflo et al. (2015) found similar results for a school subsidy programme in Kenya proposing a model of education shifting preference for committed vs. casual relationships to explain how such interventions sometimes observe unchanged STI outcomes.

7 Conclusion

The ongoing HIV crisis in Africa is most severely impacting young women and adolescent girls. The years to come following the COVID-19 pandemic and the energy crisis threaten to put at risk what gains have been made against HIV so far. Reduced resources from high-income countries will shrink public health budgets at a time when more funding is needed. Available resources should be focussed on reducing labour market inequalities towards young women, particularly those socially excluded or stigmatised, to reduce reliance on transactional and commercial sex in order to prevent HIV infection. There is a need for a concerted global effort to improve the underlying structural economic apparatus currently stacked against women in order to improve their ability to protect themselves.

As well as structural interventions, there is a swathe of interventions and potential policies aimed at protecting vulnerable young women from all types of economic shocks that can be utilised. From climate shocks to religious celebrations, and political unrest to health shocks, interventions to improve the underlying coping strategies of vulnerable young women will help reduce the reliance on transactional sex. Cash transfers aimed to improve the basic income of women to have a greater capacity to cope with shocks (Baird et al. 2012; Pettifor et al. 2016), savings interventions to change behaviours towards saving more through incentives and compartmentalising money to help cope with economic shocks (Jones and Gong 2021) and health insurance for adolescents and young women engaging in commercial and transactional sex and their economic dependents (Lépine and Szawlowski 2022). All of these have proved effective and focused on correcting inequalities against women.

There is a growing belief that more needs to be done to limit the impacts of economic shocks of COVID-19 and climate change and to cope with the disproportionate ill-health Africans will suffer. Unfortunately, the political will does not match that of the required investment, and contributions have fallen woefully short. The climate financing gap will soon be over $100bn a year based on the commitments made by COP for climate adaptation (Bonasia 2022), and only $9.8bn of the required $38bn needed to combat COVID-19 has so far materialised. The problem is so severe that Nobel prize winner Ester Duflo believes that a new "Marshall plan", similar in scale to that investments after world war two made in Europe, is required to prevent the developing world from a protracted crisis (*Le Monde.fr* 2020).

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10.2 Appendix 2 – Senegal Questionnaire

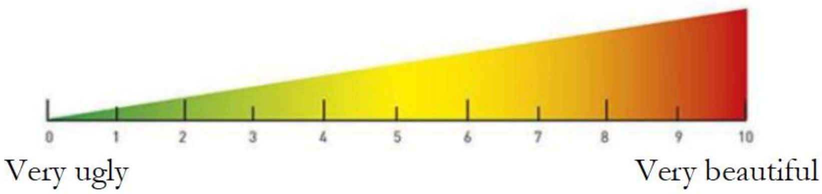
SENEGAL – FINAL SURVEY 2020

Administration

- Day
- Interview starting hour
- Interview ending hour
- deviceid

Identification and consent

- Investigator ID (use the same identifiers as in the 2015 & 2017 survey)
- Indicate where the interview takes place Pikine/Mbao/Rufisque/Sebikotane/Other
- If other structure, indicate its name (text)
- Rank of the participant (number)
- INVESTIGATOR: Using a scale from 0 to 10, please rate the beauty of the respondent you interviewed. 0 = extremely ugly and 10 = extremely beautiful.



- Did you participate in the survey in 2015 or 2017? If yes, which one?

- Identifier of the participant (if participated in 2015 or 2017 waves)

INVESTIGATOR: The respondent was never investigated. Be sure to write 0 as the identifier in the next question.

- Did the respondent give her consent? Yes/No

If no: The interview is over, thank the respondent, validate the questionnaire and move on to another respondent.

If yes: Give the newsletter to the participant. Have the participant sign the consent letter. Thank the participant for her participation.

Module 0 - Miscellaneous information

Objective: To ensure that the respondent has participated in the 2017 survey and is able to match the information collected here to the 2017 database

INVESTIGATOR: You're at the beginning of the interview. At the end of the interview, don't forget to finalize the form.

- Full name (text)

- Telephone contact (number)
- Do you agree to be contacted at this telephone number in the future for further information or to find out if you would be willing to participate in another survey? Yes/no
- How old are you? (years)

Module 1 - Recent important events

Leaving sex work

If participated in 2015 or 2017: "We investigated you just before Tabaski 2017, between those three years, many things may have happened and we'd like to know what changed in your life."

If new participant: "Please consider Tabaski 2017, about three years ago, between those three years, many events may have happened and we would like to know what changed in your life."

- Are you still having paid sex? Yes/no

For those who have left:

- When did you leave sex work? (date)
- For how many years in total did you work as a sex worker? (number of years)
- Do you still consider yourself to be a sex worker? Yes/no
- Do you expect to become a prostitute again in the future? Yes/no
- How did you manage to leave sex work? Marriage / remarriage / new activity / donation / other
- If other, please specify (text)

For those who are still in sex work:

- Have you tried to leave sex work between the two surveys (in the last 3 years)? Yes/no
- If yes, why didn't it work? (text)
- Has your sex worker (FSW) registration status changed in the last 3 years? Yes, registered/ Yes, went back to being clandestine/ No
- If clandestine to registered, why did you decide to register? (text)
- If registered to clandestine, Why did you decide to stop being registered? (text)
- Between the two surveys (over the last 3 years), has your way of working as a sex worker (FSW) changed (independent versus protective)? Yes/no/I do not know
- If yes, are you : self-employed/ working for a PIMP/ working for a madame
- How many times have you been arrested by the police in the last 3 years? (number of times)
- Have you been in prison in the last 3 years? Yes/no
- How many times have you been in prison? (number of times)
- How many nights have you spent in prison? (number of nights)
- How many episodes of STIs have you had in the last 3 years? (number of STIs)

Important events since Tabaski 2017

If participated in 2015 or 2017: In the 3 years between this survey and the one you participated in 3 years ago, many changes may have occurred in your life. We would like to know if you have been confronted with any important events in your professional or private life.

If new participant: In the 3 years since Tabaski 2017, many changes may have taken place in your life. We would like to know if you have been confronted with any important events in your professional or private life.

- In the last three years (between these two surveys), have you started a new professional activity? Yes/no
- If yes, what is this activity? Student/ White-collar worker/ Small business/ Agricultural work/ Domestic work/ Artisan/ Other
- In the last three years (between these two surveys), have you lost a professional activity or has a family business failed? Yes/no
- What was this activity? (text)
- During the last three years (between these two surveys), did you experience a shock in your income? No/ Significant money gain/ Significant loss of money or indebtedness
- In the last three years (between these two surveys), has your marital status changed? Yes/ No
- What was your marital status three years ago? Not married/ Married/ Divorced/Widowed
- In the last three years (between these two surveys), have you had a death in your household? Yes/ No
- If yes, who died? Father/Mother/Daughter/Son/ Uncle or Aunt/Grandparent/ Brother/Sister/Other
- In the last three years (between these two surveys), have you experienced a family breakdown? Yes/ No
- If yes, with whom? Father/Mother/Daughter/Son/ Uncle or Aunt/Grandparent/ Brother/Sister/Other
- In the last three years (between these two surveys), has a new nobody started contributing to the household income? Yes/ No
- If yes, who? Father/Mother/Daughter/Son/ Uncle or Aunt/Grandparent/ Brother/Sister/Other
- If yes, in total how much income per month does this new contributor(s) bring into the household? (amount in FCFA)
- In the last three years (between these two surveys), has a person stopped contributing to the household income? Yes/ No
- If yes, who? Father/Mother/Daughter/Son/ Uncle or Aunt/Grandparent/ Brother/Sister/Other
- If yes, in total how much income per month did you lose? (amount in FCFA)
- During the last three years (between these two surveys), have you experienced a deterioration in your physical health? Yes/ No
- If yes, what is the cause? (text)
- In the last three years (between these two surveys), have you experienced a deterioration in your mental health? Yes/ No
- If yes, what is the cause? (text)
- In the last three years (between these two surveys), how many times have you moved? Yes/ No
- If yes, were you forced to move by your landlord? Yes/ No

Module 2 - Socio-demographic information

Marital status

- What is your current marital status? Not married/ Married/ Divorced/Widowed
- If divorced, does your ex-husband pay you alimony? Yes/ No
- If yes, how much money do you receive from him per month? (amount in FCFA)
- If no, why don't you receive any alimony? He does not have enough income/ He refuses to pay/ He died / Other
- If other, please specify (text)
- If you are not currently married, do you currently have a partner or boyfriend? Yes/ No
- If married or has a partner, was your husband a client of yours? Yes/ No
- How did you meet him? He is a friend of the family/ He is a friend of a friend/ I met him by chance/ Other
- If other, please specify (text)

- If married or has partner, Is he aware that you were or are having paid sex? Yes/ No

Education

- Did you go to school? No/ Koranic school/ Public school/ Private school
- What is the highest level of education that you have attained? Elementary /middle school / secondary school / university / other
- If other, please specify (text)

Nationality

- What is your nationality? Senegal/ Mali/ Guinea/ Mauritania/ Other African country/ Other non-African country
- If other country, please specify (text)
- Where were you born? Senegal/ Mali/ Guinea/ Mauritania/ Other African country/ Other non-African country
- If born abroad, when did you arrive in Senegal? (date)
- What is your religion? Mouride / Tidjane / Layiene / Quadiriyya / Christian / Atheist / Other
- If other religion, please specify (text)

Main residence

- In which neighbourhood is your main residence located? Bambilor/ Biscuiterie/ Camberene/ Daliford/ Diack Sao /Diamaguene/Sicap M'Bao /Dieuppeul Derkle /Djidah Thiaroye Kao /Fann/Point E/ Amitie /Golf Sud /Goree /Grand /Dakar /Grand Yoff /Gueule Tapee/Colobane/Fass /Guinaw Rail Nord /Guinaw Rail Sud /Hann/ Bel Air /Hlm /Iles des Madeleines /Keur Massar /Malika /Mbao /Medina /Medina /Gounass /Parcelles Assainies /Patte D'Oie /Pikine Est /Pikine Ouest /Pikine Sud /Plateau /Mermoz/ Sacre -Coeur /Ndiareme Limamoulaye /Ngor /Ouakam /Sam Notaire/ Sicap/ Liberté /Rufisque Est/ Rufisque Centre (Nord) /Rufisque Ouest /Tivaouane Peulh-Niagha /Thiaroye Gare /Thiaroye Mer /Wakhinane Nimzatt /Yene /Yeumbeul Nord /Yeumbeul Sud /Yoff
- In the last 12 months, how many times have you moved? (number of times)
- Including yourself, how many people live with you in your household? (number of people)
- Who do you live with? Grandparents/ Mother / Father / Spouse/ Children/ Brothers, sisters, brothers-in-law, sisters-in-law, sisters-in-law/ Cousins, uncles, aunts/ Other
- How many of these people are children aged 0 to 4 living in your household (including yours and those of someone else)? (number of people)
- How many of these people are children aged 5 to 12 living in your household (including yours and those of others)? (number of people)
- How many of them go to school? (number of people)
- How many of these people are children aged 13 to 15 living in your household (including your own and others)? (number of people)
- How many of them go to school? (number of people)
- How many of these people are 16 years of age or older? (number of people)
- How many of them go to school? (number of people)
- How many work and contribute to the household income? (number of people)
- How many of them are over 65 or not working? (number of people)
- What material is the floor of your residence mainly made of? Earth or sand/ dung/ wooden boards/ palms or bamboo/ parquet or waxed wood/ vinyl or asphalt strips/ cement/ carpet/ tiles/ other
- If other, please specify (text)
- What material are the walls of your residence mainly made of? No wall/Bamboo, cane, palm, trunk/Earth, sand/ Bamboo with mud/ Stone with mud/ Adobe uncoated/ Plywood /Carton / Reclaimed wood/ Cement/Stones with lime, cement/ Bricks/ Cement blocks/ Wooden board, shingles/ Other

- If other, please specify (text)
- What material is the roof of your residence mainly made of? No roof/Stubble, palms, leaves/ Mounds of earth/ Mats/ Fins, bamboo/ Wooden boards/ Carton / Sheet metal / Reclaimed wood/ Zinc, cement fiber/ Tiles/ Cement/ Shingles/ Other
- If other, please specify (text)
- What kind of bed do you sleep on?
- If other, please specify (text)
- Do you: own your residence/ rent your residence/ live with a relative or friend/ live on the street?

Parents characteristics

- Is your mother still alive? Yes/no
- Is your father still alive? Yes/no
- What is your mother's highest level of education? No education/ Primary education/ Secondary education/ Beyond secondary education/ Don't know
- What is the highest level of education attained by your father? No education/ Primary education/ Secondary education/ Beyond secondary education/ Don't know

Capital Goods

- In your household, is there: a television/ radio/ video or video player or CD or DVD player/ gas or electric stove or stove/ improved fireplace/ refrigerator/ air conditioner/ computer/ fixed telephone/ cell phone/ washing machine/ internet at home/ car/ moped or motorcycle/ does not own any of the items on this list

Income

- On average, how much money do you make per month from the sex trade? (amount in FCFA)
- Is this the same amount that you earned in the last 30 days from sex work? Yes/no
- How much have you earned in the last 30 days from the sex trade? (amount in FCFA)
- Excluding the sex work, what is your occupation? No other occupation/ Student / White collar / small business / agricultural /domestic work / artisan / other
- If other, please specify (text)
- For those who report having another occupation, in the last 12 months, have you worked (in that occupation)? Yes/no
- For those who report having another occupation, on average, how much money do you earn per month from this (other) activity? (amount in FCFA)
- Is this amount the same as the amount you earned in the last 30 days from that (other) activity? Yes/no
- How much have you earned in the last 30 days from this (other) activity? (amount in FCFA)

Expenses

1) Expenses last 2 days

- In the last 2 days, how much did your household spend on food? (amount in FCFA)
- In the last 2 days, how much did your household spend on public transport (fast bus, auntie, dem dikk, shared taxi)? (amount in FCFA)

2) Expenses last 7 days

- In the last 7 days, how much did your household spend on cigarettes? (amount in FCFA)

- In the last 7 days, how much did your household spend on alcohol? (amount in FCFA)

3) ***Expenses last 30 days***

- In the last 30 days, how much has your household spent on ceremonies (clothing and ceremony costs), religion and recreation (travel, sports, books)? (amount in FCFA)

- In the last 30 days, how much did your household spend on health care (consultations, examinations, medicines, hospitalization, transportation)? (amount in FCFA)

- In the last 30 days, how much did your household spend on energy (water, electricity, oil, gas, coal)? (amount in FCFA)
- In the last 30 days, how much did your household spend on clothing (shoes, loincloth, cloth for clothing, suit, garment) other than formal wear? (amount in FCFA)

- In the last 30 days, how much did your household spend on education (parent fees, books and supplies, transportation, school fees)? (amount in FCFA)

- In the last 30 days, how much did your household spend on housing? (amount in FCFA)
- In the last 30 days, how much has your household spent on loan repayments? (amount in FCFA)
- In the last 30 days, how much has your household spent on household, furnishings and equipment (furniture, repairs, paint, beds, cupboards, chairs, carpets, dishes, linen)? (amount in FCFA)

- In the last 30 days, how much did you spend on grooming (makeup, hairdressing, cosmetics)? (amount in FCFA)
- How much money has your household managed to save in the last 30 days? (amount in FCFA)

Debt

- Is your household in debt? Yes/no
- If yes, What is the approximate amount of your household debt? (amount in FCFA)

Savings

- Are you taking part in a tontine? Yes/no
- If taking part in a tontine, How much money per month do you put into the tontine? (amount in FCFA)
- If taking part in a tontine, Have you ever received money from the tontine? (amount in FCFA)
- If taking part in a tontine, When did you receive the money? (date)
- If taking part in a tontine, How much money did you receive? (amount in FCFA)
- Do you have an orange money account? Yes/no
- If has orange money account, How much money do you have in your orange money account? (amount in FCFA)
- Do you have a bank account or an account at another financial institution that you can use yourself? Yes/no
- If has a bank account, How much money do you have in this account? (amount in FCFA)
- Considering all possible forms of savings (tontine, accounts, home savings, etc.), have you saved in the last 30 days? Yes/no
- If yes, how much money have you saved (personally) in the last 30 days? (amount in FCFA)
- Considering all possible forms of savings (tontine, accounts, home savings, etc.), in the last 12 months how much money have you saved? (amount in FCFA)

- How much savings can you have available tomorrow if you need them? (amount in FCFA)
- 30 days ago, how much savings can you have available if you need them? (amount in FCFA)
- Considering all possible forms of savings, in the last 30 days, did you contribute more or withdraw more? Contribute more/ contribute as much as withdrawals/ withdraw more

Remittances

- In the past 12 months, has anyone not living with you sent contributions to your household in the form of money or property? Yes/no
- If yes, how much money have members of your household received in the last 12 months from Nobody who does not live with you? (amount in FCFA)
- In the past 12 months, has anyone in your household sent contributions in the form of money or goods to people who do not live with you? Yes/no
- If yes, how much money have members of your household sent in the last year to people who do not live with you? (amount in FCFA)

Expenses for the next few days

- Do you have enough money today to meet the daily expenses of today and tomorrow? Yes/no

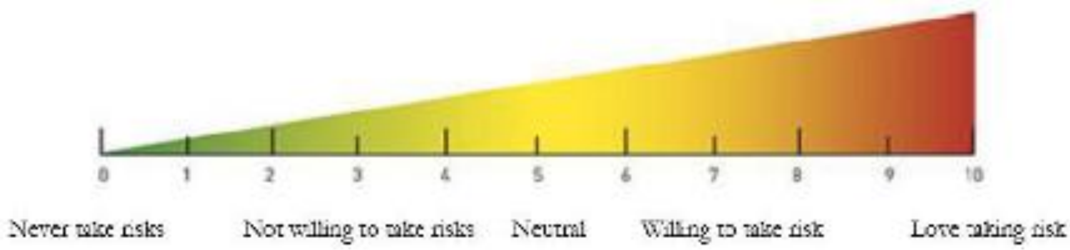
Food Insecurity

- In the past 4 weeks, how often have you worried that your household doesn't have enough food? Never, Rarely (1-2 times), Sometimes (3-10 times), Often (>10 times)
- In the past 4 weeks, how many times have you or a member of your household eaten a limited variety of food because of a lack of resources? Never, Rarely (1-2 times), Sometimes (3-10 times), Often (>10 times)
- In the past 4 weeks, how many times have you or a member of your household had to eat a smaller meal than you felt you needed because there was not enough food or resources to get more? Never, Rarely (1-2 times), Sometimes (3-10 times), Often (>10 times)
- In the past 4 weeks, how many times have you or another household member had fewer meals in a day because there was not enough food? Never, Rarely (1-2 times), Sometimes (3-10 times), Often (>10 times)
- In the past 4 weeks, how many times have you or a member of your household fallen asleep hungry at night because there was not enough food? Never, Rarely (1-2 times), Sometimes (3-10 times), Often (>10 times)
- In the past 4 weeks, how many times have you or a member of your household gone a whole day without eating because there was not enough food or resources to buy food? Never, Rarely (1-2 times), Sometimes (3-10 times), Often (>10 times)

Module 3 - Self-reported risk and time preferences

Self-declared risk preferences

When it comes to your attitude towards risk, how do you rate on a scale of 0 to 10. 0 is very conservative people who try to limit the risks of living. 10 corresponds to the most adventurous people who like to take risks.



- in general, in everyday life? (scale of 0 to 10)
- about the money? (scale of 0 to 10)
- with regard to your health? (scale of 0 to 10)
- with regard to your sexual behaviour? (scale of 0 to 10)

Hypothetical Choices – Time preferences

People make decisions that involve a trade-off between getting something quickly or something else later. For example, people sometimes have to choose between getting a sum of money quickly or getting a larger sum later.

We are going to ask you about your preferences between getting a certain amount of money today and getting another amount in a week's time.

- You prefer: O1: 4 000 FCFA now; O2: 4 000 FCFA in a week
- You prefer: O1: 3 000 FCFA now; O2: 4 000 FCFA in a week
- You prefer: O1: 2 000 FCFA now; O2: 4 000 FCFA in a week
- You prefer: O1: 1 000 FCFA now; O2: 4 000 FCFA in a week
- You prefer: O1: 500 FCFA now; O2: 4 000 FCFA in a week
- You prefer: O1: 300 FCFA now; O2: 4 000 FCFA in a week
- You prefer: O1: 100 FCFA now; O2: 4 000 FCFA in a week

We will again ask you for your preferences between receiving a certain amount of money in the future, in one or two weeks.

- You prefer: O1: 4 000 FCFA in a week; O2: 4 000 FCFA in two weeks
- You prefer: O1: 3 000 FCFA in a week; O2: 4 000 FCFA in two weeks
- You prefer: O1: 2 000 FCFA in a week; O2: 4 000 FCFA in two weeks
- You prefer: O1: 1 000 FCFA in a week; O2: 4 000 FCFA in two weeks
- You prefer: O1: 500 FCFA in a week; O2: 4 000 FCFA in two weeks
- You prefer: O1: 300 FCFA in a week; O2: 4 000 FCFA in two weeks
- You prefer: O1: 100 FCFA in a week; O2: 4 000 FCFA in two weeks

Module 4 - Sex trade

***For those still in sex work*:**

- How long have you been having paid sex in Dakar? (number of months)
- To what extent do you identify yourself as a sex worker? Strongly disagree/ disagree/ neither agree nor disagree/ agree/ strongly agree
- How long do you expect to continue as a sex worker? Less than one year/ between 1 and 2 years/ between 3 and 5 years/more than 5 years/ forever

Stopping sex work

- Do you want to quit the sex trade? Yes/no
- If yes, are you free to stop whenever you want? Yes/no
- If no, why aren't you free to stop? It is my main source of income / I have no financial support from my family / Clients blackmail me / Other
- If other, please specify (text)

Legislation

- Do you think that in Senegal, prostitution is..: Illegal, I risk going to jail if I solicit clients/ Legal, I am free to do what I want / Regulated, I have the right to solicit clients if I am registered and perform my routine visits
- Do you have a PIMP or a Madame to take care of you? PIMP/Madame/nobody

Workplace

- Where do you usually find/meet your clients? Bars or nightclubs/ Brothel or brothel/ Your home/ Client's home/ Public places/ Rented room/ Hotel/ Telephone/ Internet/ Other
- Where do you usually have sex with your clients? Bars or nightclubs/ Brothel or brothel/ Your home/ Client's home/ Public places/ Rented room/ Hotel/ Other

Type of clients

- Do you have occasional clients? Yes/no
- Do you have regular clients? Yes/no

Regular working week

Think of a normal work week, that is, a week with no surprises where you have neither fewer nor more clients than usual. If last week was a normal week, you can indicate how many clients you had in the last 7 days. If last week was an unusual week where you had either many more clients or many fewer clients, don't think of last week but think of another week that resembles the weeks you usually have.

- In general, how many different occasional clients do you have in a week? (number of clients)
- In general, how many sexual acts do you have with occasional clients in a week? (number of acts)
- In general, how many different regular clients do you have in a week? (number of clients)
- In general, how many sexual acts do you have with regular clients in a week? (number of acts)
- On average, how many clients do you have per night worked? (number of clients)

Last week of work

We will now consider the past 7 days. Tell me about the last seven days only.

- In the last 7 days, how many different clients have you had? (number of clients)
- In the past 7 days, on how many occasions have you engaged in sexual acts with clients? (number of acts)
- In the last 7 days, how much money have you earned in total from clients? (amount in FCFA)
- In the last 7 days, what is the minimum price you accepted for vaginal sex with a client? (amount in FCFA)
- In the last 7 days, how many days have you worked as a sex worker (FSW)? (number of days)
- In the last 7 days, how many days have you worked at another job? (number of days)

Penultimate week of work

Now I want you to think back to the 7 days before last week. So the 7 days prior to the period I just asked you.

- During that week, how many different clients did you have? (number of clients)
- During that week, on how many occasions did you engage in sexual acts with clients? (number of acts)
- During that week, how much money did you make in total from clients? (amount in FCFA)
- During that week, what was the minimum price you accepted for vaginal sex with a client? (amount in FCFA)
- During that week, how many days did you work as a sex worker (FSW)? (number of days)
- During that week, how many days did you work at another job? (number of days)

Relationship with the police

INVESTIGATOR: The following questions are sensitive. It is important that you remain neutral when asking them. You must also reassure the participant about the confidentiality of the information disclosed.

- Have you ever paid a bribe to a police officer? Yes/No/ Pay in kind (sexual act)
- If yes, when was the last time you did it? Less than a month ago/ Between 1 and 6 months/ Between 6 and 12 months/ More than 12 months ago
- How much money did you give him? (amount in FCFA)
- On average, how many times a year do you pay a bribe? (number of times)
- On average, how much money do you pay? (amount in FCFA)
- Have you ever been harassed by a police officer? Yes/no
- If yes, what was the reason this policeman harassed you? To have sex with me/ To get money out of me / Other
- If other, please specify (text)
- If he took money, how much money did he ask you for? (amount in FCFA)
- Did you have sexual intercourse with this policeman? Yes/no
- Have you ever been in jail for your sex work (FSW) activity? Yes/no
- If yes, how many times in your life? (number of times)
- If yes, for how long? (If the person indicates that he or she has been imprisoned several times, please indicate the total time spent in prison).
- INVESTIGATOR: indicate the most relevant unit of duration (days, weeks, months)
- number of days (or nights) spent in prison
- number of weeks spent in prison
- number of months spent in prison

Registration

- Are you registered with the authorities? Yes/no
- If yes (registered), how long have you been registered with the authorities? (number of months)
- If yes, For what MAIN reason have you registered with the authorities? To benefit from health services/ Following imprisonment for illegal prostitution/ Following the discovery of my activity by a member of my entourage/ Other
- If other, please specify (text)
- If no (not registered), why aren't you registered? I don't know the legal system/ I don't have identity papers/ I want to be discreet/ I don't see the point of registering/ I only work as a sex worker occasionally/I am not old enough/ Other
- If other, please specify (text)
- If you don't see the point of registering, why? (text)
- If unregistered sex worker, do you have an appointment card? Yes/no

Subjective probabilities about the consequences of registration

I will now ask you questions about the likelihood of certain events occurring in the future and the consequences that these events could have on you.

Expected consequences of illegal prostitution activity and registration

- What is the likelihood that you will be stopped by the police if you solicit a client in a bar or nightclub next time? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely
- What is the likelihood of an official FSW being stopped by the police if they solicit a client in a bar or nightclub? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely
- What is the probability of an illegal FSW being arrested by the police if they solicit a client in a bar or nightclub? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely

Financial consequences of an arrest

INVESTIGATOR - PUT IN SITUATION THE FSW: "Imagine you are soliciting a client in a bar. A policeman comes and asks you to show him your health card."

If you're stopped by the police for soliciting clients in a bar:

- What is the minimum fine you would have to pay? (amount in FCFA)
- What is the maximum amount you would have to pay? (amount in FCFA)

Distribution of the financial consequences of an arrest

- What is the likelihood that your fine will be less than 5,000 FCFA? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely
- What is the probability that your fine will be less than 10 000 FCFA? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely
- What is the probability that your fine will be less than 15 000 FCFA? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely

Consequences in terms of imprisonment

If you're stopped by the police for soliciting clients in a bar:

- What's the likelihood that you'll go to prison? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely

Consequences in terms of imprisonment

What is the minimum period of imprisonment that you would suffer? INVESTIGATOR: indicate the most relevant unit of time (days, weeks, months)

- number of days (or nights) spent in prison
- number of weeks spent in prison
- number of months spent in prison

What is the maximum length of imprisonment you would receive? INVESTIGATOR: indicate the most relevant unit of time (days, weeks, months)

- number of days (or nights) spent in prison
- number of weeks spent in prison
- number of months spent in prison

Likelihood that the health card will be requested

- How likely is it that a bouncer/bar manager will ask you to show him the sanitation logbook? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely
- How likely is it that a policeman will ask you to show him the health record? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely
- How likely is it that a client will ask you to show them the health records? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely

Social networks

Now I'm going to ask you about other women you know in the field.

- How many girls do you know in the business? (number of girls)
- Do you belong to a sex worker (FSW) group? Yes/no

For those who are part of a sex worker (FSW) group:

Sex worker (FSW) group

- What is the name of this FSW group? (text)
- Are you a group leader? Yes/no
- What is the name of the President or Leader of this FSW group? (text)
- How many women are there in this FSW group? (number of women in group)
- Are there registered sex workers in this group? Yes/no
- How often do you meet? Every day/ At least twice a week/ Every week /At least twice a month /Every month /Less than once a month
- What types of activities are organized by the FSW group? Advocacy/ Revenue-generating activity /Medical visit with the mobile clinic / Training /Advanced strategy or community-based screening /Other

- If other, please specify (text)

Sex worker support

Among the sex workers you know:

- How many girls do you visit? (number of girls)
- How many girls can you borrow money from? (number of girls)
- How many girls will you talk to when you need reassurance? (number of girls)
- How many girls can you go to for medical advice or to discuss health problems? (number of girls)

Girls working in the same area

- Are there any other girls working at the same address as you? Yes/no

For those who work in the same place as other girls

- In your opinion, per month, most of the girls earn: More than you/ Same as you/ Less than you
- In your opinion, what proportion of girls use a condom? All/ More than half/ Half/ Less than half/ None of them
- In your opinion, do they use condoms? All the time/ Most of the time/ Half of the time/ Sometimes/ Never
- What is the likelihood that girls in your area will use a condom the next time they have paid sex? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely
- What is the likelihood that girls in your zone will use a condom for each of the next TEN paid sexual encounters? Very unlikely/ Unlikely/ As likely as not likely / Probably/ Very likely

Please tell me the extent to which you agree with the following sentence:

- There is a lot of competition among sex workers for clients. Strongly disagree/ disagree/ neither agree nor disagree/ agree/ strongly agree

Module 5 - Stated Preference Survey

DCE - default preferences

- Do you have a file with the police or the health centre? No file/ file at the health centre/ file with the police
- If you have a file at the health centre, how long do you think you will have a file? Whilst a sex worker/for life
- If you have these files at the health and police stations, for how long do you think you will have these files? Whilst a sex worker/for life
- Do you have the health book (registration card)? Yes/no
- Do you feel that confidentiality is respected when you go to the hospital? Yes/no
- Have you ever gone for medical check-ups or biological tests related to your FSW activity? Yes/no
- If you do go for medical check-ups or biological tests related to FSW activity, do you pay for your medical visits and biological tests? Yes/no
- If you do not go for medical check-ups or biological tests related to FSW activity, do you think you should pay for medical visits and biological tests?
- If you do pay for your medical visit, how much per visit? (amount in FCFA)

- Do you receive psychosocial follow-up? Yes/no

Current Registration Policy

INVESTIGATOR READ: Sex work is legal and regulated in Senegal. To exercise it legally, you must:

- register with the authorities;
- undergo routine monthly medical check-ups and test negative for STIs.
- carry an up-to-date health card, confirming your compliance with routine medical visits

Your ID and photo will also be kept at the hospital and in a police file to prove your registration. These records will not be deleted if you leave sex work.
Being registered will not affect your human rights, you and your family members will still be able to travel outside Senegal, access the justice system or the profession of your choice.

Senegalese law stipulates that unregistered sex workers risk a fine of 30,000 FCFA and up to 6 months in prison if arrested by the police.

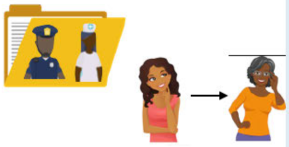
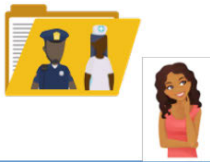
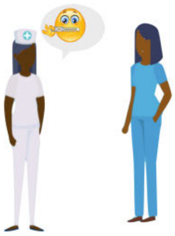
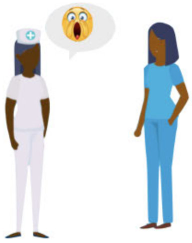
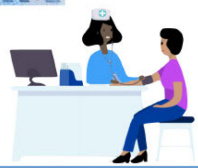
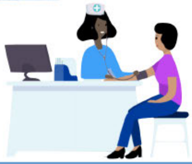
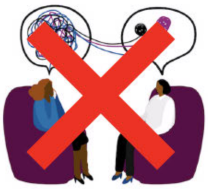
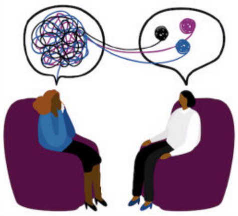
DCE introduction

We will now describe the different variants of the registration policy. There are ten questions, and each question presents two policy options that we would like you to compare. We will ask you to tell us whether you prefer Policy A, or Policy B, or neither.

Each policy option described depends on the following: file, proof of registration, hospital confidentiality, free medical visits and psychosocial follow-up.

Remember that there are no right or wrong answers.

Example:

Q1	Politique A	Politique B
Fichier	Poste de santé et police, fichée a vie 	Poste de santé et police si PS 
Preuve d'enregistrement	Carte actuelle, plus petite 	Code QR
Confidentialité à l'hôpital	Confidentialité garantie 	Confidentialité non garantie 
Visites médicales et tests	Gratuits  = 0 FCFA 	Payants = 2000 FCFA  
Suivi Psychosocial	Pas de suivi 	Suivi 

DCE – Unregistered sex worker (PSC) - Block 1, Scenario 1 - 10

- Imagine two registration policies: Policy A, and Policy B. Which do you prefer? A, B or neither (prefer to remain unregistered)
- You prefer to remain unregistered, however which policy do you prefer? A or B

DCE – Unregistered sex worker (PSO) - Block 2, Scenario 1 - 10

- Imagine two registration policies: Policy A, and Policy B. Which do you prefer? A, B or neither (prefer to remain unregistered)
- You prefer to remain unregistered, however which policy do you prefer? A or B

DCE – Registered sex worker (PSO) - Block 1, Scenario 1 - 10

- Imagine two registration policies: Policy A, and Policy B. Which do you prefer? A, B or neither (prefer to remain unregistered)
- You prefer the current registration policy, however which policy do you prefer? A or B

DCE – Registered sex worker (PSO) - Block 2, Scenario 1 - 10

- Imagine two registration policies: Policy A, and Policy B. Which do you prefer? A, B or neither (prefer to remain unregistered)
- You prefer the current registration policy, however which policy do you prefer? A or B

Module 6 - Economic shocks

We will now turn to the shocks you may have suffered recently.

COVID-19

- Have you heard of COVID-19? Yes/no
- What are the symptoms of COVID-19? Cough/ Fever/ Fatigue/ Loss of taste or sense of smell/ Diarrhoea/ Aching /Headaches /Conjunctivitis/Skin rash/Sore throat/Other
- Have you had COVID-19? Yes/no
- Has anyone in your household had COVID-19 (excluding you)? Yes/no
- How many members of your household (excluding you)? (number)

Behaviours COVID-19

- While schools were closed, who looked after your children? Me/ Another member of the household/ They left my house temporarily/Has no dependent children/Nobody
- What educational activities did your children pursue while the schools were closed? None / Study alone/ homework or exercise given by the teacher / homework or exercise given by the family/ Educational program on television or radio/ Online courses on the internet/An educator employed by the family
- What precautions did you take to avoid becoming infected with COVID-19? Wash your hands frequently/ Wear a face mask /Avoid crowded areas /Avoid visiting the elderly/ Avoid going out /Nothing
- If other, please specify (text)

Effects of COVID-19

READ: Now, I want you to remember when there was containment and curfew because of COVID-19:

- What effect did COVID-19 have on your attendance at the health facilities? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on health centre visits in general? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on your monthly visits? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on the number of clients? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on client types? I see more regular clients/ I see more casual clients /No change

- What was the effect of COVID-19 on the price you charge? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on the frequency of condom use with clients? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- If there was a change, how did COVID-19 affect condom use? Condom stockout/ Afraid to go to the pharmacy /Lockdown and curfews make it harder to buy condoms/ No money to buy condoms/ Harder to negotiate condom use with clients / Wanting to charge clients more/Other
- If other, please specify (text)
- What has been the effect of COVID-19 on violence experienced by clients? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on violence experienced by police officers? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on income from sex work? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- If you are in another occupation, what was the effect of COVID-19 on income from that other occupation? Strong increase/ Slight increase/No change/Slight decrease/Strong decrease
- What was the effect of COVID-19 on your overall mental health? Strong improvement/ Slight improvement/ No change/ Slight deterioration/ Sharp deterioration
- What is the main reason why COVID-19 affected your mental health? Less social interaction/ Less money/ Domestic Violence/ Other types of violence/ Other
- If other, please specify (text)

<u>Effect of tabaski in general</u>

READ: Now we're going to talk about Tabaski.

I would like you to compare the type of clients you have at this time before Tabaski to a normal part of the year.

- What is the effect of Tabaski on the number of clients you see? Strong increase/ Slight increase/ No change/ Slight decrease/ Strong decrease
- What is the effect of Tabaski on the types of clients? I see more regular clients/ I see more casual clients/ No change
- What is the effect of Tabaski on the price you charge? Strong increase/ Slight increase/ No change/ Slight decrease/ Strong decrease
- What is the effect of Tabaski on the frequency of condom use with clients? Strong increase/ Slight increase/ No change/ Slight decrease/ Strong decrease
- How does Tabaski affect condom use? Condom stockout/Afraid to go to the pharmacy/ No money to buy condoms /Harder to negotiate condom use with clients /Wanting to charge clients more /Other
- If other, please specify (text)
- What is the effect of Tabaski on clients' experience of violence? Strong increase/ Slight increase/ No change/ Slight decrease/ Strong decrease
- What is the effect of Tabaski on income from sex work? Strong increase/ Slight increase/ No change/ Slight decrease/ Strong decrease
- If you work in another profession, what is the effect of Tabaski on income from another profession? Strong increase/ Slight increase/ No change/ Slight decrease/ Strong decrease
- What is the effect of Tabaski on your overall mental health? Strong improvement/ Slight improvement/ No change/ Slight deterioration/ Sharp deterioration
- What is the main reason why Tabaski has affected your mental health? Less social interaction/ Less money/ Domestic violence/ Other types of violence/ Other
- If other, please specify (text)

READ: I will now ask you some questions about the next Tabaski celebration that will take place in the coming weeks. When I ask you about household budgets, I mean the general amount of money you have to spend each week or each month on food and other expenses.

- Are you going to celebrate Tabaski this year? Yes/no
- If not, why not? Non-Muslim/ No money / COVID-19/ Animal shortages/ High prices/ Animal died before the ritual/ Victim of theft/ Other

Tabaski 2020

- How many people will you celebrate Tabaski with? (number of people)
- Do you plan to buy or contribute to the purchase of the animal this year? Yes/no
- If yes, how many people do you or will you share the cost with, excluding you? (number of people)
- Have you already bought today the animal that you will sacrifice during the festival? Yes/no

Tabaski 2020 - Animal not yet purchased

- Why haven't you bought the animal yet? Lack of money/ Worried about the possibility of theft/ No storage place for the animal /More expensive if bought earlier / Other
- If other, please specify (text)
- What is the main animal you plan to buy for the party? Mouton/ Goat/ Ewes/ Cut meat/ Beef/ Other
- If other, please specify (text)
- When do you ideally expect to incur the costs? The same day/ The day before/ 2 days before / 3 days before / 4 days before/ 5 days before / 6 days before/ 1 week before/ 2-3 weeks before/ 1 month before/ Between 2 and 6 months before/ Between 7 and 11 months before/ 12 months before/ Don't know
- How do you plan to procure the animals? Purchase/ Breeding at home/ Government Donation/ Gift from a friend or family member/ Other
- If other, please specify (text)
- How much money do you plan to spend in total on animals? (amount in FCFA)

Tabaski 2020 – Animal already purchased

- What's the main animal you bought for the party? Mouton/ Goat/ Ewes/ Cut meat/ Beef/ Other
- If other, please specify (text)
- How did you get the animals? Purchase/ Breeding at home/ Government Donation/ Gift from a friend or family member/ Other
- If other, please specify (text)
- When did you buy the animal? (date)
- How much did you spend in total on the animals? (amount in FCFA)

- With the exception of the animal, will you have any other expenses for Tabaski? Yes/no

Tabaski 2020 - Other costs

- What are these costs? (text)
- What is the total value of these costs? (amount in FCFA)
- When do you ideally expect to incur the other costs? The same day/ The day before/ 2 days before / 3 days before / 4 days before/ 5 days before / 6 days before/ 1 week before/ 2-3 weeks before/ 1 month before/ Between 2 and 6 months before/ Between 7 and 11 months before/ 12 months before/ Don't know

Tabaski 2020 - Financial Pressure

- To what extent does the cost of Tabaski have an impact on household finances? No impact/ Low impact/ Modest impact /Wide impact/ Very broad impact
- How long will it take for the household to overcome these expenses after Tabaski? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months/ Between 4 and 6 months/ More than 6 months/ Don't know
- What means will you use to pay for the costs of Tabaski this year? Earning extra income through sex work/ Earn more from another activity/ Reduce household expenses/ Donation from a household member/ Donation from a third party or friends/ Donation from a regular client (not for sex work) /Help from family or friends for work (not for sex work and not for giving money)/ Government donation / Donation from a non-governmental organization/ Migrant remittances (outside Senegal) / Savings /Sale of assets/ Borrowing/ Removal of children from school/ Other
- If other, please specify (text)
- What is the main way to fund these costs this year? Earning extra income through sex work/ Earn more from another activity/ Reduce household expenses/ Donation from a household member/ Donation from a third party or friends/ Donation from a regular client (not for sex work) /Help from family or friends for work (not for sex work and not for giving money)/ Government donation / Donation from a non-governmental organization/ Migrant remittances (outside Senegal) / Savings /Sale of assets/ Borrowing/ Removal of children from school/ Other
- If other, please specify (text)
- How will you earn extra income from sex work? Have more clients/ Doing more sexual acts/ Increase the price per sex act
- How will you manage to raise the price? Spend the night/ Having more oral sex/ Having more anal sex/ Having more unprotected sex/ Accepting riskier clients/ Other
- If other, please specify (text)

READ: We will now talk about the Tabaski of 2017, which corresponds to the Tabaski that took place at the time of our last survey 3 years ago.

Do you remember the 2017 Tabaski? Yes/no

Tabaski 2017

- How many people did you celebrate Tabaski with in 2017? (number of people)
- How many people did you share the costs of Tabaski 2017 with, excluding you? (number of people)
- Did you buy an animal? Yes/no
- Approximately how much did you spend in total on animals? (amount in FCFA)
- Approximately how many days before Tabaski did you buy the animal? The same day /The day before/ 2 days before/ 3 days before/ 4 days before /5 days before /6 days before /1 week before/2-3 weeks before
- 1 month before/Between 2 and 6 months before/ Between 7 and 11 months before/ 12 months before
- Approximately how much did Tabaski cost you in total in 2017? (amount in FCFA)
- What was the primary means of financing these costs in 2017? Earning extra income through sex work /Earn more from another activity
- /Reduce household expenses/ Donation from a household member / Donation from a third party or friends /Donation from a regular client (not for sex work) /Help from family or friends for work (not for sex work and not for giving money)/ Government Donation /Donation from a non-governmental organization/Migrant remittances (outside Senegal) /Savings/Sale of goods/ Borrowing/ Removal of children from school /Other
- If other, please specify (text)
- How did you earn extra income from sex work? Have more clients/Doing more sexual acts/Increase the price per sex act
- How did you manage to raise the price? Spend the night/ Having more oral sex/ Having more anal sex/ Having more unprotected sex/ Accepting riskier clients/ Other
- If other, please specify (text)

Economic shocks

- During the 30 days, what economic shocks (in addition to COVID-19) have you or your household experienced? No shock/ Medical expenses/ Eviction/ Theft or burglary/ Received an important gift or inheritance/ Death in the family/ Divorce or abandonment /Bankruptcy of a business or loss of employment/ Started a new business or a new job/ Change in incoming or outgoing transfers /Change in the price of basic necessities/ Other
- If other, please specify (text)

Economic shocks - Medical expenses

You have indicated that your household has incurred a significant and unexpected medical expense in the last 30 days. If you have had more than one, please provide me with the details of the most recent major unexpected medical expense. Do not count regular check-ups or medications that you have to buy for yourself or your household, but only those expenses that are unexpected. If your household has experienced several episodes of illness in the past month, please consider the most recent event.

- When did this expense occur? (date)
- What was the total amount of this expense? (amount in FCFA)
- Was this expense related to an illness for yourself or someone else? The participant/someone else
- To what extent was this medical expense anticipated? Unpredictable/ Pretty predictable/ Fully predictable
- To what extent did this have an impact on your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long did or will it take for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- What is the main method of paying for these costs? Earning extra income through sex work / Earn more from another activity / Donation from a household member / Donation from a third party or friends /Donation from a regular client (not for sex work) /Help from family or friends for work (neither for sex work nor for giving money)/Government Donation /Donation from a non-governmental organization/Migrant remittances (outside Senegal) /Savings/Sale of capital/Borrowing/Removal of children from school/Other
- How will you earn additional income from sex work? Have more clients/ Doing more sexual acts/ Increase the price per sex act
- How will you manage to raise the price? Spend the night/ Having more oral sex/ Having more anal sex/ Having more unprotected sex/ Accepting riskier clients/ Other
- Have there been any other unexpected major medical expenses in the last 30 days? Yes/no
- What was their total amount? (amount in FCFA)
- When was the second most recent expense? (date)

Economic shocks - Eviction

You have indicated that you have been evicted from your home in the last month. If you have been evicted more than once in the past month, please consider the most recent eviction.

- When were you evicted? (date)
- What was the reason for your eviction? Sex work in the home/ The landlord found out that you were a sex worker (but not working from home)/ Other reason
- If other, please specify (text)
- What was the total cost of the eviction? (amount in FCFA)
- To what extent was this expense anticipated? Unpredictable/ Pretty predictable/ Fully predictable

- To what extent did it impact on your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long after the eviction did, or will it take, for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- What is the main method of paying for these costs? Earning extra income through sex work / Earn more from another activity / Donation from a household member / Donation from a third party or friends /Donation from a regular client (not for sex work) /Help from family or friends for work (neither for sex work nor for giving money)/Government Donation /Donation from a non-governmental organization/Migrant remittances (outside Senegal) /Savings/Sale of capital/Borrowing/Removal of children from school/Other
- How will you earn additional income from sex work? Have more clients/ Doing more sexual acts/ Increase the price per sex act
- How will you manage to raise the price? Spend the night/ Having more oral sex/ Having more anal sex/ Having more unprotected sex/ Accepting riskier clients/ Other
- How many other times have you been evicted in the last 30 days? (number of times)
- How much did these other evictions cost in total? (amount in FCFA)

<u>Economic Shocks - Robbery</u>

You have indicated that you have been the victim of a robbery or burglary in the last 30 days. If you have been the victim of more than one robbery, please start with the most recent.

- When was the last robbery or burglary? (date)
- What was stolen? (text)
- Who was the thief? Client/ Policeman/ Other sex worker/ Someone else/Don't know
- What was the approximate value of everything that was stolen? (amount in FCFA)
- To what extent was the theft anticipated? Unpredictable/ Pretty predictable/ Fully predictable
- To what extent did it impact on your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long after the eviction did, or will it take, for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- What is the main method of coping with these losses? Earning extra income through sex work / Earn more from another activity / Donation from a household member / Donation from a third party or friends /Donation from a regular client (not for sex work) /Help from family or friends for work (neither for sex work nor for giving money)/Government Donation /Donation from a non-governmental organization/Migrant remittances (outside Senegal) /Savings/Sale of capital/Borrowing/Removal of children from school/Other
- How will you earn additional income from sex work? Have more clients/ Doing more sexual acts/ Increase the price per sex act
- How will you manage to raise the price? Spend the night/ Having more oral sex/ Having more anal sex/ Having more unprotected sex/ Accepting riskier clients/ Other
- How many other robberies, burglaries or criminal damage have you experienced in the past 30 days? (number of other robberies)
- What is the approximate total amount of thefts? (amount in FCFA)

<u>Economic Shocks - Major Donations Received</u>

You have indicated that you have received an unexpected gift or a substantial donation or a gift of at least one month's income. I am interested in the most recent of these gifts.

- When did you receive the gift? (date)
- What was the gift? (text)

- Who was the gift from? Grandparents/ Mother/ Father/ Spouse/ Children/ Brothers, sisters, brothers-in-law, sisters-in-law/ Cousins, uncles, aunts/ Other/ Nobody/ Don't know
- What was the value of the gift? (amount in FCFA)
- How much was the donation expected? Unpredictable/ Pretty predictable/ Fully predictable
- To what extent did the donation affect your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long did or will it take for your household to absorb this positive shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- Did the donation have an impact on your sex work? Have fewer clients/ Have more clients/ Fewer sexual acts/ Doing more sexual acts / Lower the price per sex act/ Increase the price per sex act/ No change in sex work
- Were there any other significant donations or gifts in the last 30 days? Yes/no
- How much did these other important gifts or donations add up to? (Amount in FCFA)

Economic Shocks - Death

You have indicated that a death has occurred in your family in the last 30 days.

- How many members of your family have died in the last 30 days? (number of family members)
- When did this first family member die? (date)
- When did this second family member die? (date)
- When did this third family member die? (date)

Please consider only the most recent death:

- What was the cause of death? (text)
- What was the total cost of the funeral and other ceremonial expenses? (amount in FCFA)
- Was the deceased a productive member of the household who contributed to the household income? Yes/no
- To what extent was the death anticipated? Unpredictable/ Pretty predictable/ Fully predictable
- To what extent did this death have an impact on your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long did, or will it take, for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- What is the main method of coping with these losses? Earning extra income through sex work / Earn more from another activity / Donation from a household member / Donation from a third party or friends /Donation from a regular client (not for sex work) /Help from family or friends for work (neither for sex work nor for giving money)/Government Donation /Donation from a non-governmental organization/Migrant remittances (outside Senegal) /Savings/Sale of capital/Borrowing/Removal of children from school/Other
- How will you earn additional income from sex work? Have more clients/ Doing more sexual acts/ Increase the price per sex act
- How will you manage to raise the price? Spend the night/ Having more oral sex/ Having more anal sex/ Having more unprotected sex/ Accepting riskier clients/ Other

Economic Shocks - Divorce

You indicated that you have been divorced within the last 30 days.

- When did the divorce take place? (date)

- How much did the divorce cost you? (amount in FCFA)
- To what extent were these costs anticipated? Unpredictable/ Pretty predictable/ Fully predictable
- To what extent did it affect your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long has it taken, or will it take, for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- Has this divorce had an impact on your sex work? Have fewer clients/ Have more clients/ Fewer sexual acts/ Doing more sexual acts / Lower the price per sex act/ Increase the price per sex act/ No change in sex work

__Economic Shocks - Bankruptcy__

You have indicated that you have been bankrupt or lost a job in the last 30 days. If you have lost more than one job in the past month, please consider the most recent job loss.

- When did this bankruptcy or job loss occur? (date)
- To what extent was the job loss or bankruptcy of the business anticipated? Unpredictable/ Pretty predictable/ Fully predictable
- To what extent did this event have an impact on your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long did, or will it take, for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- Did this job loss/bankruptcy have an impact on your sex work? Have fewer clients/ Have more clients/ Fewer sexual acts/ Doing more sexual acts / Lower the price per sex act/ Increase the price per sex act/ No change in sex work

__Economic shocks - New job__

You have indicated that you started a new job/business or professional activity within the last 30 days. Please tell us about the most recent one.

- When did this new job/business or professional activity start? (date)
- What is the new job / business / professional activity? (text)
- To what extent was the new job/business or professional activity planned? Unpredictable/ Pretty predictable/ Fully predictable
- How has this new source of income affected your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- Has this new job had an impact on your sex work? Have fewer clients/ Have more clients/ Fewer sexual acts/ Doing more sexual acts / Lower the price per sex act/ Increase the price per sex act/ No change in sex work

__Economic Shocks - Change in Transfers__

You have indicated that there have been changes in transfers received or sent by your household in the last 30 days.

- When did the change in remittances occur? (date)
- What happened to the household budget as a result of the change in remittances? Increase in household income/ decrease in household income
- To what extent was the change in remittances expected? Unpredictable/ Pretty predictable/ Fully predictable

__Economic shocks - Increase in income due to change in remittances__

- How much has your household income increased over the last 30 days compared to normal? (amount in FCFA)
- How has this increase in income affected your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long did or will it take for your household to absorb this positive shock to your household finances to return to normal? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- Has this increase in income had an impact on your sex work? Have fewer clients/ Have more clients/ Fewer sexual acts/ Doing more sexual acts / Lower the price per sex act/ Increase the price per sex act/ No change in sex work

Economic shocks - Decrease in income due to the change in remittances

- How much has your household income decreased in the last 30 days compared to normal? (amount in FCFA)
- How has this decrease in income affected your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long did or will it take for your household to get over this negative shock to your household finances to return to normal? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- What is the main method of coping with this drop in income? Earning extra income through sex work / Earn more from another activity / Donation from a household member / Donation from a third party or friends /Donation from a regular client (not for sex work) /Help from family or friends for work (neither for sex work nor for giving money)/Government Donation /Donation from a non-governmental organization/Migrant remittances (outside Senegal) /Savings/Sale of capital/Borrowing/Removal of children from school/Other
- How will you earn additional income from sex work? Have more clients/ Doing more sexual acts/ Increase the price per sex act
- How will you manage to raise the price? Spend the night/ Having more oral sex/ Having more anal sex/ Having more unprotected sex/ Accepting riskier clients/ Other

Economic shocks - Rising prices for basic necessities of life

You have indicated that there has been an increase in the price of food or other basic needs for your household in the last 30 days. Do not include the price of Tabaski animals but other food costs.

- When did this price increase occur? (date)
- What kind of goods have increased in price? (text)
- Approximately how much more did it cost you in the last 30 days? (amount in FCFA)
- To what extent was the price change expected? Unpredictable/ Pretty predictable/ Fully predictable
- How has this price change affected your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad
- How long did or will it take for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- Has this price increase had an impact on your sex work? Have fewer clients/ Have more cust omers/ Fewer sexual acts/ Doing more sexual acts / Lower the price per sex act/ Increase the price per sex act/ No change in sex work

Economic shocks - Price increases for basic necessities of life

You have indicated that there has been an increase in the price of food or other basic needs for your household in the last 30 days. Do not include the price of Tabaski animals but other food costs.

- When did this other shock occur? (date)
- What kind of goods did the other shock include? (text)
- Approximately how much more did it cost you in the last 30 days? (amount in FCFA)
- To what extent was the other shock expected? Unpredictable/ Pretty predictable/ Fully predictable
- How did this other shock affect your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad
- How long did or will it take for your household to overcome this negative shock? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months /Between 4 and 6 months/ More than 6 months /Don't know
- Did this other shock have an impact on your sex work? Have fewer clients/ Have more clients/ Fewer sexual acts/ Doing more sexual acts / Lower the price per sex act/ Increase the price per sex act/ No change in sex work

Module 7 - PrEP

PrEP Experiences

- Did you participate in the PrEP demonstration project in 2015-2016? Yes/no
- Are you currently on PrEP? Yes/no
- If yes, why are you getting PrEP? (text)
- If yes, how do you get PrEP? (text)

Subjective expectations about PrEP

READ: PrEP is a pill that can prevent HIV. To be effective, you need to take one pill a day. PrEP does not prevent sexually transmitted infections other than HIV. To be eligible for PrEP, you must test negative for HIV and have adequate kidney function, which requires a urine test. PrEP can cause mild side effects (nausea, diarrhoea, abdominal pain, headaches, etc.) but can also cause more serious side effects such as kidney failure or bone fragility. This is why regular follow-up visits to the clinic are necessary.

We would like to know your personal opinion on such a drug. There is no right or wrong answer.

To what extent do you agree with the following statements?

- I know what PrEP is. Strongly disagree/ Disagree/ All right, then/ I couldn't agree more/ Don't know
- I would be willing to take an HIV test and a urine test to determine if I am eligible for PrEP. Strongly disagree/ Disagree/ All right, then/ I couldn't agree more/ Don't know
- I'd be willing to take a pill every day. Strongly disagree/ Disagree/ All right, then/ I couldn't agree more/ Don't know
- I'd be afraid of the side effects that PrEP might have. Strongly disagree/ Disagree/ All right, then/ I couldn't agree more/ Don't know
- I think PrEP would greatly reduce the risk of getting HIV. Strongly disagree/ Disagree/ All right, then/ I couldn't agree more/ Don't know
- I would be willing to go to the health centre once a month to pick up the drugs. Strongly disagree/ Disagree/ All right, then/ I couldn't agree more/ Don't know

Module 8 - Care utilization and prevention

We will now turn to your relationship with the health care system.

Relationship with health care workers

- When you go to the health centre, do you feel that you are not respected by the health staff? Very often/ Often/ A few times/ Never

HIV Status

INVESTIGATOR: Be careful this question is delicate, be sure to ask it tactfully and ensure the FSW of the confidentiality of his answer.

- Are you HIV positive? Yes/no

Random List #1

I'm going to read you four sentences. I'm asking you to count how many of those sentences you agree with. You don't have to tell me which sentences you agree with, just how many sentences you agree with. To help you count the number of sentences you agree with, I am going to give you four marbles. Please place these marbles in your right hand and keep your hands behind your back. If you agree with the sentence I am reading, please transfer one marble from your right hand to your left hand. If you do not agree with this sentence, please do nothing. Once all the sentences have been read, you will tell me how many sentences you agree with. This number should correspond to the number of marbles you have in your left hand. I will now read those sentences.

1. It is safer to take the client home than to a hotel.
2. I used a condom the last time I had sex with a client.
3. I prefer the client to pay me before the act.
4. Monday is the day I have the most clients.

Can you tell me how many of these four sentences you agree with? (number 1 – 4)

Random List #1

I'm going to read you three sentences. I'm asking you to count how many of those sentences you agree with. You don't have to tell me which sentences you agree with, just how many sentences you agree with. To help you count the number of sentences you agree with, I will give you 3 marbles. Please place these marbles in your right hand and keep your hands behind your back. If you agree with the sentence I am reading, please transfer one marble from your right hand to your left hand. If you do not agree with this sentence, please do nothing. Once all the sentences have been read, you will tell me how many sentences you agree with. This number should correspond to the number of marbles you have in your left hand. I will now read those sentences.

1. It is safer to take the client home than to a hotel.
2. I prefer the client to pay me before the deed.
3. Monday is the day I have the most clients.

Can you tell me how many of these three sentences you agree with? (number 1 – 3)

Random list #2

I'm going to read you four sentences. I'm asking you to count how many of those sentences you agree with. You don't have to tell me which sentences you agree with, just how many sentences you agree with. To help you count the number of sentences you agree with, I am going to give you four marbles. Please place these marbles in your right hand and keep your hands behind your back. If you agree with the sentence I am reading, please transfer one marble from your right hand to your left hand. If you do not agree with this sentence, please do nothing. Once all the sentences have been read, you will tell me how many sentences you agree with. This number should correspond to the number of marbles you have in your left hand. I will now read those sentences.

1. The majority of my clients are Senegalese.
2. I used a condom the last time I had sex with a client.
3. I usually spend the whole night with the client
4. Most often I solicit clients by phone

Can you tell me how many of those four sentences you agree with? (number 1 – 4)

Random list #2

I'm going to read you three sentences. I'm asking you to count how many of those sentences you agree with. You don't have to tell me which sentences you agree with, just how many sentences you agree with. To help you count the number of sentences you agree with, I will give you 3 marbles. Please place these marbles in your right hand and keep your hands behind your back. If you agree with the sentence I am reading, please transfer one marble from your right hand to your left hand. If you do not agree with this sentence, please do nothing. Once all the sentences have been read, you will tell me how many sentences you agree with. This number should correspond to the number of marbles you have in your left hand. I will now read those sentences.

1. The majority of my clients are Senegalese.
2. Usually I spend the whole night with the client...
3. Most often I solicit clients by phone

Can you tell me how many of those three sentences you agree with? (number 1 – 3)

Module 9 - Subjective expectations regarding prevention behaviours

Subjective probabilities of STI infection

- What's the likelihood that you're HIV-positive today? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely
- What is the probability that you will be HIV positive in a year's time? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely

READ: The following questions are about HIV

- If you have UNPROTECTED SEX with an HIV-positive person, what is the likelihood that you too will become infected as a result of that sexual encounter? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely
- If you have PROTECTED SEX with an HIV-positive person, what is the likelihood that you too will become infected as a result of this report? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely
- If you have UNPROTECTED SEX with an HIV-positive person and you have a sexually transmitted disease, what is the likelihood that you too will become infected as a result of this sexual encounter? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely

READ: The following questions are about STIs other than HIV

- If you have UNPROTECTED SEX with a person who has an STI other than HIV, what is the likelihood that you will become infected with that STI as a result of that sexual encounter? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely
- If you have PROTECTED SEX with a person who has an STI other than HIV, what is the likelihood that you will become infected with that STI as a result of this sexual encounter? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely

Subjective probabilities of STI infection - Set A

- In your opinion, how much UNPROTECTED SEX with an HIV-positive person do you think you need to be sure you are HIV positive? (number of unprotected sexual encounters)

- How much PROTECTED SEX do you think you need to have with an HIV-positive person to be sure you are getting HIV? (number of protected sexual encounters)

Subjective probabilities of STI infection - Set B

- In your opinion, how many unprotected sexual encounters with a person who has an STI other than HIV before you are sure you have this STI? (number of unprotected sexual encounters)

- How many unprotected sexual encounters do you think you had with a person who has an STI other than HIV before you were sure you had that STI? (number of protected sexual encounters)

Subjective probabilities of STI infection - Set C

READ: Suppose you have an STI.

- How much UNPROTECTED SEX do you think you need to have with an HIV-positive person to be sure you are HIV positive? (number of unprotected sexual encounters)

- How much PROTECTED SEX do you think you need to have with an HIV-positive person to be sure you have HIV? (number of protected sexual encounters)

Subjective probabilities of COVID-19

READ: The following questions relate to the COVID-19 situation

- Imagine going to the hospital in the time of COVID-19. What is the likelihood that you would become infected with COVID-19 as a result? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely

- Imagine going shopping in a crowded market for 2 hours. What is the likelihood that you would become infected with COVID-19 as a result? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely
- If you were infected with COVID-19, what is the likelihood that you would be so seriously ill that you would need to be hospitalized? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely
- If you were infected with COVID-19, what is the likelihood that you would be so seriously ill that you would lose your life? Very unlikely/ Unlikely/ As likely as not likely /Probably /Very likely

Module 10 – Characteristics of sexual acts

READ: I'm now going to ask you about your last two sexual encounters with clients.

Last client

Please think about your LAST CLIENT:

- When was the last time you had sex with a client? (date)
- What time did you meet the client? (time)
- At what address did you meet the client? Bambilor/ Biscuiterie/ Camberene/ Daliford/ Diack Sao/ Diamaguene/Sicap M'Bao /Dieuppeul Derkle/ Djidah Thiaroye Kao/ Fann/Point E/ Amitie/ Golf Sud /Goree /Grand Dakar /Grand Yoff/ Gueule Tapee/Colobane/Fass/ Guinaw Rail Nord /Guinaw Rail Sud
- Hann/ Bel Air /Hlm/ Iles des Madeleines /Keur Massar/ Malika /Mbao/ Medina/ Medina /Gounass/ Parcelles Assainies/ Patte D'Oie/ Pikine Est/ Pikine Ouest/ Pikine Sud/ Plateau
- Mermoz/ Sacre -Coeur/ Ndiareme Limamoulaye/ Ngor/ Ouakam/ Sam Notaire/ Sicap Liberté/ Rufisque Est/ Rufisque Centre (Nord)/ Rufisque Ouest/ Tivaouane Peulh-Niagha /Thiaroye Gare/ Thiaroye Mer/ Wakhinane Nimzatt/ Yene/ Yeumbeul Nord/ Yeumbeul Sud/ Yoff/Don't know
- Where did you meet the client? Bars or nightclubs/ Brothel/ At home/ At the client's home/ Somewhere public/ Rented room/ Hotel/ Phone /Internet/ Other
- Where did the sexual intercourse take place? Bars or nightclubs/ Brothel/ At home/ At the client's home/ Somewhere public/ Rented room/ Hotel/ Other
- On that date, were you suffering from any of these symptoms? Lower abdominal pain/ Smelly vaginal discharge/ Burns during urination/ Wound or ulcer on genitals /Swelling in the groin/ Itching in the genital area/ Didn't have any STI symptoms

Last Client - Characteristics

- Was this client a casual client or a regular client? Occasional client/regular client
- How old was this client? (age)
- Was the client more handsome/ clean on him/her than average? Less handsome or clean/ As beautiful or clean/ More beautiful or clean
- Was the client richer than average? Less rich/ as rich/ richer
- What nationality was this client? Sénégal/ Other West African countries/ Other East African countries/ Toubab/ Lebanese/ Mauritanian/ Chinese/ Indian/ Arabic/ Other nationality
- On a scale of 0 to 10 do you think this client was a person at risk for AIDS? (scale 1 – 10)

Last client - Registration

- Does this client know your registration status? Yes/no
- Has this client asked you to show him your health record? Yes/no

Last Client – Alcohol

- Did you use alcohol or drugs before having sex with this client? Yes/no
- If yes, what did you use? (text)
- Had the client used alcohol or drugs? Yes/no
- If yes, what did he or she use? (text)

Last Client – Condom

- Did you use a condom during sex with your last client? Yes/no
- DON'T READ: Do you think FSW is telling the truth? Yes/no
- If yes, did you use double protection (or "double protec")? Yes/no
- If no, what was the MAIN reason? I trust my client/ I don't like the feel of condoms/ The client didn't want to use condoms/ There were no condoms available/ I want to get pregnant/ I was under the influence of alcohol/ I don't trust the condom/ To make more money/ Other
- Was it difficult to convince the client to use a condom? Yes/no
- Did you spend the night with this client? Yes/no
- How many sexual encounters have you had with this client? (number of sexual encounters)
- Did you use a condom each time you had sex? Yes/no
- DO NOT READ: Do you think that FSW is telling the truth? Yes/no
- Did you use double protection (or "double protection")? Yes/no

Last Client - Sexual Intercourse

- With this last client, did you have vaginal intercourse? Yes/no
- With this last client, did you have anal intercourse? Yes/no
- Did you perform fellatio on this client? Yes/no
- Was there more than one client present during this sexual intercourse? Yes/no
- How long did this intercourse last? (in minutes)
- What price did the client pay? (amount in FCFA)
- Was there a negotiation to arrive at that price? Yes/no
- Was there an intermediary (tour guide)? Yes/no
- Is there a fixed price in the area (locality)? Yes/no
- Did you receive payment before or after the relationship? Before/ after don't know, don't remember
- At the time of the sexual act, was there anyone in your household who was ill or injured? Yes/no

Last client – Chocs

- Which member of the household was sick or injured? Child/ Parent (father or mother)/ Brother or Sister/ Grandparent/ Other
- What was the illness or accident? (text)
- Please rate the severity of this illness No big deal at all/ Kind of serious/ Serious/ Very serious/ Extremely serious
- To what extent was this disease predicted? Unpredictable/ Pretty predictable/ Fully predictable
- How much does it cost to treat this person? (amount in FCFA)
- How has this expense affected your household finances? No impact/ Low impact/ Modest impact/ Wide impact/Very broad impact

- How long after this sexual act, how long will it take for your household finances to return to normal? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months/ Between 4 and 6 months/ More than 6 months

Last Client - Abuse

INVESTIGATOR: The following questions are sensitive. It is important that you remain neutral when asking them.

- Were you abused during this sexual act? Yes/no
- If yes, what kind of violence did you experience? Emotional or psychological/ Threats of physical or sexual violence/ Physical violence /Sexual Violence
- How many times have you been abused by this client in the last 3 months? (number of times)

Last Client - Other FSWs

- Does this client see other FSWs? Yes/no
- How many other FSWs do you think he sees? (number of FSWs)

Penultimate client

Please think about your PENULTIMATE CLIENT

- When was the second last time you had sex with a client? (date)
- What time did you meet the client? (time)
- At what address did you meet the client? Bambilor/ Biscuiterie/ Camberene/ Daliford/ Diack Sao/ Diamaguene/Sicap M'Bao /Dieuppeul Derkle/ Djidah Thiaroye Kao/ Fann/Point E/ Amitie/ Golf Sud /Goree /Grand Dakar /Grand Yoff/ Gueule Tapee/Colobane/Fass/ Guinaw Rail Nord /Guinaw Rail Sud
- Hann/ Bel Air /Hlm/ Iles des Madeleines /Keur Massar/ Malika /Mbao/ Medina/ Medina /Gounass/ Parcelles Assainies/ Patte D'Oie/ Pikine Est/ Pikine Ouest/ Pikine Sud/ Plateau
- Mermoz/ Sacre -Coeur/ Ndiareme Limamoulaye/ Ngor/ Ouakam/ Sam Notaire/ Sicap Liberté/ Rufisque Est/ Rufisque Centre (Nord)/ Rufisque Ouest/ Tivaouane Peulh-Niagha /Thiaroye Gare/ Thiaroye Mer/ Wakhinane Nimzatt/ Yene/ Yeumbeul Nord/ Yeumbeul Sud/ Yoff/Don't know
- Where did you meet the client? Bars or nightclubs/ Brothel/ At home/ At the client's home/ Somewhere public/ Rented room/ Hotel/ Phone /Internet/ Other
- Where did the sexual intercourse take place? Bars or nightclubs/ Brothel/ At home/ At the client's home/ Somewhere public/ Rented room/ Hotel/ Other
- On that date, were you suffering from any of these symptoms? Lower abdominal pain/ Smelly vaginal discharge/ Burns during urination/ Wound or ulcer on genitals /Swelling in the groin/ Itching in the genital area/ Didn't have any STI symptoms

Penultimate client – Characteristics

- Was this client a casual client or a regular client? Occasional client/regular client
- How old was this client? (age)
- Was the client more handsome/ clean on him/her than average? Less handsome or clean/ As beautiful or clean/ More beautiful or clean
- Was the client richer than average? Less rich/ As rich/ Richer
- What nationality was this client? Sénégal/ Other West African countries/ Other East African countries/ Toubab/ Lebanese/ Mauritanian/ Chinese/ Indian/ Arabic/ Other nationality
- On a scale of 0 to 10 do you think this client was a person at risk for AIDS? (scale 0 – 10)

Penultimate client – Registration

- Does this client know your registration status? Yes/no
- Has this client asked you to show him your health record? Yes/no

Penultimate client - Alcohol

- Did you use alcohol or drugs before having sex with this client? Yes/no
- If yes, what did you use? (text)
- Had the client used alcohol or drugs? Yes/no
- If yes, what did he or she use? (text)

Penultimate client - Condoms

- Did you use a condom during sex with this client? Yes/no
- DO NOT READ: Do you think FSW is telling the truth? Yes/no
- If yes, did you use double protection (or "double protec")? Yes/no
- If no, what was the MAIN reason? I trust my client/ I don't like the feel of condoms/ The client didn't want to use condoms/ There were no condoms available/ I want to get pregnant/ I was under the influence of alcohol/ I don't trust the condom/ To make more money/ Other
- Was it difficult to convince the client to use a condom? Yes/no
- Did you spend the night with this client? Yes/no
- How many sexual encounters have you had with this client? (number of sexual encounters)
- Did you use a condom each time you had sex? Yes/no
- DO NOT READ: Do you think that FSW is telling the truth? Yes/no
- If yes, did you use double protection (or "double protection")? Yes/no

Penultimate client – Sex act

- With this penultimate client, did you have vaginal intercourse? Yes/no
- With this penultimate client, did you have anal intercourse? Yes/no
- Did you perform fellatio on this penultimate client? Yes/no
- Were there more than one client during this sexual intercourse? Yes/no
- How long did the intercourse last? (in minutes)
- What price did the client pay? (amount in FCFA)
- Was there a negotiation to arrive at that price? Yes/no
- Was there an intermediary (tour guide)? Yes/no
- Is there a fixed price in the area (locality)? Yes/no
- Did you receive payment before or after the relationship? Before/after
- At the time of the sexual act, was there anyone in your household who was ill or injured? Yes/no
- Was this illness or injury the same as the illness or injury that affected the last sexual act? Yes/no

Penultimate client - Shocks

- Which member of the household was sick or injured? Child/ Parent (father or mother)/ Brother or Sister/ Grandparent/ Other

- What was the illness or accident? (text)
- Please rate the severity of this illness No big deal at all/ Kind of serious/ Serious/ Very serious/ Extremely serious
- To what extent was this disease predicted? Unpredictable/ pretty unpredictable/ fully predictable
- How much does it cost to treat this person? (amount in FCFA)
- How has this expense affected your household finances? No impact/ Low impact/ Modest impact/ Wide impact/ Very broad impact
- How long after this sexual act, how long will it take for your household finances to return to normal? No recovery required/ 1 or 2 days/ 3 to 7 days/ Between 1 and 2 weeks/ Between 2 weeks and 1 month/ Between 1 and 3 months/ Between 4 and 6 months/ More than 6 months/ Don't know

<u>Penultimate client - Violence</u>

INVESTIGATOR: The following questions are sensitive. It is important that you remain neutral when asking them.

- Were you abused during this sexual act? Yes/no
- If yes, what kind of violence did you experience? Emotional or psychological/ Threats of physical or sexual violence/ Physical violence/ Sexual Violence
- How many times have you been abused by this client in the last 3 months? (number of times)

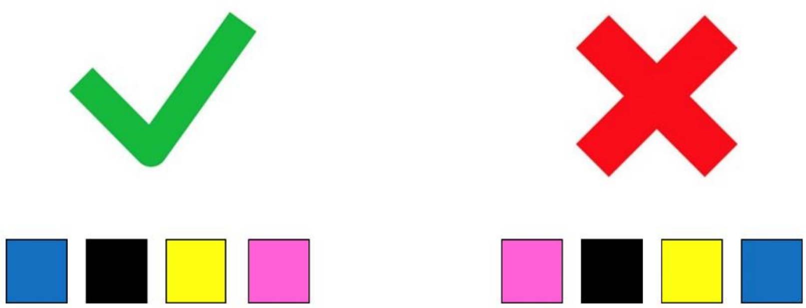
<u>Penultimate client – Other FSWs</u>

- Does this client see other FSWs? Yes/no
- How many other FSWs do you think he sees? (number of FSWs)

Module 15 – Colorbox

INSTRUCTIONS INVESTIGATOR: Place the box containing 10 envelopes on the table, which contain a card with two colour codes, one for 'yes' represented by the green tick pictogram and the other for 'no' represented by the red cross pictogram.

READ: In each envelope is a card on which there is a green tick pictogram meaning YES to the left of the card and a red cross pictogram meaning NO to the right of the card. Each 'yes'/'no' option is colour-coded. Each colour code contains four boxes.



I'm going to ask you a series of questions. You don't have to answer the question I'm going to ask you directly, but instead you have to give me the colour code corresponding to its answer. The colour code can contain the following four colours: blue, yellow, black, pink.

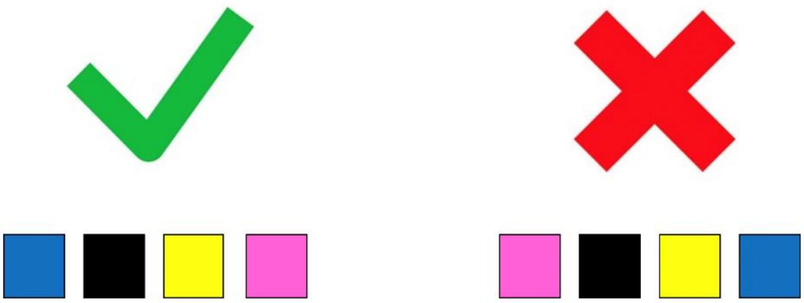
In this box there are 10 envelopes containing a card with a different color code for YES/NO. These cards have been printed and the envelopes have been sealed by someone else, so I don't know the meaning of the colour code you are going to give me. To make sure I don't see the answer, please hold the card so that I cannot see the colour codes and then keep this card with you when you leave the room.

- INVESTIGATOR: Does the participant know the colours (blue, yellow, black, pink)? Yes/no

Colorbox: Example

INVESTIGATOR READ: We'll start with a practice.

For example, if I ask you: "Were you born in Dakar?" and the card you pick contains the following colour codes:



- INVESTIGATOR READ: If you were born in Dakar, what colour code do you give me?

INVESTIGATOR: Check off the colors starting from left to right...

- Colour 1 (blue, yellow, black, pink)
- Colour 2 (blue, yellow, black, pink)
- Colour 3 (blue, yellow, black, pink)
- Colour 4 (blue, yellow, black, pink)

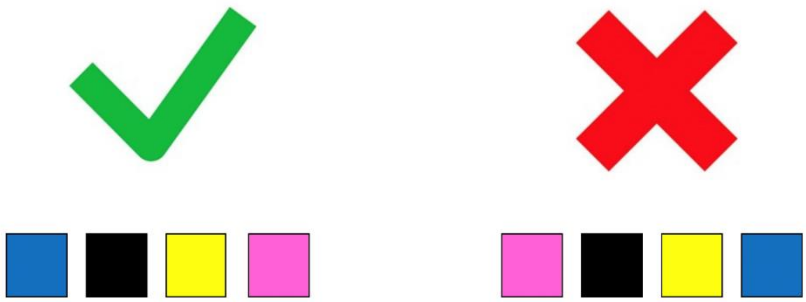
INVESTIGATOR: The respondent gave the wrong answer.

INVESTIGATOR, please explain again to the participant

INVESTIGATOR READ: a card on which there is a green tick pictogram meaning YES on the left side of the card and a red cross pictogram meaning NO on the right side of the card. Each 'yes'/'no' option is colour-coded. Each colour code contains four boxes. You don't have to answer the question I'm going to ask you directly, but instead you have to give me the colour code corresponding to its answer. The colour code can contain the following 4 colours: blue, yellow, black, pink.

Colorbox: Example 2

INVESTIGATOR READ: If you were not born in Dakar, what colour code do you give me?



- Colour 1 (blue, yellow, black, pink)
- Colour 2 (blue, yellow, black, pink)
- Colour 3 (blue, yellow, black, pink)
- Colour 4 (blue, yellow, black, pink)

INVESTIGATOR: The respondent gave the wrong answer.

INVESTIGATOR, please explain again to the participant

Colorbox: Condom with last client

INVESTIGATOR READ: Now, I'm going to ask you to answer some more questions. Please pick an envelope at random, open the envelope and keep the card out of my sight. Remember that I don't know the colour code on this card.

Did you use a condom during sex with your last client? If had multiple sexual encounters, refer to the last sexual encounter with that last client.

- Colour 1 (blue, yellow, black, pink)
- Colour 2 (blue, yellow, black, pink)
- Colour 3 (blue, yellow, black, pink)
- Colour 4 (blue, yellow, black, pink)

Colorbox: Seropositivity

INVESTIGATOR READ: Now, I'm going to ask you to answer another question. Please pick another envelope at random, open the envelope and keep the card out of my sight. Remember that I don't know the colour code on this card.

Are you HIV-positive?

- Colour 1 (blue, yellow, black, pink)
- Colour 2 (blue, yellow, black, pink)
- Colour 3 (blue, yellow, black, pink)
- Colour 4 (blue, yellow, black, pink)

Module 11 – Mental health and psychological variables

Satisfaction

For the following questions, please answer using the following scale:

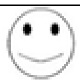
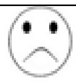
1	2	3	4	5
Not at all satisfied	Not satisfied	Neutral	Satisfied	Quite satisfied

How satisfied are you with your life?

- ... in general? (scale 1 – 5)
- ... as far as your income is concerned? (scale 1 – 5)
- ... with regard to your family life? (scale 1 – 5)
- ... with regard to your professional activity? (scale 1 – 5)
- ... with regard to your friendships? (scale 1 – 5)
- ... as far as your sentimental relations are concerned? (scale 1 – 5)
- ... with regard to your health? (scale 1 – 5)

Happiness and self-esteem

For the next question, please answer using the following scale:

				
5	4	3	2	1

- How happy are you in your life? (scale 1 – 5)
- Please indicate the extent to which the following statement applies to you. "I have high self-esteem." Not true of me/ Pretty much not true of me/ Neither true nor false/ Pretty much true of me/ Very true of me/ Don't know

Scale PHQ-9

In the past two weeks, how often have you been bothered by the following problems?

- Little interest or pleasure in doing things. Never/ Several days/ More than half of the time/ Almost every day
- Being sad, depressed or desperate. Never/ Several days/ More than half of the time/ Almost every day
- Difficulty falling asleep or staying asleep, or oversleeping. Never/ Several days/ More than half of the time/ Almost every day
- Feeling tired or lacking energy. Never/ Several days/ More than half of the time/ Almost every day
- Having little appetite or eating too much. Never/ Several days/ More than half of the time/ Almost every day
- Having a low opinion of oneself, or feeling like a loser, or having disappointed one's family, or having disappointed oneself. Never/ Several days/ More than half of the time/ Almost every day
- Having difficulty concentrating on daily activities, such as reading the newspaper or watching television. Never/ Several days/ More than half of the time/ Almost every day
- Moving or talking so slowly that others might have noticed, or on the contrary, being so agitated that you find it difficult to hold still compared to usual. Never/ Several days/ More than half of the time/ Almost every day
- Thinking that it would be better to die or consider hurting yourself in any way. Never/ Several days/ More than half of the time/ Almost every day

Personal Effectiveness

For the following questions, please answer using the following scale:

1	2	3	4
Strongly disagree	Disagree	All right. All right.	Strongly agree

Do you feel able to:

- ... resolve a situation of conflict with the police (scale 1 – 4)
- ... interact with aggressive clients (scale 1 – 4)
- ... deal with emergencies such as sudden illness (scale 1 – 4)
- Overall, I often feel powerless to deal with life's problems (scale 1 – 4)

Help from other FSWs

For the following questions, please answer using the following scale:

1	2	3	4
Strongly disagree	Disagree	All right. All right.	Strongly agree

Do you feel able to ask other FSWs for help with :

- ... resolve a situation of conflict with the police (scale 1 – 4)
- ... interact with aggressive clients (scale 1 – 4)
- ... deal with emergencies such as sudden illness (scale 1 – 4)
- Why don't you feel able to ask other FSW for help? They may want to help, but they're struggling with their own problems/ They won't want to help/ I don't usually like to ask others for help with my own problems/ They might want something in return /I'm not close enough to my relationships with other sex workers /I am physically alone when I am confronted with the problem /I don't trust them/ Other reason
- If other, please specify (text)

Religious beliefs

For the following questions, please answer using the following scale:

1	2	3	4
Strongly disagree	Disagree	All right. All right.	Strongly agree

- I believe God is protecting me (scale 1 – 4)
- The events of my life are determined by God (scale 1 – 4)
- I find strength and comfort in religion (scale 1 – 4)

Module 12 – Violence suffered

I will now turn to some sensitive issues relating to violence you may have suffered over the last 12 months.

In the last 12 months, have you ever been subjected to violence?

- from your CURRENT PARTNER? Yes/no
- If yes, what kind of violence have you experienced? Emotional or psychological/ Threats of physical or sexual violence/ Physical violence/ Sexual Violence
- from a CLIENT? Yes/no
- If yes, what type of violence have you experienced? Emotional or psychological/ Threats of physical or sexual violence/ Physical violence/ Sexual Violence
- from a POLICE OFFICER ? Yes/no
- If yes, what type of violence have you suffered? Emotional or psychological/ Threats of physical or sexual violence/ Physical violence/ Sexual Violence

- If you have been physically or sexually abused by a CLIENT have you reported it to the police? Yes/no

Module 14 – Membership of a health insurance scheme

READ: I'm now going to ask you about your health insurance...

- Do you currently have health insurance? Yes/no
- Does the insurance cover all members of your household? Yes/no

Module 17 – Altruism

Altruism - explanation

READ: This game is played by pairs of two people. Each pair consists of yourself and one other person: the receiver. In this game, you have been given a sum of money and have been asked how much of it you want to give to the receiver. The game is played with 2 different types of receivers. The first receiver is a talibé child and the second is a professional sex worker. After playing the game, we will give the money to an association that works with talibé children and to a professional sex worker. Therefore, as a player you don't know exactly who this person is, but we assure you that this person will receive the money sent by you for good, once the game is over. Moreover, these people will only receive your money, that is to say that the money given by the other players will go to other talibés and other sex professionals than those who will receive your money. Only the researcher and the investigator will know who will receive the money, because we are the ones who will give it to them.

So there are two parts to this game. For each part of this game, we will give you 1,000 CFA francs in 50 franc coins, in other words you will receive a total of 2,000 CFA francs for both parts of the game. At each game, you will decide how much of the 1,000 CFA Francs you want to keep for yourself and how much you will give to the receiver. For example you can keep everything for yourself and the receiver will not receive anything. You can also give 100 CFA francs to the receiver and keep 900 CFA francs for yourself. If you give 500 CFA francs to the receiver, you will keep 500 CFA francs for yourself. You can also give more money to the receiver than you are going to keep for yourself. If you give 600 CFA francs, you will keep 400 CFA francs for yourself. If you give 800 CFA francs, you will keep 200 CFA francs for yourself. You may also wish to give all the money you have received to the recipient.

Do you have any questions about the game?

READ: We will now begin the game.

Altruism - Talibé

We'll start with the first catcher: the talibé.

We are going to hand out two envelopes, one of which contains 1,000 FCFA (in pieces of 50 FCFA).

Please leave in the envelope marked "Talibé" the amount you are willing to give to a talibé child.

Altruism - Sex worker - explanations

We're going to move on to the second receiver, a professional sex worker.

We're going to ask you to choose how much you would give to a FSW. We're going to ask you to make that choice three times. However, only one of your choices will actually be made. Specifically, at the end of the interview, we will draw lots if it is what you gave to the first, second or third FSW that will actually be given to a FSW. So you will keep the rest.

For example, imagine that you decide to give 100 CFA francs to the first FSW, 600 FCFA to the second FSW and 450 FCFA to the third FSW. If it is the second envelope that is drawn, then a FSW will receive 600 FCFA and you will keep 400 FCFA.

ENQUETEUR : ATTENTION. Be careful not to divulge the characteristics of the FSWs!

ENQUETEUR : GIVE THE 3 ENVELOPES WITH THE 1000 FCFA TO THE FSW.

INTERVIEWER: BE CAREFUL TO READ WHAT IS WRITTEN ON THE TABLET, THE ORDER OF THE DIFFERENT FSWS CHANGES FROM ONE RESPONDENT TO ANOTHER.

Altruism - Sex Worker - Envelope 1

INVESTIGATOR: Take the envelope n°1 and stick the post-it "FSW" on it.

INVESTIGATOR READ: "In the first envelope "For you" there is 1000 FCFA, place in envelope n°1 the amount you are willing to give to another FSW"

INVESTIGATOR: Place the first "For You" envelope and envelope #1 on the side and proceed to envelope #2.

Altruism - Sex Worker - Envelope 2

INVESTIGATOR: Take the envelope n°2 and stick the post-it "clandestine FSW" on it.

INVESTIGATOR READ: "In the second envelope "For you" there is 1000 FCFA, place in envelope n°2 the sum you are willing to give to another clandestine FSW"

INVESTIGATOR: Place the second "For You" envelope and envelope #2 on the side and proceed to envelope #3.

Altruism - Sex Worker - Envelope 3

INVESTIGATOR: Take the envelope n°3 and stick the post-it "official FSW" on it.

INVESTIGATOR READ: "In the third envelope "For you" there is 1000 FCFA, place in envelope n°3 the sum you are willing to give to another official FSW"

INVESTIGATOR: Place the third "For You" envelope and envelope #3 on the side

Altruism - Sex Worker - Envelope 1

INVESTIGATOR: Take the envelope n°1 and stick the post-it "FSW" on it.

INVESTIGATOR READ: "In the first envelope "For you" there is 1000 FCFA, place in envelope n°1 the amount you are ready to give to another FSW"

INVESTIGATOR: Place the first "For You" envelope and envelope #1 on the side and proceed to envelope #2.

Altruism - Sex Worker - Envelope 2

INVESTIGATOR: Take the envelope n°2 and stick the post-it "official FSW" on it.

INVESTIGATOR READ: "In the second envelope "For you" there is 1000 FCFA, place in envelope n°2 the sum you are ready to give to another official FSW"

INVESTIGATOR: Place the second "For You" envelope and envelope #2 on the side and proceed to envelope #3.

Altruism - Sex Worker - Envelope 3

INVESTIGATOR: Take the envelope n°3 and stick the post-it "clandestine FSW" on it.

INVESTIGATOR READ: "In the third envelope "For you" there is 1000 FCFA, place in envelope n°3 the sum you are willing to give to another clandestine FSW"

INVESTIGATOR: Place the third "For You" envelope and envelope #3 on the side

Altruism - Sex Worker - Envelope 1

INVESTIGATOR: Take the envelope n°1 and stick the post-it "official FSW" on it.

INVESTIGATOR READ: "In the first envelope "For you" there is 1000 FCFA, place in envelope n°1 the amount you are willing to give to another official FSW"

INVESTIGATOR: Place the first "For You" envelope and envelope #1 on the side and proceed to envelope #2.

Altruism - Sex Worker - Envelope 2

INVESTIGATOR: Take the envelope n°2 and stick the post-it "clandestine FSW" on it.

INVESTIGATOR READ: "In the second envelope "For you" there is 1000 FCFA, place in envelope n°2 the sum you are willing to give to another clandestine FSW"

INVESTIGATOR: Place the second "For You" envelope and envelope #2 on the side and proceed to envelope #3.

Altruism - Sex Worker - Envelope 3

INVESTIGATOR: Take the envelope n°3 and stick the post-it "FSW" on it.

INVESTIGATOR READ: "In the third envelope "For you" there is 1000 FCFA, place in envelope n°3 the sum you are ready to give to another FSW"

INVESTIGATOR: Place the third "For You" envelope and envelope #3 on the side

Altruism - Sex Worker - Envelope 1

INVESTIGATOR: Take the envelope n°1 and stick the post-it "clandestine FSW" on it.

INVESTIGATOR READ: "In the first envelope "For you" there is 1000 FCFA, place in envelope n°1 the sum you are willing to give to another clandestine FSW"

INVESTIGATOR: Place the first "For You" envelope and envelope #1 on the side and proceed to envelope #2.

Altruism - Sex Worker - Envelope 2

INVESTIGATOR: Take the envelope n°2 and stick the post-it "official FSW" on it.

INVESTIGATOR READ: "In the second envelope "For you" there is 1000 FCFA, place in envelope n°2 the sum you are ready to give to another official FSW"

INVESTIGATOR: Place the second "For You" envelope and envelope #2 on the side and proceed to envelope #3.

Altruism - Sex Worker - Envelope 3

INVESTIGATOR: Take the envelope n°3 and stick the post-it "FSW" on it.

INVESTIGATOR READ: "In the third envelope "For you" there is 1000 FCFA, place in envelope n°3 the sum you are ready to give to another FSW"

INVESTIGATOR: Place the third "For You" envelope and envelope #3 on the side

INVESTIGATOR READs: "At the end of the interview we'll draw lots to see which envelope will be handed out."

Module 16 – Risk aversion game

We now offer you to play an investment game that will allow you to earn money that will be paid to you at the end of the interview. With this game, you can win between 0 and 7500 FCFA. The amount you will earn depends on the decisions you will make.

Jeu Gneezy and Potters - winnings

You start the game with an amount of 3,000 CFA francs.

You have to decide which part of this amount (between 0 and 3000 FCFA) you want to invest in a business where : You have a one in two chance of losing the amount you have committed to the lottery (if you draw the orange ball with a cross) and a one in two chance of winning 2.5 times this amount (if you draw the orange ball).

Game explanation

For example, if you decided to put 1,000 FCFA into this business. Your winnings will amount to 2 000 FCFA if you lose - if you draw the orange ball with a cross (3000-1000). Your winnings will amount to 4 500 FCFA if you win - if you draw the orange ball (2000 + 2500). In other words, you are sure to keep the amount you don't invest but you can increase your earnings by investing in this business.

The table below shows some of the examples of winnings.

Choices	**Gains**	
Investment	Gain if orange ball with a cross	Gain if orange ball
3 000	0	7 500
2 500	500	6 750
2 000	1 000	6 000
1 500	1 500	5 250
1 000	2 000	4 500
500	2 500	3 750
0	3 000	3 000

Game ex1

First we're going to do a practice round so that you understand the game. You will then shoot one of four balls into a black bag. There are two orange balls and two orange balls with crosses. So there is an equal chance that you will shoot an orange ball or an orange ball with a cross.

- How much money would you like to commit to this game? 3000 FCFA/ 2500 FCFA/ 2000 FCFA/ 1500 FCFA / 1000 FCFA / 500 FCFA / 0 FCFA

INVESTIGATOR: Ask the respondent how much money he or she can win and the probability associated with each amount.

- On a scale from 0 to 100, how likely do you think it is that you will draw an orange ball / win the high amount? (scale 1 – 100)

- For those who don't say 50, INVESTIGATOR: Remind the SP that she will shoot a ball into the bag and that the probability of winning the amount does not depend on her expertise in the trade but that there is a 50/50 chance that she wins and a 50/50 chance that she loses because 2 out of 4 balls are winners.

READ: You will draw a ball from the black bag to see how much you would have won if it wasn't for the practice round.

- You have drawn one ball: orange ball with a cross/ orange ball

INVESTIGATOR: Ask the participant how much she would have won if it wasn't the practice round at all.

- Defer the amount indicated by the respondent (amount in FCFA)

If the amount does not match the amount she would have earned, automatically renew a second round of training.

- Do you understand the game or would you like us to do another round of training? Switch to the real game/ Redo a practice round

Game ex2

So we're going to do another practice run.

- How much money would you like to put into this game? 3000 FCFA/ 2500 FCFA/ 2000 FCFA/ 1500 FCFA / 1000 FCFA / 500 FCFA / 0 FCFA

INVESTIGATOR: Ask the respondent how much money they can win and the probability associated with each amount.

- On a scale from 0 to 100, what do you think is the probability that you will draw an orange ball / win the high amount? (scale 1 – 100)

READ: As before, you will draw a ball from the black bag to see how much you would have won if the game had been drawn and it was not the practice round.

- You have drawn one ball: orange ball with a cross/ orange ball

INVESTIGATOR: Ask the participant how much she would have won if it hadn't been a practice round at all.

- Defer the amount indicated by the respondent (amount in FCFA)

If the amount does not match the amount she would have earned, automatically renew a third round of training.

- Do you understand the game or would you like us to do another round of training? Switch to the real game/ Redo a practice round

Game ex3

So we're going to go for another round of training.

- How much money would you like to commit to this game?

3000 FCFA/ 2500 FCFA/ 2000 FCFA/ 1500 FCFA / 1000 FCFA / 500 FCFA / 0 FCFA

INVESTIGATOR: Ask the respondent how much money they can win and the probability associated with each amount.

- On a scale from 0 to 100, what do you think is the probability that you will draw an orange ball / win the high amount? (scale 1 – 100)

READ: As before, you will draw a ball from the black bag to see how much you would have won if the game had been drawn and it was not the practice round.

- You have drawn one ball: orange ball with a cross/ orange ball

Game choice

We will now move on to the **real game**.

- How much money would you like to put into this game? 3000 FCFA/ 2500 FCFA/ 2000 FCFA/ 1500 FCFA / 1000 FCFA / 500 FCFA / 0 FCFA
- On a scale from 0 to 100, how likely do you think it is that you will shoot an orange ball / win the high amount? (scale 1 – 100)

INVESTIGATOR: Remind the FSW that she is going to shoot a ball into the bag so the probability of winning the amount does not depend on her expertise in the trade but that there is a 50/50 chance that she wins and a 10/50 chance that she loses.

READ: You will now draw a ball in the black bag to see how much you will win.

- You have drawn one ball: orange ball with a cross/ orange ball
- Game wins (amount in FCFA)

INVESTIGATOR: note and announce how much the respondent has earned

READ: The interview is now over, we thank you for your time and we will give you the financial compensation that corresponds to the earnings of the different tasks.

Altruism - Donated Money

- Amount given to a talibé (amount in FCFA)

INVESTIGATOR: Please place one orange ball, one orange ball with a cross and one orange ball with a circle.

READ: We will now draw lots to see which FSW envelope will be distributed.

INVESTIGATOR: Please make the draw and indicate the ball that was drawn.

READ: The first envelope will be distributed

READ: The second envelope will be distributed

READ: The third envelope will be distributed

- INVESTIGATOR: Please indicate the amount that the FSW has put in the envelope n°1 (amount in FCFA)
- INVESTIGATOR: Please indicate the amount that the FSW has put in the envelope n°2 (amount in FCFA)
- INVESTIGATOR: Please indicate the amount that the FSW has put in envelope no. 3 (amount in FCFA)

READ: The first envelope will be distributed

READ: The second envelope will be distributed

READ: The third envelope will be distributed

- Amount actually given to another FSW (amount in FCFA)

Payment

- You've won ${jeu2_gain} FCFA in the experimental game
- You gave ${talibe} FCFA to a talibe child
- You gave ${sexworker} FCFA to another FSW
- FSW to receive ${payment2} FCFA

Module 18 – Medical record

- The participant: Has a file in the STI health centre/ Has a medical record at another STI health centre/ Has no medical records/ Has a medical file but the interview does not take place at the STI health centre

INVESTIGATOR: Please tell the supervisor that FSW has a medical record at the health centre. The information on the HIV test (date and result) must be sent by email with the FSW idx to Aurelia and Carole.

- Does the sex worker come monthly for visits? Monthly (12 times over the last 12 months)/ Frequently (more than 8 times over the last 12 months)/ Occasionally (between 7 and 6 times over the last 12 months)/ Rarely (less than 6 times over the last 12 months) /Information not indicated

Last HIV test

- A HIV test appears in the medical record. Yes/no

- Date of last visit where an HIV test was conducted (Date)
- HIV test result. Positive/negative

10.3 Appendix 3 – Ethics approvals

10.3.1 LSHTM approval for secondary data

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LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Observational / Interventions Research Ethics Committee

Mr Henry Cust
LSHTM

5 June 2020

Dear Henry,

Study Title: Economic Shocks and Risky Sexual Behaviours - Primary Data

LSHTM Ethics Ref: 21228

Thank you for responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Covering Letter	Henry Cust Upgrade Document	01/12/2019	1
Investigator CV	cv_aurélia	12/03/2020	1
Investigator CV	Curriculum Vitae 2020	12/03/2020	1
Information Sheet	Consent form	12/03/2020	1
Local Approval	Senegal Ethics	21/03/2020	1
Protocol / Proposal	Protocole_vague3_2020_v1.1	25/03/2020	2
Protocol / Proposal	Study Protocol Ethics v4	25/03/2020	1
Protocol / Proposal	Protocole_vague3_2020_clean_clarifications	20/05/2020	3
Information Sheet	Consent (inc LSHTM)	20/05/2020	2
Local Approval	Original Senegal ethics approval	20/05/2020	2
Local Approval	UCL ethics application 17341.001	20/05/2020	1
Covering Letter	Cover Letter	20/05/2020	1
Protocol / Proposal	QUESTIONNAIRE 2020_clarification_update II	21/05/2020	1
Covering Letter	Cover Letter II	28/05/2020	2
Covering Letter	Cover Letter III	01/06/2020	3
Covering Letter	Addendum_Update	01/06/2020	1
Covering Letter	Transfer of status	01/06/2020	1
Covering Letter	Cover Letter IV	05/06/2020	4
Covering Letter	Consent (inc LSHTM)_v3	05/06/2020	3

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

[redacted]

Professor Jimmy Whitworth
Chair

ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

10.3.2 LSHTM approval for primary data

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Observational / Interventions Research Ethics Committee

LSHTM

30 June 2021

Dear ,

Study Title: Economic Shocks and Risky Sexual Behaviours - Primary Data

LSHTM Ethics Ref: 21228- 1

Thank you for your letter responding to the *Observational* Committee's request for further information on the above amendment to research and submitting revised documentation.

The further information has been considered *on behalf of the Committee by the Chair*.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above amendment to research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval for the amendment having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Other	Protocole_vague3_2021_tracked	31/03/2021	1
Other	Qx 2021	31/03/2021	1
Local Approval	SNG ethics_FR_ENG	31/03/2021	1
Other	Qx 2021 v2	03/06/2021	2
Covering Letter	Amendment Cover Letter	18/06/2021	1

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

[redacted]

Chair

ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

Improving health worldwide

10.3.5 Senegal Approval

English Translation:

REPUBLIC OF SENEGAL **No 00000038**

MINISTRY OF HEALTH

AND SOCIAL ACTION **Dakar, 21 February 2020**

Attn:

Assistant Prof Aurélia Lépine

UCL

Subject: Ethical approval of your research project

Project number: SEN19/88

Project title: Optimizing the public health benefits of sex work regulation in Senegal

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On January 30 2020, the following members of the CNERS conducted an ethical and scientific review of the referenced protocol. Based on our review of the literature, we find that your research project meets the ethical and scientific standards set out in the regulatory system for health research.

- Pr Anta Tal DIA/President of the CNERS
- Pr Cheikh Mbacke LO/Ordre des chirurgiens-dentistes (Dentist Association)
- Pr Alioune DIEYE/Researchers/Immunologist
- Dr Aissatou TOUR/Researcher/IPD
- Dr Joseph MENDY/FMOP/UCAD
- Dr Djiby FAYE/Ordre des Pharmaciens (Pharmacy Association)
- Dr El Hadji Imbrahima TOURE/DPM/MSAS
- Dr Samba Cor SARR DR/DPRS/MSAS
- Dr Aldiouma DIALLO/Researcher/IRD
- Mme Yeya Birane WANE RADDHO
- Mme Ami Colle GUEYE/Islamic Institute of Dakar

A certificate of ethical and scientific approval which attests to the compliance of your research project with the ethics and science policy for health research is therefore issued as of February 17, 2019. We would like to remind you that, to ensure the validity of your ethics certificate for the duration of your project, you are responsible for producing, each year, an ongoing monitoring report accompanied by a request for an extension.

The next follow-up must be done no later than: **21 February 2021.**

An automatic reminder will be sent to you by email a few weeks before the expiry date of your certificate.

If changes are made to your project, you will have to introduce an amendment for project modification and obtain approval from CNERS before implementing these changes. Finally, when your project is completed, you will have to produce a final report.

Please note that under the Policy on Ethics and Science in Health Research, it is the responsibility of researchers to ensure that their research projects maintain ethical approval for the entire duration of the research and to inform CNERS of the completion of the research.

We wish you every success in the conduct of your research.

REPUBLIQUE DU SENEGAL
Un Peuple – Un But – Une Foi

MINISTERE DE LA SANTE
ET DE L'ACTION SOCIALE

CNERS
SENEGAL
Comité National d'Ethique
pour la Recherche en Santé

AVIS ETHIQUE ET SCIENTIFIQUE

La présente atteste que le projet de recherche décrit ci-dessous a fait l'objet d'une évaluation en matière d'éthique et scientifique de la recherche en santé et qu'il satisfait aux exigences de notre politique en cette matière.

Numéro du projet : SEN19/88

Titre du projet de recherche : Optimiser les bénéfices de santé publique de la réglementation du commerce du sexe au Sénégal

Chercheur principe :
Pr Aurélia Lépine
Université de Londres

Co chercheurs :
Pr Cheikh Tidiane Ndour
UCAD et DLSI

Date d'approbation du projet : 21 février 2020
Date d'entrée en vigueur du certificat : 21 février 2020
Date d'échéance du certificat : 20 février 2021

[redacted]

REPUBLIQUE DU SENEGAL
Un Peuple – Un But – Une Foi

N° 00000038 MSAS/DPRS/CNERS

MINISTERE DE LA SANTE
ET DE L'ACTION SOCIALE

Dakar, le 21 FEB 2020

CNERS
SENEGAL
Comité National d'Ethique pour la Recherche en Santé

A l'attention de :
Pr Aurélia Lépine
Université de Londres

Objet : Approbation éthique de votre projet de recherche

Numéro du projet : SEN19/88

Titre du projet de recherche : «Optimiser les bénéfices de santé publique de la réglementation du commerce du sexe au Sénégal »

Le 30 janvier 2020, les membres du CNERS dont les noms suivent ont procédé à l'évaluation éthique et scientifique du protocole visé en référence. Suivant l'examen de la documentation reçue, nous constatons que votre projet de recherche rencontre les normes éthiques et scientifiques définies dans le système réglementaire de la recherche en santé.

- Pr Anta Tal DIA/Présidente du CNERS
- Pr Cheikh Mbacké LO/Ordre des chirurgiens-dentistes
- Pr Alioune DIEYE/Enseignant chercheur/Immunologiste
- Dr Aïssatou TOURE/Chercheur/ IPD
- Dr Joseph MENDY/FMOP/UCAD
- Dr Djiby FAYE Ordre des Pharmaciens
- Dr El Hadji Ibrahima TOURE/DPM/MSAS
- Dr Samba Cor SARR DR/DPRS/MSAS
- Dr Aldiouma DIALLO/Chercheur/IRD
- Mme Yéya Birane WANE RADDHO
- Mme Ami Collé GUEYE/Institut Islamique de Dakar

Un certificat d'approbation éthique et scientifique qui atteste de la conformité de votre projet de recherche à la politique d'éthique et scientifique de la recherche en santé est par conséquent émis en date du 17 février 2019. Nous désirons vous rappeler que, pour assurer la validité de votre certificat d'éthique pendant toute la durée de votre projet, vous avez la

English Translation:

REPUBLIC OF SENEGAL **No 00000038**

MINISTRY OF HEALTH **Dakar, 21 February 2020**

AND SOCIAL ACTION

Attn:

Assistant Prof Aurélia Lépine

UCL

Subject: Ethical approval of your research project

Project number: SEN19/88

Project title: Optimizing the public health benefits of sex work regulation in Senegal

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The next follow-up must be done no later than: **21 February 2021.**

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Please note that under the Policy on Ethics and Science in Health Research, it is the responsibility of researchers to ensure that their research projects maintain ethical approval for the entire duration of the research and to inform CNERS of the completion of the research.

We wish you every success in the conduct of your research.

Original letter of approval to health facilities and access medical records

REPUBLIQUE DU SENEGAL
Un Peuple – Un But – Une Foi

MINISTERE DE LA SANTE
ET DE L'ACTION SOCIALE

Direction Générale de la Santé

Direction de la Lutte contre la Maladie

Division SIDA/IST

Le Chef de Division

DIVISION SIDA / IST
STOP SIDA
M.S.A.S - SENEGAL

00000038
N°.........................MSAS/DGS/DLM/DLSI

Dakar, le..17 FEV 2020..............................

Objet : Demande d'autorisation de collecte de données au niveau des Centres de Mbao, Rufisque, Pikine et Diamnadio

Dans le cadre du projet d'optimisation des bénéfices de santé publique de la réglementation du commerce du sexe au Sénégal, une enquête ciblant la cohorte active des professionnelles du sexe et déjà démarrée en 2015.

Cette année, en s'inscrivant dans la continuité University College London en collaboration avec la Division de Lutte contre le Sida et les IST va cibler les centres de santé Mbao, Rufisque, Pikine et Diamnadio.

Cette étude financée par le Medical Research Council au Royaume-Uni est une collaboration entre University College London et la Division de Lutte contre le Sida et les IST, département du Ministère de la Santé et de l'Action Sociale du Sénégal.

Dans cette optique, nous sollicitons l'autorisation de collecte des données au niveau des sites cités et un appui pour le bon déroulement de cette enquête.

Je vous prie Messieurs/ Mesdames les Chef de centre, l'expression de notre parfaite considération.

Professeur Cheikh Tidiane Ndour

[redacted]

- Médecin Chef District de Diamniadio
- Médecin Chef District de Mbao
- Médecin Chef District de Pikine
- Médecin Chef District de Rufisque

Translation FR to ENG - Letter of approval to access health facilities and medical records

Republic of Senegal

one people - one goal - one faith

Health Minister

and Social Action

Directorate General for Health

Disease Control Directorate

AIDS/STI Division

The Head of Division

Subject: Request for authorisation to collect data from the Mbao, Rufisque, Pikine and Diamandio centres

As part of the project to optimize the public health benefits of the regulation of sex work in Senegal, a survey targeting the active cohort of sex workers began in 2015.

This year, as part of the University College London continuum in collaboration with the Division of AIDS and STIs will target the Mbao, Rufisque, Pikine and Diamnadio health centres.

This study, initiated by the Medical Research Council in the United Kingdom, is a collaboration between University College London and the Division of AIDS and STIs, a department of the Senegalese Ministry of Health and Social Welfare.

In this regard, we were seeking permission to collect data at the sites mentioned and support for the proper conduct of the survey.

Please accept, ladies and gentlemen, the expression of our highest consideration.

Professor Cheikh Tidiane Ndour