Managing HIV Prevalence & High-Risk Sexual Behaviour: The Influence of Specific Social Determinants in Malawi

by

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An essay submitted to the Department of Economics in partial fulfillment

of the requirements for the degree of Master of Arts

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Kingston, Ontario, Canada

August, 2019

1 Abstract

The HIV epidemic has been driven by a combination of sociocultural, socioeconomic and health-related determinants. Over the years, there have been many biomedical advances in treatment aimed at controlling the spread of HIV infection in many countries. While the HIV vaccine is now reaching clinical trials, the majority of infected individuals living in underdeveloped countries still have limited access to treatment advances. As a result, there is a need to gain a deeper understanding of the social determinants involved in managing HIV prevalence to help improve the lives of those impacted by the disease. This research study assesses the influence that specific determinants had on contracting and managing the spread of infection in Malawi during the disease outbreak. The empirical section of the results begins by comparing factors contributing to individual's propensity to engage in risky behaviour and the likelihood to seek HIV testing across peak years of the epidemic. In addition, the final section of the results is motivated from the theoretical framework and the two prior empirical sections surrounding how the knowledge of learning your HIV status impacts behaviour in follow-up years – while controlling for specific demographics. The methodology used across the various models consists of standard OLS, a marginal effect analysis and an instrumental variable approach. The findings indicate that gender and regional effects played a vital role in Malawi during the epidemic on an individual's propensity to engage in risky behaviour. Additionally, the same determinants were significant for individuals seeking HIV testing during that time. The impact of social status, family-related effects and social relationships were also crucial factors for overall disease management during this turbulent time in Malawi.

2 Acknowledgements

Firstly, I would like to express my sincere gratitude to my advisor, Dr. Sumon Majumdar, for his constant support and guidance in helping me complete this research study.

I would like to thank Dr. Hans-Peter Kohler from the University of Pennsylvania for providing me the opportunity to explore the Malawi Longitudinal Study of Families and Health (MLSFH) survey. This unique data set has enriched my master's essay experience.

I wish to express my sincere thanks to my fellow graduate students for their constant motivation and encouragement. It takes a large support system to have success academically and I will always be grateful for their support during my pursuit of this degree. Additionally, I would like to thank all the professors at QED for providing me with the tools to succeed in my future career. Queen's is a fantastic place to be a graduate student and I will always cherish my time here.

Lastly, I am eternally grateful for my family for their unconditional love, endurance and encouragement throughout my academic career. They have been selfless in giving me the best of everything and I cannot thank them enough for their constant support over all these years.

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3 Introduction

3.1 Background Information: HIV Epidemic

This research study focuses on the time period surrounding the human immunodeficiency virus (HIV) epidemic in Malawi. The pinnacle of this epidemic was devastating for all those impacted by this new and unknown virus throughout the world. HIV is a particular virus that attacks cells that help the human body fight infection and is spread through human contact, most commonly occurring during unprotected sex. If left untreated, HIV can lead to acquired immunodeficiency syndrome (AIDS).[1] It is believed that HIV originated from different monkey species in West Africa during the 1930's through the transfer of blood while hunting. The virus found in the various monkey species known as simian immunodeficiency virus (SIV) was found to have become HIV through contact with humans.[2] The similarities between monkeys and humans allowed for the disease to be transmitted easily and made it difficult to accurately measure how many individuals were impacted by the disease prior to the 1980's.[3] Over the decades, the virus slowly spread across Africa and into other parts of the world becoming a global pandemic with more than 70 million people infected with the virus.[4] Moreover, the Sub-Saharan Africa (SSA) region was impacted the most by the resulting epidemic, containing approximately half of the infected population[5] – with the highest mortality rates occurring during the pinnacle years of the epidemic (1998-2010). Specifically, Malawi has been severely impacted by the HIV epidemic as the country has one of the highest HIV prevalence rates in the world.

Since the first case of AIDS was identified in May 1985, morbidity and mortality data continued to show a rapidly escalating epidemic – that impacted generations.[6] It has been estimated that approximately 2.1 million adults and children have died as a result of the disease – with the majority living in extreme poverty in the SSA region. Specifically, the poverty in Malawi has had many dimensions which contributed to the resulting HIV epidemic. The peak years of the epidemic were generalized – meaning it impacted high risk groups as well as the general population. The time period from 1998-2013 was described as the pinnacle of the HIV epidemic in the SSA region – where some individuals were infected with the disease – but almost everyone was impacted by the epidemic. Hence, nobody could escape a time that was devastating for both health and social implications.[7]

[1] "Overview: About HIV/AIDS", 2019
[2] Lovgreen,"HIV Originated with Monkeys", 2003
[3] "Origin of HIV/AIDS", 2018
[4] "Why the HIV Epidemic Is Not Over", 2019
[5] "Origin of HIV/AIDS", 2018
[6] Mwale,"HIV/AIDS in Malawi", 2002
[7] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015

3.2 Rationale of the Study

There has been a significant amount of contribution related to outcomes stemming from HIV infection in the SSA region. However, there has been little work surrounding what influenced the management of HIV prevalence and the associated sexual behaviour tendencies – due to data limitations.[8] High-risk sexual behaviour was an obvious concern throughout the disease epidemic in Malawi – with lack of sexual protection and an increase in sexual activity (number of partners) being prime contributors to contracting the virus. Furthermore, accounting for determinants of this type of sexual behaviour is critical in HIV prevention research in order to facilitate even more change in these underdeveloped countries. Hence, the motivation of this research seeks out the various social determinants that guided individuals towards their management of HIV prevalence and risky behaviour during the peak years of the HIV epidemic.

Throughout the epidemic, inconsistent condom use during sexual intercourse continued to pose as a health challenge. Generally, men of reproductive age in Malawi continued to be vulnerable to new HIV infection – due to their engagement in risky sexual behaviour. This influence was exacerbated by cultural beliefs, customs, varying demographics and lack of preventative measures.[9] In response, the Malawi health sector has been promoting different sexual and reproductive health campaigns to change and influence people's sexual behaviour which have laid the foundation for this research.

Over the years, the push for this increased awareness resulted in the promotion of HIV testing through voluntary counselling and testing (VCT) centres. This particular type of testing arose during the pinnacle years of the epidemic and typically involved two counselling sessions before and after treatment. VCT centres have become popular in many parts of Africa as a way for individuals to learn their HIV status. The data in this research study focuses on these particular centres for various regions in Malawi. Additionally, the amount of disease testing has increased in Malawi due to the introduction of antiretroviral therapy (ART) in 2008. This type of therapy was established as an alternative to treat the HIV virus through enhanced medical techniques. After the year 2008, the expansion of ART was embraced by the Government of Malawi – due to external funding that had a major impact on reducing mortality rates in the country. Furthermore, this type of disease management – when taken in the correct combination – prevented the growth/spread of HIV. Kohler (2015) states that ART impacted important life-cycle behaviours in the general population of Malawi such as investment in children, improved mental health, and increased agricultural productivity. Kohler (2015) notes that prior to the year 2008, the life expectancy of individuals living in Malawi was very low and the impor-

[8] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015
[9] Maonga, Gondwe, Machira, "Determinants of Risky Sexual Behaviour Among Youth in Malawi", 2018

tance of ART was extraordinary in reducing mortality rates as a result of the epidemic. According to Fedor, Kohler, Behrman (2012) there are many potential benefits of increased HIV testing – with the most obvious being the ability to provide information to individuals about their own health status – giving them control over their own prevention and treatment – ultimately reducing risky sexual behaviour.[10] This research study focuses on the time period leading up to the introduction of ART (2008) in an effort to further understand the impact that certain social determinants had on managing the spread of HIV infection.

Early diagnosis is key to successful treatment of HIV. During the epidemic, most infected individuals received and had access to health care services – but only as their symptoms became progressively worse. According to Alder Health Services, individuals who were unaware of their HIV status were three times more likely to transmit the virus compared to those who were aware of their HIV status – with these statistics being inflated in many underdeveloped countries. Furthermore, those individuals that were unaware of their HIV status were responsible for approximately 50% to 70% of new HIV infections – making testing for HIV crucial for longevity and quality of life. The HIV epidemic in Malawi has had a tremendous influence for all living in the country. Hence, understanding more about specific factors that led to the behavioural implications resulting from individual's learning their HIV status during the epidemic can further aid in the process towards increasing specific preventative measures today.

3.3 Objectives of the Study

Despite the existing sexual and reproductive health policies aimed at improving the health and well-being of people in Malawi, little is known about key factors that influenced individual's propensity to engage in high-risk sexual activity during the epidemic. The main motivation for this research paper surrounds the management of HIV prevalence and high-risk sexual behaviour in Malawi during the pinnacle years of the disease outbreak (2004-2006). The breakdown of this research study begins by describing prior literature which builds the foundation for the theoretical framework – and outlines the behavioural implications for respondents in the MLSFH. This framework is built from a microeconomic perspective and motivates the respondents likelihood of engaging in high-risk sexual behaviour and if the same respondents sought HIV testing during this time. This framework utilizes comparative statics to compare the respective utility levels gained from the decision to seek testing during the epidemic. These measures are compared with the findings in the empirical results section. In addition, this study improves upon prior research by measuring the effect of respondents in the survey learning their own HIV status on sexual behavioural change in follow-up years

[10] Fedor, Kohler, Behrman, "The Impact of Married Individuals Learning HIV Status in Malawi", 2012

of the survey. This specific section of the results is motivated from the two prior empirical sections and deepens the understanding of sexual risk management during the HIV epidemic in Malawi. This research study utilizes various econometric models which allow for a deeper insight into how this cohort managed HIV prevalence and high-risk sexual behaviour during a time of heightened mortality in Malawi.

4 Literature Review

4.1 Implications from Learning HIV Status

This research paper explores characteristics from that of Fedor, Kohler and Behrman (2012) who assessed the impact of learning HIV status on marital stability and sexual behaviour within marriage. The authors utilized a randomized experiment as part of the MLSFH and used a two stage least squares estimation method to estimate the casual relationship between HIV status and marital/sexual behaviour. The authors chose this estimation method due to the observed self-selection bias that is at play with individuals learning their HIV status. In order to correct for this bias, the authors instrumented with a distance variable along with a respective monetary incentive variable. The authors then used the predicted value from the first stage regression to obtain a more consistent estimator to represent an individual learning their HIV status. The results suggest that knowledge of HIV status does not impact the chances of divorce for either HIV negative or HIV positive respondents. Furthermore, among HIV positive respondents, the authors observed increased condom use with spouses, as well as, fewer sexual partners in the follow-up years. The results imply a response from learning HIV status that evokes protective behaviour against future risk of infection for respondents. The root of this study lies in the resulting implications of an individual learning their own HIV status and the corresponding sexual behaviour tendencies.[11] This research complements this study by utilizing the same survey (MLSFH) and the same respective time period throughout the epidemic prior to the introduction of ART (2008). The addition to this literature comes in the form of specifying models to assess the likelihood of an individual finding out their own HIV status and the demographic factors associated with the likelihood to engage in high-risk sexual activity during the epidemic. The variables used to specify the testing probability follow similar trends to that of Fedor, Kohler and Behrman (2012). Hence, marital status, region, education and sexual history are the primary focus for this research paper in establishing the incentive to seek early detection for the disease.

[11] Fedor, Kohler, Behrman, "The Impact of Married Individuals Learning HIV Status in Malawi", 2012

4.2 Measuring Sexual Behaviour in Malawi

There is a growing importance surrounding HIV testing in SSA countries. It is evident that during the time of the epidemic, increased awareness through preventative strategies reduced mortality rates and increased the quality of life for individual's living in these underdeveloped countries. Aside from mortality rates, it is clear that behavioural changes resulted from an individual's knowledge of their own HIV status. Additionally, a similar study by Delavande and Kohler (2016) looked at the impact of HIV testing on subjective expectations and risky behaviour in Malawi. The analysis documents several unexpected results surrounding the effect of learning not just your own HIV status but also learning your spouses HIV status. The results suggest that receiving an HIV-negative test implies higher subjective expectations about being HIV-positive after two years, and individuals tend to have larger prediction errors about their HIV status after learning their own state.[12] The findings expand on Fedor, Kohler and Behrman (2012) in that among married respondents, learning only the individuals own status increases risky behaviour, while learning both statuses decreases risky behaviour. Overall, the findings complement the previous literature in suggesting that if each spouse learns the HIV status of the other – this may be beneficial in reducing sexual risk that can lead to poor adult outcomes. While this study measures the surrounding implications of learning HIV status – this research paper expands on the two previous studies and controls for the overall propensity to test for HIV during the years prior to the introduction of ART (2008) using the MLSFH. Additionally, this research study differentiates how marital status played an important role in surviving the epidemic through early detection.

Despite the growing literature, it has proven difficult to empirically establish a relationship between sexual behaviour and disease prevalence – due to the data needed to address these questions. A study by Oster (2012) found little evidence that changes in high-risk sexual behaviour are correlated with HIV prevalence – but indicated some evidence that behaviour responds to disease likelihood among those with higher life expectancies[13] – which motivates some demographic variables used in this research study. In addition, a study by Anderson (2018) demonstrated that the legal origin colonized countries in the SSA region significantly determine current day female HIV rates as a result of specific common law practices – with no evidence of changes regarding high-risk sexual behaviour. Hence, women in these common law countries have lower bargaining power within the household and are less able to negotiate safe sex practices – making them more susceptible to contracting HIV.[14] The findings of this paper are consistent with gender inequality explaining much of its presence in the SSA region during the HIV epidemic. Furthermore, a study by Thornton (2008)

[12] Delavande, Kohler, "HIV/AIDS-Related Expectations and Risky Sexual Behaviour in Malawi.", 2016
[13] Oster, "HIV and Sexual Behaviour Change.", 2012
[14] Anderson, "Legal Origins and Female HIV.", 2018

investigated the impact of learning HIV test results on condom purchases and on the number of sexual partners – through a particular survey administered two months after the testing took place – which is a similar design to the survey used in this research paper. This study utilizes a similar dependent variable describing high-risk sexual behaviour, i.e number of sexual partners. Thornton's (2008) empirical results focused on individuals who expressed interest in HIV testing and makes use of exogenous variation introduced by the randomized incentives to pick up test results. The findings indicated that individuals who were informed of an HIV positive test result increased condom purchases – with no change in condom purchases observed for individuals who tested negative. The results found no impact of testing on a resulting change in respondents sexual behaviour.[15] A similar paper by Aureo, Shapira, & Todd (2014) used a similar data set to that of Thornton (2008) – but with a larger sample. The authors make use of an additional survey year gathered after the testing took place (2006). Aureo, Shapira, & Todd (2014) found that individuals who revised their beliefs on their own HIV positive status reduced their sexual activity – but do not modify their usage of condoms.[16] This study had similar findings to that of Coates (2008) who documented significant reductions in sexual activity among those who tested negative using randomized trials in Kenya, Tanzania and Trinidad.[17]

4.3 The Relevance of Antiretroviral Therapy (ART)

The MLSFH survey documents a turbulent time in Malawi surrounding the HIV epidemic. The prevalence of the disease was widespread with many individuals receiving little to no treatment in many SSA countries. Without treatment, HIV advances in stages. The three stages include; (1) acute HIV infection, (2) clinical latency and (3) AIDS. Furthermore, ART was developed in 2008 to utilize and increase awareness of HIV medicine to treat HIV infection. This type of therapy does not cure the virus but does reduce growth and spread of the infection. Hence, the drugs are usually used in combinations of three or more drugs from a class known as combination therapy. A study by Tomita, Garret & Werner (2014) addressed the impact of ART on health-related quality of life among South African women. The authors state that concerns are often raised regarding potential adverse effects of ART on longevity of human life. The authors assessed this status using five sub-domains; physical well-being, emotional well-being, functional and global well-being, social well-being, and cognitive functioning. The methodology consisted of an adjusted mixed-effects model since the introduction of ART with explanatory variables: age, gender, education, knowledge of HIV status, marital status and BMI class. This type of statistical model utilized both fixed and random effects and is useful in

[15] Thornton,"The Demand and Impact of Learning HIV Status.", 2008
[16] Aureo, Shapira, Todd,"How Beliefs About HIV Status Affect Risky Behaviours: Evidence from Malawi.", 2014
[17] Coates, "Behavioural Strategies to Reduce HIV Transmission.", 2008

a wide variety of disciplines.[18] The authors findings are consistent with other quality of life studies that detected positive treatment outcomes in physical, emotional/mental and social well-being. Moreover, some studies do raise concerns over potential negative consequences of ART such as possible short-term reactionary effects from the treatment. However, the authors did not detect any detrimental negative impacts of ART on overall quality of life for South-African women. This research utilizes similar explanatory variables such as: educational level, gender, and social standing in Malawi. The contribution to the literature comes from looking at a specific country (Malawi) before the introduction of ART (2008) in an effort to distinguish the likelihood of engaging in high-risk sexual behaviour and the propensity to seek HIV testing during the epidemic.

In addition, a study by McGrath, Eaton, & Tanser (2013) reported trends in sexual behaviour indicators for men aged 17-54 years and women aged 17-49 years in South Africa – based on annual surveys during ART scale-up from 2005 to 2011. The authors utilized data from generalized epidemic settings and found no evidence of increased sexual risk-taking following ART availability – suggesting that general trends in sexual behaviour were not counter-acting preventative effects of HIV treatment.[19] However, the authors note that the promotion of VCT centres and ART substantially increased knowledge of HIV status among both sexes in South Africa. A similar study by Sheer, Kakowa & Chawira (2007) found an effect of sexual behaviour that is specific to VCT centre uptakes in rural Zimbabwe – similar to that of Delavande & Kohler (2012).[20] However, the analysis by McGrath, Eaton, & Tanser (2013) does not assess causal relationships between learning an individual's HIV status and sexual behaviour – which motivates the methods used in this research study. The authors found condom use with a regular partner slightly higher amongst those who knew their HIV status, but the suggested increase in reported condom usage also occurred amongst those who did not know their status – implying that changes were not solely based on individuals in rural Zimbabwe learning their HIV status.

4.4 Demand for Learning HIV Status

It has been documented that previous studies have attempted to measure not just the knowledge surrounding HIV status – but the demand for learning their own disease status. Thornton (2008) evaluated this concept using an experiment in which individuals in rural Malawi were randomly assigned monetary incentives to learn their HIV results after being tested. The first portion of the experiment design involved offering these

[18] Tomita, Garrett, Werner,"Health-Related Quality of Life Dynamics of HIV-Positive South African Women.", 2014
[19] McGrath, Eaton, Tanser, "Sexual Behaviour in a Rural High HIV Prevalence South African Community.", 2013
[20] Sherr, Kakowa, Chawira, "Voluntary Counselling and Testing.", 2007

incentives to encourage respondents to obtain test results followed by specific costs to certain VCT centres (travel distance). The methodology consisted of OLS and specific binary choice models for the dependent variables of interest followed by a routine robustness check for consistency of the various estimators. The authors found that a monetary incentive of less than a tenth of a day's wage doubled the rate of result-seeking among the various respondents in rural Malawi. Additionally, the distance to a VCT centre from a respondent's home had a strong negative impact on result-seeking. The results indicate that HIV-positive individuals with a sexual partner who had obtained their test results exhibited a higher demand for condoms than those who had not received their results – suggesting the importance of increased awareness surrounding HIV testing.[21] This study is similar to that of Fedor, Kohler and Behrman (2012) who assessed the impact of learning HIV status on marital stability and sexual behaviour within marriage in Malawi. The authors utilized similar distance and monetary incentive instruments to reduce self-selection bias in their study.[22] The data used in this research study (MLSFH) contains similar variables surrounding VCT centres in three specific regions in Malawi (North, South, Central) prior to the introduction of ART (2008) – which are used to distinguish between the demographic factors involved in assessing the overall demand for testing during the epidemic.

A similar study by Obermeyer & Osborn (2016) looked specifically at the utilization of these testing centres – with a variety of social and behavioural evidence. The authors make the point as to how testing for HIV is the gateway to treatment, care and prevention. However, the use of testing globally is low – especially in underdeveloped countries. Hence, the majority of individuals living with HIV get testing and counselling only when they have already been diagnosed with advanced stages of the disease. The authors found that social factors in various countries related to clients attitudes and perceptions surrounding HIV testing during the epidemic in the SSA region. Specifically, the emotional connotations of HIV tests, gender differences, stigma and informal education.[23] Furthermore, this research study explores these various demographic factors by focusing on particular regions in Malawi during the epidemic – while measuring for the propensity to seek testing and engagement in high-risk sexual behaviour being the focal points of the research.

[21] Thornton,"The Demand and Impact of Learning HIV Status.", 2008
[22] Fedor, Kohler, Behrman, "The Impact of Married Individuals Learning HIV Status in Malawi", 2012
[23] Osborn, Obermeyer, "Understanding Client Satisfaction with HIV Testing and Counselling Services.", 2016

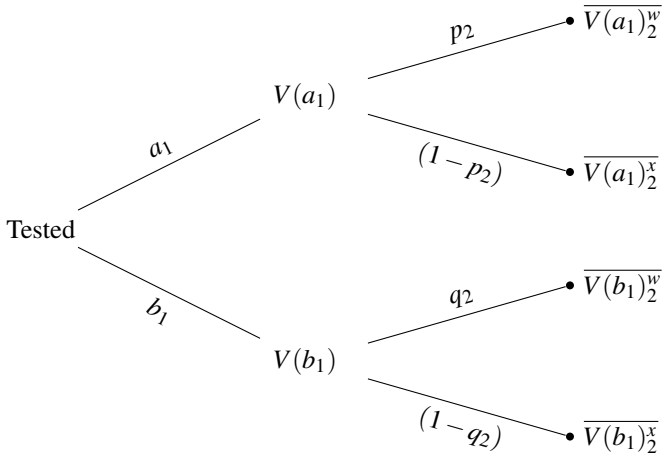
5 Model

5.1 Theoretical Framework: The Impact of Learning HIV Status on Changes in Sexual Behaviour

The motive for this framework uses an alternative perspective to that of Delavande and Kohler (2016) who measured HIV/AIDS expectations and high-risk sexual behaviour in Malawi. This framework formulates the first two baseline models in the empirical section – which is followed by a final model assessing the sexual behavioural change from learning one's HIV status – while controlling for additional social determinants. Hence, consider an individual in Malawi, i, who is living in the epidemic during two periods (2004-2006). Suppose we observe $r = c, n, s$ regions over $t = 1, 2$ periods prior to the introduction of ART (2008). There are $i = 1, ..., N_{rt}$ Malawian individuals in each region-period combination. In period 1, she can choose between two different actions – a_1: seeking HIV testing and b_1: not seeking HIV testing. Her period 1 utility depends on the immediate utility from testing, $V(a_1)$, associated with the action, a_1, versus the immediate utility from not testing, $V(b_1)$, associated with the action, b_1.

Furthermore, her period 2 utility, $\overline{V}$, depends on the optimal decision in period 1, in terms of deciding to seek testing at a VCT centre. Her utility, $\overline{V(a_1)_2^w}$, is generated from engaging in more sexual activity, w, based on the knowledge of learning her status, a_1, conditioned on the probability, p_2. Alternatively, her utility, $\overline{V(a_1)_2^x}$, is generated from engaging in less sexual activity, x, based on the knowledge of learning her status, a_1, conditioned on the probability, $(1 - p_2)$. Furthermore, the alternative utility measures are constructed with the same notion – but surround the optimal decision of not seeking testing, b_1, conditioned on the probability, q_2. For simplicity, the following figure outlines this proposed framework:

Figure 1: Implications of Testing on Sexual-Risk Management



In general, this model is constructed based on the notion of how a Malawian individual, i, changes her sexual behaviour based on the knowledge of finding out her HIV status in the prior period. Hence, her expected utility is as follows – assuming that the utility function depends on a random term, ε_t, that is unobservable and captures heterogeneity.[24] An individual, i, chooses a particular action that maximizes her lifetime expected utility from respective probabilities based on her decision in period 1, i.e., she solves the following problem according to the first equation:

$$\underset{a_t}{\text{maximize}} \quad V(a_t)[a_t + p_t + (1-p_t] + V(1-a_t)[(1-a_t) + q_t + (1-q_t)] + \varepsilon_t \tag{1}$$

In order to further motivate the empirics used in this research study, it is useful to consider the utility levels generated in period 2 from a more microeconomic perspective. These utility levels were constructed based on the association that individuals in Malawi were more prone to being sexually active with a spouse/sexual partner during the epidemic. Hence, the utility generated from a certain level of sexual activity, s, is as follows: $u(s) = \sqrt{s}$. However, this higher level of sexual activity increases the spread of infection to a spouse/partner with probability, $p(s)$, in each region in Malawi. As a result, a spouse/partner's utility if infected, W_1, or not infected, W_0, depends on the HIV status of their spouse/partner – making the optimality condition surrounding the decision to learn your HIV status vital, where $p_1 > p_0$. Therefore, an individual choosing whether or not to learn their status has a direct impact on their level of utility generated in period 2:

[24] Delavande, Kohler, "HIV/AIDS-Related Expectations and Risky Sexual Behaviour in Malawi.", 2016

$$\underset{s}{\text{maximize}} \quad 2\sqrt{s} + p_1 s W_1 + (1-p_1) s W_0 \equiv \overline{V(a_1)_2^w} \tag{2}$$

$$\underset{s}{\text{maximize}} \quad 2\sqrt{s} + q_1 s W_1 + (1-q_1) s W_0 \equiv \overline{V(b_1)_2^w} \tag{3}$$

The second equation represents an individual choosing to test and finding out they are HIV positive and the third equation represents an individual choosing to not seek HIV testing – both under the assumption that each individual will maximize their respective utility. These microeconomic foundations of each individual's utility in period 2 take into consideration the utility of the spouse/partner when determining the behavioural implications in the follow-up period. In addition, these equations are based on individuals being sexually active, w, in period 2. Furthermore, this framework provides the foundation to compare the utility levels generated in period 2 based on the cost of testing, c, and if this decision has an impact on the resulting propensity to engage in high-risk sexual behaviour. It is evident that this theoretical model has considered not just the utility of each individual but also their spouse/partner. In order to gain more insight regarding the implications for the various parameters used in this research study, the FOCs are obtained for each respective utility level generated in period 2. Hence, the respective FOCs are given by:

$$s = \left(\frac{-1}{p_1 w_1 + (1-p_1) w_0}\right)^2 \tag{4}$$

$$s = \left(\frac{-1}{q_1 w_1 + (1-q_1) w_0}\right)^2 \tag{5}$$

Now, inputting equations 4 and 5 into each respective utility function yields:

$$\overline{V(a_1)_2} = \left(\frac{-1}{p_1 w_1 + (1-p_1) w_0}\right)\left(2 + p_1\left(\frac{-1}{p_1 w_1 + (1-p_1) w_0}\right) w_1 + 1\right) \tag{6}$$

$$\overline{V(b_1)_2} = \left(\frac{-1}{q_1 w_1 + (1-q_1) w_0}\right)\left(2 + q_1\left(\frac{-1}{q_1 w_1 + (1-q_1) w_0}\right) w_1 + 1\right) \tag{7}$$

With reference to equations 6 and 7, it is evident that an individual's respective utility in period 2 from deciding to seek testing depends on exogenous factors such as: an individual's probability to commit sexual activity and their corresponding spouse/partner's utility based on their infection status during the epidemic. In order to further understand the underlying changes in the exogenous parameter, some underlying assumptions are made as follows: 1) The spouse/partner's utility is set to a positive value or zero based on the infection status, 2) The probability to commit the spread of infection with a spouse/partner, $p(s)$ is between 0 and 1, and 3) Assume $p_1 = q_1$. Furthermore, the various utility levels in Figure 1 were measured with the maximized

parameter, s, in order to distinguish the resulting utility generated in period 2. Moreover, it is determined that with a maximized exogenous parameter, s, the resulting level of utility is independent of whether or not your spouse/partner is infected due to sexual activity being optimized. Hence, the associated level of utility is still negative based on the optimality conditions being expressed in the above equations. While this framework is based on strict underlying assumptions, it useful to consider alternative factors from prior literature that likely influenced the management of HIV prevalence during the epidemic. Furthermore, this framework also controls for specific demographic factors associated with individuals choosing to engage in high-risk sexual behaviour, as well as, the propensity to seek HIV testing. The MLSFH allows for the documentation of follow-up interviews after visiting specific testing centres – which help to distinguish the empirical sections of this research study. Hence, the dependent variable is specified in period 2 based on prior period control variables:

$$\begin{aligned} \textit{Sexual Activity}_{r2} = \delta_0 + \textit{Gender}_r\delta_1 + \textit{Age}_r\delta_2 + \textit{Education}_{r1}\delta_3 + \textit{Wealth Quantile}_{r1}\delta_4 + \\ \textit{Family History}_{r1}\delta_5 + \textit{Marital Status}_{r1}\delta_6 + \textit{Tested HIV}_{r1}\delta_7 + \varepsilon_{rt} \end{aligned}$$

The resulting covariates were specifically chosen to help better understand how factors in the previous period influenced sexual behaviour in later years during the epidemic. This framework is under the assumption that individuals who sought testing would likely decrease high-risk sexual behaviour in the follow-up period. Additionally, societal factors are also controlled for to ensure overall accuracy in the model. However, there is an obvious self-selection bias surrounding the choice to seek HIV testing during the epidemic. Furthermore, to counteract this endogeneity issue, an instrument *Distance* is utilized for the variable, *Tested HIV*, in the first period, i.e:

$$\textit{Tested HIV}_{r1} = \beta_0 + \textit{Distance}_r\beta_1 + \varepsilon_{rt}$$

This same instrument was utilized in a 2SLS analysis in the study by Fedor, Kohler and Behrman (2012) who assessed the impact of learning HIV status on marital stability and sexual behaviour using the MLSFH. The purpose of this instrument is to reduce the likely measurement error that could have occurred as a result of individual's systematically lying about the propensity to seek HIV testing. Moreover, in order to first estimate this casual behavioural effect from one period to the next – it is essential to consider the impact of individual's, i, propensity to first engage in high-risk sexual behaviour and seek HIV testing in each respective period. The resulting empirics will then be used to motivate and compare the framework described above.

5.2 Baseline Model (1): High-Risk Sexual Behaviour

It is first useful to consider a baseline model of what prompted individuals to engage in high-risk sexual behaviour during the epidemic. This section begins by describing a baseline model of demographic factors that are assumed to have had an influence on risky behaviour in Malawi – based on prior literature with the MLSFH. There are $i = 1, ..., N_{rt}$ Malawian individuals in each region-period combination. This first model coincides with specific demographics that present the likelihood of engaging in high-risk sexual behaviour – at a time of heightened mortality rates. The conditional likelihood of committing increased high-risk sexual behaviour is as follows for each region-period combination :

$$\begin{aligned} \textit{Sexual Activity}_{rt} = \delta_0 + \textit{Gender}_{rt}\delta_1 + \textit{Age}_{rt}\delta_2 + \textit{Education}_{rt}\delta_3 + \textit{Wealth Quantile}_{rt}\delta_4 + \\ \textit{Family History}_{rt}\delta_5 + \textit{Marital Status}_{rt}\delta_6 + \varepsilon_{rt} \end{aligned}$$

An important goal of HIV prevention remains in reducing sexual risk behaviour. Hence, when constructing this baseline model, the dependent variable, *Sexual Activity*, is measured using the number of sexual partners in the MLSFH. In addition, this baseline model controls for other determinants likely to be correlated with an individual's propensity to engage in this sexual behaviour in each period. The variables $Gender_{rt}$ and Age_{rt} are used to measure the impact of being an older male on the likelihood of a unit increase in the number of sexual partners. In many underdeveloped countries, there is evidence of older males being more at risk for HIV infection. Hence, the purpose of controlling for these variables is to assess if the impact was the same in Malawi during varying years of the epidemic. Furthermore, the variables $Education_{rt}$ and $Wealth\ Quantile_{rt}$ are controlled for across the three distinct regions during the specified time periods in the baseline model. These demographic variables are utilized under the assumption that Malawian individuals with a higher social standing were less likely to engage in more risky sexual behaviour, i.e. less likely to contract HIV during the epidemic. It has been documented that HIV infection is confined to the poorest members of specific SSA countries where the consequences of poverty have been linked to higher rates of mortality. While education levels remain low, it is still useful to measure the impact of seeking higher education/wealth levels on the likelihood of engaging in less sexual activity. This model is under the assumption that varying degrees of education and wealth are not correlated due to the type of work that most Malawian individuals do for a living – which typically does not involve higher forms of education.

In addition, $Family\ History_{rt}$, is used to assess how relatives with HIV influenced overall behavioural trends during the epidemic. Although the effects of HIV on individuals who contract the disease have been relatively known for sometime – the understanding of the indirect effects on individuals within a family and

certain social settings have been less documented in the literature.[25] Hence, utilizing a variable that establishes a casual relationship between family history and potential sexual tendencies can help establish a better understanding of the sexual risk management during the HIV epidemic. The main assumption with this covariate is that having more relatives diagnosed with HIV likely decreased the amount of sexual activity. This is due to family members being less accessible when other family members were dealing with the infectious disease. Furthermore, the variable, $Marital\ Status_{rt}$, was also used to assess the impact of being non-married on the propensity to engage in high-risk sexual behaviour. The presence of divorce rates were extremely high during the HIV epidemic and measuring the impact of sexual activity from divorced individuals can help better understand the behavioural trends during a turbulent time in Malawi. In addition to this baseline model accounting for determinants of high-risk sexual behaviour, the next section will consider factors influencing the propensity to seek HIV testing – and establish a connection between the two baseline models – which motivates the entire theoretical framework.

5.3 Baseline Model (2): HIV Testing

The following model is an extension of section 5.2 with the variable, $Tested\ HIV_{rt}$, being the focal point across each respective region-period combination in Malawi. As the HIV epidemic progressed, the number of individuals who sought testing substantially increased. Thornton (2008) states that the rise in HIV testing was an effective preventative strategy and led to the development of ART. For example, in South Africa, government expenditures on counselling and testing increased from $2.4 million in 2000 to $17.3 million in 2004.[26] Hence, the impact of early detection was vital for longevity and was seen as a way to mange risky sexual behaviour. The final baseline model is as follows:

$$Tested\ HIV_{rt} = \delta_0 + Gender_{rt}\delta_1 + Age_{rt}\delta_2 + Education_{rt}\delta_3 + Wealth\ Quantile_{rt}\delta_4 + Family\ History_{rt}\delta_5 + Marital\ Status_{rt}\delta_6 + Sexual\ History\ *\ Distance_{rt}\delta_7 + \varepsilon_{rt}$$

The purpose behind utilizing the same covariates is to compare the casual relationships between high-risk sexual behaviour and the likelihood to seek testing in Malawi during the epidemic – with the same underlying assumptions described in 5.2. Furthermore, the addition of the interaction term surrounding *Sexual History* and *Distance* is under the assumption that an individual that had more sexual history and was not close to a testing centre likely played a role in them not seeking testing for the disease. These two models (5.2 & 5.3)

[25] Palloni, "Reproducing Inequalities.", 2006
[26] Thornton,"The Demand and Impact of Learning HIV Status.", 2008

form the basis for interpreting the general model (5.1) and contribute to the understanding of how finding out one's HIV status influenced behavioural changes in later periods.

6 Data

6.1 Malawi Longitudinal Study of Families and Health Survey (MLSFH)

The MLSFH is one of the few publicly available longitudinal cohort studies documenting a specific country in the SSA region during the pinnacle years of the HIV epidemic. The MLSFH respondents were selected as representatives of the rural population of Malawi (East Africa) during a time where the standards of living were low and nutritional needs of the majority of the population were not met.[27] The MLSFH is a collaboration of the University of Pennsylvania and the University of Malawi. The MLSFH is based in three regions of Malawi with each specific fraction of the popualtion being: Rumphi (1.29%), Mchinji (3.50%) and Balaka (2.42%).[28] In terms of HIV infection, the majority of rural areas in Malawi were impacted the most during the epidemic. For instance, pregnant women attending antenatal clinics in Blantyre, Malawi's largest city, saw infection rates rise from 2.6% in 1986 to over 30% in 1998 – and held similar trends throughout the epidemic in urban centres in Malawi.[29] The major data collection rounds took place in 1998, 2001, 2004, 2006, 2008 and 2010 for the same 4,000 respondents – with the initial sample established using a cluster random sampling strategy.[30] However, the data is limited after 2008 with many of the variables not defined. This research study focuses on the years 2004-2006, which are defined as the pinnacle years of the epidemic. For each subsequent survey year, follow up questions were designed to assess the quality of life for individuals living through the epidemic. For this purpose, the MLSFH maintained a respondent database across time periods before and after the introduction of ART and is still improving today.

In terms of weaknesses, the MLSFH does not have a nationally representative sample design due to the large costs associated with such a project. Moreover, the dataset only focuses on the three distinct regions in Malawi, implying that some urban areas where approximately 15% of the Malawi population lived were not reflected in the survey.[31] On the other hand, attrition is a concern regarding the MLSFH as it was difficult to track respondents due to mortality and volume – leading to questions surrounding topics that many respondents felt disrupted their own privacy. In an effort to reduce this bias, the covariates controlled

[27] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015
[28] "Population and Housing Census.", 2008
[29] Mwale,"HIV/AIDS in Malawi", 2002
[30] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015
[31] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015

for in this research study attempt to partial out the true effect of certain demographics. As a result, this motivates the final empirical section which focuses on the sexual behavioural implications from learning your HIV status in the prior period of study.

6.2 MLSFH Specifics

The MLSFH has measured and documented the health, social, economic and demographic context of the population living in Malawi across all rounds of the survey from the years 1998-2010. The structure of the survey consists of a main data-key and separate surveys for each follow up round. The seven rounds of the MLSFH provide longitudinal data on aspects such as: household structure, family change, human capital (health, schooling, nutritional status), social capital (social networks), HIV testing surveys, mortality documentation, and sexual diary questionnaires (sexual behaviour).[32] It is worth noting that the sexual diary questionnaires are separate from the original data-key. These diaries were also conducted face to face in an effort to account for more accurate results and reduce overall bias in the survey. In addition, the survey has been geocoded since 2004 and 2006 – with multiple modules involving probabilities for HIV and health-related outcomes that have been used in an array of studies. Furthermore, the MLSFH has also conducted repeated HIV testing and counselling (HTC) at respondent's homes – while keeping track of test results for each respondent. However, due to privacy constraints, the respondent ID's changed for each individual for each respective year – making it difficult to track each individual across time. Hence, the key HIV testing variable used for this respective analysis originates from each main survey from a random VCT centre in the three distinct regions of Malawi.

6.3 What has the MLSFH found?

The MLSFH has made several important contributions in areas related to social networks, HIV/AIDS, fertility/reproductive health, family dynamics, intergenerational relations, and religion.[33] The majority of these areas motivate this research study in terms of choosing proper covariates to assess how certain social determinants prevented the spread of HIV infection during the epidemic. Furthermore, the MLSFH is one of the few sources of longitudinal data in the SSA region to cover informal social interactions amongst a selective cohort. For instance, studies from Kohler and Watkins have shown that interactions surrounding the epidemic were a frequent topic of conversation regarding awareness of HIV testing and preventative

[32] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015
[33] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015

strategies. The authors were able to track and understand the relationship between spouses using categorical response variables – which are used in this research study. The authors note that the social interactions related to the epidemic were found to have important effects on HIV-related risk perceptions and behaviours in Malawi.

In addition, there has also been a variety of publications related to sexual behaviour and HIV prevention strategies. Although sexual behaviour generally declines with age, the MLSFH has shown that there has continued to be considerable levels of sexual activity and HIV infection risks among older Malawian adults. For instance, Freeman and Anglewicz (2012) measured the impact of the older generation on HIV prevalence. Their findings indicate that men's average number of sexual partners remained above one and HIV prevalence is significantly higher for men aged 50-64 (8.9%) than men aged 15-49 (4.1%). The authors state that this behavioural onset is likely to increase due to the accessibility towards antiretroviral treatment in the SSA region for the older population.[34] Furthermore, the MLSFH has also contributed to preventative strategies that women and men in rural Malawi were using to reduce their HIV infection risks,[35] with a focus on risk management – which motivates the methodology behind this research study.

7 Methodology

7.1 Data Segmentation

This research paper uses subsample years from 2004-2006 of the MLSFH before the introduction of ART (2008). The purpose of this data segmentation is to illustrate how certain demographic variables influenced respondents to seek HIV testing during a time when awareness and treatment implementation was limited – with the disease reaching its apex in terms of overall mortality. There is still no cure or effective vaccine for treating HIV, however, with the rapid scale up of ART this fatal disease has transformed to a manageable condition in many underdeveloped countries.[36] The initial process involved eliminating certain variables across the respective time period that didn't relate to social demographics, sexual behaviour or HIV status among the respondents. The focus interview years were recoded to represent the likelihood of seeking testing along with the propensity to engage in sexual behaviour. Furthermore, each interview year focuses on only individuals who completed the entire survey and was merged with a distance variable to the nearest VCT centre to reduce the self-selection bias in the MLSFH. In addition, this research study focuses on only individuals that were

[34] Freeman, Anglewicz, "HIV Prevalence and Sexual Behaviour at Older Ages in Rural Malawi.", 2012
[35] Goulder, Watkins, "HIV and SIV CTL Escape: Implications for Vaccine Design.", 2004
[36] Kharsany, Quarraisha, "HIV Infection and AIDS in SSA: Current Status, Challenges and Opportunities.", 2016

deemed sexually active in each period of the study. This segmentation was utilized to construct three models surrounding the propensity to engage in high-risk sexual behaviour, the likelihood to seek HIV testing and a comparison of how sexual tendencies changed from respondent's learning their HIV status in the prior year of the MLSFH.

7.2 Empirical Specifics

In order to analyze the variables of interest, the methodology consists of standard OLS, binary choice models and an instrumental variable approach covering the years prior to the introduction of ART (2004-2006). The specification for which model type is based on the various dependent variables used in the study – *Sexual Activity* and *Tested HIV*. The first section of the empirical results measures the propensity to engage in high-risk sexual behaviour across both periods using standard OLS. The purpose behind using both periods with the same covariates is to assess if there were any changes in terms of a respondent's, *Sexual Activity*, as the years approached the introduction of ART (2008). The variable, *Sexual Activity*, is a categorical response variable measuring the number of sexual partners at each respective follow-up year of the MLSFH. Additionally, the second section of the empirical results measures the likelihood to seek HIV testing in each period, i.e. *Tested HIV.* The follow-up period analyzes individuals who did not seek testing in the prior period to assess if there were any behavioural changes as the epidemic approached a time of heightened mortality. Specifically, this section of the results uses both standard OLS and a probit model – which follows a cumulative standard normal distribution (ϕ). This particular type of binary choice model is based on parametric assumptions surrounding the error term.

Due to the nature of the data provided in the MLSFH, the above-mentioned binary choice model was strategically chosen as it fits non-linear data in a better manner than a traditional OLS model. However, due to the strict assumptions addressed in a standard probit model – both the binary choice model and the standard OLS model are used as a robustness check for the second section of the empirical results. The majority of survey responses in the MLSFH are non-linear by nature. Furthermore, a probit model is estimated to assess the likelihood that a Malawian individual sought HIV testing at their nearest VCT centre during the epidemic. However, in assuming normality with the probit model, this creates heteroskedastic errors implying that the error terms do not have constant variance. As a result, a robustness check on the various models was run to ensure that the statistical inference holds under these different assumptions. To further increase the validity of the results, a marginal effects analysis was performed for the binary choice model. The purpose is to show the change in probabilities (coefficients) of the control variables with respect to a one-unit change in

the dependent variable. For further analysis, the output is displayed in a step-wise sequence to showcase the significance of each of the covariates along with an F-test to compare the model fit to the data set (MLSFH). For the second section of the results showcasing the likelihood to seek HIV testing – an interaction term was included in the models up to the year 2006. The purpose of including this interaction term is to gauge the varying risk management as a result of an individual deciding to seek HIV testing during the epidemic. Moreover, this baseline model includes a *Sexual History* variable and a *Distance* variable. This interaction term is constructed under the hypothesis that the relationship between the amount of sexual history on the likelihood to seek testing was different for varying distances to a VCT centre.

Lastly, the final section of the empirical results is motivated from the two prior baseline models. This section of the results measures the behavioural changes resulting from individuals learning their HIV status in the prior period using an instrumental variable approach. The main focus of this model stems from Fedor, Kohler and Behrman (2012) who assessed the impact of learning HIV status on marital stability and sexual behaviour within marriage in Malawi. The authors utilized a randomized experiment as part of the MLSFH and used a two stage least squares estimation method to estimate the casual relationship between HIV status and marital/sexual behaviour. The authors chose this estimation method due to the observed self-selection bias that is at play with individuals learning their HIV status. Furthermore, this section of the results uses the same underlying instrument to account for the endogeneity issue.

8 Summary Statistics

8.1 Standard Demographics

The first subset of demographics segments the respondents from 2004-2006 in Malawi for gender, age and region for those individuals that completed the main survey in the MLSFH. These key explanatory variables were merged from the data-key to each respective time period. While the specific factors determining the transmission of HIV from one individual to another are purely personal, this disease has become an epidemic due to factors that are much more complex. For instance, gender discrimination has been an issue throughout the HIV epidemic due to the lack of empowerment of women through prostitution and other various factors. According to Temah (2009), the risk of contamination from an infected man to an uninfected woman was three times greater than the risk of infection from an infected woman to an uninfected man.[37] Additionally, previous work by Freeman and Anglewicz (2012) measured the impact of HIV prevalence stemming from

[37] Temah, "What Drives HIV/AIDS Epidemic in Sub-Saharan Africa?", 2009

risky behaviour from older Malawian individuals. Hence, controlling for these demographic trends provides insight into what influenced sexual risk management throughout the epidemic.

Table 1: Standard Demographics (i)

Variables	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
2004 MLSFH	–	–	–	–	–
Gender	3,288	0.4555961	0.4981001	0	1
Age	3,232	1970.304	14.12374	1916	1991
Region	3,288	1.996655	0.8119437	1	3
2006 MLSFH	–	–	–	–	–
Gender	3,289	0.4551535	0.4980605	0	1
Age	3,259	1971.035	13.49298	1916	1993
Region	3,289	2.022499	0.8143211	1	3

With reference to Table 1, the observations are relatively consistent across the respective time periods. The variable, *Gender*, is coded as binary to represent Malawian adults being male (1) – with slightly more females surveyed. Furthermore, the variable, *Age*, was recoded to represent an ascending categorical variable from 1916 to 1993 across the respective time periods. For simplicity, this variable is segmented into three specific categories to indicate the specific age and further segment this demographic. Moreover, the variable, *Region*, is coded into three distinct dummy variables representing different areas in Malawi (Central, South, North). The majority of the respondents are from the central region of Malawi, which contains the national capital, Lilongwe – and was the most prone to HIV infection during the epidemic. This particular region borders neighbouring countries Zambia and Mozambique – with the main ethnic group being Chewa.

Furthermore, the next subset of demographics segments the respondents from 2004-2006 in Malawi based on education and wealth levels for those individuals that completed the main survey in the three distinct regions. These key explanatory variables were merged from the data-key to each main survey of the MLSFH. During the HIV epidemic, one of the key determinants of the virus was related to an individual's education level. At the beginning of the epidemic in the SSA region, the virus impacted people regardless of their education. However, Parker (2000) showcased that higher levels of education as the epidemic progressed exposed individuals to more infection – due to the higher socio-professional category that many of the individuals were involved in throughout Malawi.[38] Parker (2000) concluded that roughly 75% of people diagnosed with HIV in Brazil in the 1980's had secondary or university education, but by the early 1990's and onward this

[38]Temah, "What Drives HIV/AIDS Epidemic in Sub-Saharan Africa?", 2009

measure has fallen to approximately 30% of the population.[39] This declining result was likely a cause of educated people being more informed about prevention measures – ultimately causing a delayed response for many individuals to be sexually active based on educational needs – especially in regions where girls were sent into marriage as soon as they abandoned school.[40] Aside from educational purposes, the epidemic spread the fastest in poorer countries in the SSA region – due to income inequality. This type of inequality created a high-risk environment for all individuals in the country due to poor preventative measures. This difference in societal standing also created a rural division in many SSA regions – which motivates the regional covariates used in this research study. As a result, a country with a wider dispersion in their wealth quantile was more likely to have had a higher HIV prevalence rate due to a greater part of the population not having access to basic services. Hence, this research study utilizes these varying social determinants to measure how certain factors helped in the management of HIV infection as the epidemic grew closer to the introduction of ART.

Table 2: Standard Demographics (ii)

Variables	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
2004 MLSFH	–	–	–	–	–
Education	1,955	0.820872	0.383474	0	1
Wealth Quantile	2,447	1.797303	0.7498875	1	3
2006 MLSFH	–	–	–	–	–
Education	3,640	0.7601648	0.4270414	0	1
Wealth Quantile	2,959	1.798581	0.7459501	1	3

The variable, *Education*, in the MLSFH was coded from having: (1) No School, (2) Primary Education, (3) Secondary Education or (4) Higher. Primary school and secondary education is provided by the government with these schools providing a transition into higher education for a small percentage of the population in Malawi.[41] For most individuals in Malawi, primary education is the highest level of education they received during the epidemic. For simplicity, this variable was recoded as binary to test the exposure of education in the three distinct regions of Malawi. Malawi is one of the least developed countries in the world and education is proven as one of the critical pathways to improving living conditions in various countries – but little work has been documented surrounding the impact of education during the HIV epidemic.[42] The variable, *Wealth Quantile*, in the MLSFH was coded into five categories ranging from: (1) Poorest to

[39] Parker, Easton, Charles, "Structural Barriers and Facilitators in HIV Prevention: A Review of International Research.", 2000
[40] Temah, "What Drives HIV/AIDS Epidemic in Sub-Saharan Africa?", 2009
[41] "Ripple Africa", 2019
[42] "Education Facts in Malawi", 2019

Wealthiest (5). For ease of computation, this variable was recoded into three categories (33.33%) to represent specific portions of adult's annual wealth in Malawi for each respective survey round. The majority of the jobs in Malawi come in the form of manual labor within each respective family. Prior literature has shown a direct correlation between an individual's level of wealth and education. As evident in Table 3, there appears to be some correlation between education and wealth quantile at the 5% significance level. However, the specific correlation coefficients are not high enough to suggest a multicollinearity issue.

Table 3: Correlation Matrix

	Gender	*Education*	*Wealth Quantile*
2004 MLSFH	–	–	–
Gender	1.0000		
Education	-0.1072*	1.0000	
Wealth Quantile	-0.0028	-0.1332*	1.0000
2006 MLSFH	–	–	–
Gender	1.0000		
Education	0.1494*	1.0000	
Wealth Quantile	0.0005	0.2528*	1.0000

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

8.2 Sexual Behaviour & Family

Generally, men of reproductive age in Malawi continue to be vulnerable to new HIV infection and re-infection due to the engagement in high-risk sexual behaviour – including having sexual intercourse with multiple non-marital sexual partners.[43] With increased sexual activity and limited awareness surrounding HIV testing facilities, controlling for the variable, *Sexual History*, reduced bias in other covariates for determining the effect of individuals seeking testing during the epidemic. The variable is utilized in the second section of the results as part of an interaction term. For simplicity, this variable was coded as binary representing individuals having sexual intercourse frequently. With reference to Table 4, the average level of *Sexual History* decreased across consecutive periods of the study.

The MLSFH also allows for the documentation of various social networks throughout the duration of the HIV epidemic in Malawi. For the purpose of this research paper, an individual's, *Marital Status*, is one of the

[43] Maonga, Gondwe, Machira, "Determinants of Risky Behaviour Among Youth in Malawi.", 2018

focal points of the study – as described in the theoretical framework. Marriage is nearly universal in Malawi, divorce is common and remarriage is frequent across years. The interactions between husbands and wives were among the most important factors in surviving the epidemic. The design of the MLSFH allows for the ability to control for an individual's status across periods in order to assess how this status influenced sexual tendencies and the overall propensity to seek HIV testing.[44] The years prior to ART showcased the highest mortality rates in the epidemic which makes this period intriguing for how certain factors may have caused individuals to seek testing for the disease. Furthermore, the variable, *Marital Status*, in the MLSFH was coded as being: (1) Never Married, (2) Widowed, (3) Divorced, (4) Separated and (5) Married. In order to more accurately measure the perceived sexual tendencies arising from living in Malawi during the epidemic – the variable, *Marital Status*, was recoded to represent individual's being married with a spouse or non-married – which is composed of individual's who were never married, widowed, divorced or separated. This key covariate serves as a robustness check as it was measured across all waves of the survey to account for individual's changing their marital status at different points in time from the central data-key in the MLSFH.

Furthermore, family structure and relationships are a crucial component in an individuals overall quality of life in many underdeveloped countries – especially during the epidemic.[45] Hence, controlling for the variable, *Family History*, measures the likelihood of an individual seeking HIV testing based on their own family members being diagnosed with the disease throughout the peak years of the disease outbreak. The MLSFH provides measures of family and household structure from 2004 onward and the variable, *Family History*, was coded as the number of individual's diagnosed with HIV in a particular family. For ease of computation, this variable was recoded as follows: (0) No Family Members, (1) 1-4 Family Members, (2) 5-10 Family Members for each respective year.

[44] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015
[45] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015

Table 4: Sexual Behaviour & Family

Variables	Obs.	Mean	Std. Dev.	Min	Max
2004 MLSFH	–	–	–	–	–
Sexual History	1,947	0.8151002	0.388316	0	1
Marital Status	3,192	0.266291	0.4420873	0	1
Family History	1,919	0.5627931	0.6571113	0	2
Sexual Activity	1,955	0.7514066	0.6692484	0	2
2006 MLSFH	–	–	–	–	–
Sexual History	2,891	0.741266	0.4380149	0	1
Marital Status	3,289	0.190635	0.3928619	0	1
Family History	2,881	0.7042694	0.665634	0	2
Sexual Activity	2,892	1.150761	0.3626778	0	2

With reference to Table 4, the observations are relatively consistent for individuals in Malawi who completed the full survey for each year in the MLSFH. The variables *Sexual History* and *Family History* are lower due to the main survey in 2004 having less observations. However, the increasing trend in the variable, *Family History*, is perhaps reflecting the sinusoidal nature of individual's engaging in sexual activity during the epidemic – as living with a family member diagnosed with HIV likely influenced more precautionary measures.

8.3 HIV Testing & Risk Perceptions

Members of the MLSFH cohort have weathered through one of the greatest global health crisis of the 20^{th} and early 21^{st} century. The HIV epidemic in Malawi struck all regions with an immense amount of poverty and famine. As the members of the cohort grew older, they saw spouses, children and friends suffer and die.[46] It is evident that whether one became HIV positive or negative was dependent on whether one had access and took advantage of biomedical treatment in the form of VCT centres. Furthermore, this research study explores the fundamental determinants that influenced individuals to seek HIV treatment during that time. In addition, the final section of the empirical results documents how the knowledge of finding out your own HIV status influenced sexual tendencies. HIV testing is touted as a strategy for prevention as the majority of individual's infected with the virus during the epidemic did not know their status – making the knowledge of learning your status during this time crucial for longevity. The MLSFH allows for the documentation of

[46] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015

individuals across time periods who sought testing for the disease throughout varying rounds of the survey. The analysis took place prior to the introduction of ART (2008) as this period had the highest mortality rate and testing awareness was limited. Furthermore, the MLSFH contains distances in kilometres to the nearest VCT centres from each respondent's home.

Table 5: HIV/AIDS Testing Characteristics

Variables	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
2004 MLSFH	–	–	–	–	–
Tested HIV	1,955	0.2097187	0.4072119	0	1
Distance	3,287	1.951358	01.255553	0	5.191559
2006 MLSFH	–	–	–	–	–
Tested HIV	2,889	0.6237452	0.484529	0	1
Distance	2,819	1.92232	1.217194	0	5.191559

With reference to Table 5, the variable, *Distance*, has a maximum distance of approximately 5.20 kilometres in each of the three regions in Malawi. In addition, this variable is slightly decreasing across the respective years. For confidentiality reasons, the HIV testing that took place through the MLSFH made each respondent use a separate ID from the main survey. Hence, the analysis in this research study utilized testing that took place outside the main survey to a VCT centre of the respondent's choice. In order to reduce self selection bias and gain the true effect of specific covariates on the likelihood of an individual seeking HIV testing, the variable, *Distance*, was controlled for and used as an interaction term along with the variable, *Sexual History*, to gain a better understanding of the sexual tendencies that influenced Malawian individuals to explore medical treatment. In addition, this variable is used as an instrument in the final section of the empirical results. Furthermore, the variable, *Tested HIV*, was utilized across all periods for each respective main survey. The MLSFH documents this variable to gain a grasp of the propensity to seek testing during the pinnacle of the epidemic – where mortality was extremely high. It is interesting to note that as the epidemic approached the introduction of ART (2008), the average likelihood of individual's seeking HIV testing increased. This variable is coded as binary with (0) No and (1) Yes and is measured across the survey rounds as a form of a robustness check to account for any missed or gained observations during that time period.

9 Results

9.1 Propensity to Commit High-Risk Sexual Behaviour

The majority of HIV testing programs today in the SSA region aim to reduce risk-taking behaviours by providing individuals with information about their own status. This results section of the research study addresses the motive to commit risky sexual behaviour in Malawi – specifically assessing social determinant factors throughout the epidemic. The purpose behind these baseline models is to assess factors that influenced individuals to be more sexually active and seek to better understand if the underlying relationships were consistent with the propensity to seek HIV testing at a VCT centre (9.2). The most common pathway of infection in Malawi is in the form of heterosexual intercourse. There has been a vast improvement over the years in biomedical interventions to prevent HIV infections and in improving the quality of life for Malawian individuals who lived through the pinnacle of the epidemic. These specific interventions use a mix of clinical and medical approaches to reduce HIV transmission.[47] Moreover, to better understand associated factors that led to these interventions, it is important to understand why individuals who lived in high-risk environments engaged in those behaviours. Delavande & Kohler (2015) provided some interesting explanations into the reasoning behind these behaviours in Malawi. The authors state that differential preferences contributed to individuals in the SSA region possibly gaining higher utility from having more sexual partners – which motivates the theoretical framework in this research study. This argument is centred around the high burden of disease and the resulting high levels of non-HIV-related mortality – lowering the return of safe sex strategies. Furthermore, it is hoped that educating individuals about their own HIV status and about methods of avoiding transmission will lead them to take less risk concerning their own sex life for future generations.[48]

In order to address the likelihood to engage in high-risk sexual behaviour during the epidemic, Tables A and B (Appendix) aim to control for several social determinants outlined in section 8 of this research study – with the dependent variable being, *Sexual Activity*, measured through the number of sexual partners. This baseline model extends over two periods (2004-2006) as a robustness check and measures if the covariates changed as the period approached the introduction of ART in 2008. With reference to Tables A and B, the variable, *Gender*, is positive and statistically significant during the year 2004 implying that being a male in Malawi during the epidemic influenced the likelihood of engaging with more sexual partners by approximately 50%, with the addition of other covariates – aligning with the previous literature. Furthermore, similar findings in Table B suggest that being a male caused individuals to be at a higher risk for HIV infection in

[47] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015
[48] Aureo, Shapira, Todd, "How Beliefs About HIV Status Affect Risky Behaviours: Evidence from Malawi.", 2004

Malawi during the epidemic. These results align with Berhan (2015) who conducted a meta-analysis of risky sexual behaviour among individuals living in developing countries where the risk of HIV infection was high. The findings suggest that this behaviour was most prevalent among males who were rated as middle to high on the wealth index for being susceptible to HIV infection. These findings are consistent and lead to an interesting perspective on why some males are more prone to being more sexually active – via personality traits, genetic make-up, etc. It is evident that gender discrimination played an important role in an individual being more prone to contracting the virus during the epidemic. Additionally, these results differ from that of Berhan (2015) in terms of the variable, *Age*, for the year 2004 in Malawi – indicating that older males were more prone to engage in this behaviour. This variable was coded in segments, further justifying that middle-aged to older individuals were the most at risk. Berhan (2015) focused the study on younger individuals where the differences in being infected could have been found in the specific area being impacted by the disease outbreak.[49] Furthermore, when controlling for the variable, *Age*, during the year 2006, the coefficient is once again positive and statistically significant. This finding suggests that as the epidemic neared its peak in terms of mortality, older male individuals were more at risk by approximately 25% – holding all else constant. While the standard demographic variables *Gender* and *Age* had a clear influence in the likelihood of individuals engaging in high-risk sexual behaviour, the two regional variables *Northern Malawi* and *Central Malawi* are also controlled for to assess if there were any significant changes in terms of geographical trends during the epidemic. The third region (*Southern Malawi*) was used as a comparative measure for this analysis. The findings indicate that individuals living in these regions were less likely to commit high-risk sexual behaviour, with statistically significant negative coefficients – in comparison to the southern areas of the country. The southern region of Malawi consists of the capital city, Blantyre, making the area large and dense enough to be susceptible to contracting the disease. This area of Malawi had the most exposure during the time of epidemic, which explains why the other regions had more of an influence on managing risky behaviour in this SSA region. Hence, living in the northern or central area in Malawi decreased the likelihood of high-risk sexual activity by approximately 12% across both respective time periods – holding all else constant. It is worth mentioning that the percentage increased during the year 2006 when the areas were exposed to the highest levels of mortality – increasing the likelihood for all individuals living in the country.

In addition to the standard demographics, this results section also measures specific economic and societal factors that influenced the propensity to engage in risky sexual behaviour. For instance, the variable, *Wealth Quantile*, is controlled for and found to be negative and statistically significant in the year 2004.

[49] Berhan, "A Meta-Analysis of Risky Sexual Behaviour Among Male Youth in Developing Countries.", 2015

Hence, having a higher social standing in Malawi decreased the likelihood to engage in more sexual activity by approximately 7.0% – holding all else constant. This result is consistent with the assumptions made in the theoretical model surrounding extreme poverty and the correlation with higher HIV prevalence. It is clear that being higher on the wealth quantile decreased high-risk sexual behaviour that would have likely caused an individual to be more prone to contracting the disease during the outbreak. Furthermore, Berhan (2015) found similar results regarding younger male individuals in Africa being more prone to sexual activity based on their own wealth status at the time of the analysis. However, when controlling for, *Wealth Quantile*, in the year 2006, the sign of the coefficient changes to positive and statistically significant – while holding all other demographic factors constant. Hence, as the time period approached the introduction of ART, a higher degree of social standing did not reduce the likelihood of engaging in high-risk sexual behaviour. This finding goes against the assumptions made in the theoretical model. It is evident that the increased promotion of testing facilities influenced negative behaviour regarding wealthy individuals. Furthermore, this research study also addresses the variable, *Education*, for the respective years. The various education levels in the SSA region are much lower compared to how schooling is viewed in North America. For that reason, the correlation between the variables *Eduction* and *Wealth Quantile* is low due to the type of work in Malawi not involving higher education. The correlation between the variables was found to be -0.1332 units implying that multicollinearity between these variables is not an issue. Furthermore, the variable, *Education*, is found to be insignificant in this baseline model across both time periods. While schooling in Malawi has grown over recent years as a result of the overall upward trend of the economy, it is clear that during the peak of the epidemic, increased schooling could have been vital in changing overall risk management and quality of life for individuals during that time.

There is no denying that the cohort of the MLSFH weathered through one of the greatest global tragedies in the world – and the influence of being in a higher social class was key for managing risk during the epidemic. However, in order to further address key social determinants, this research study also focuses on social and family-specific effects – as evident in the theoretical framework. The variable, *Family History*, is controlled for and found to be positive and statistically significant across both years during the pinnacle of the disease outbreak. Hence, a unit increase in a family member having HIV corresponded to a 5.85% and a 4.50% increase in committing high-risk sexual behaviour at the 0.1% level – holding all else constant. It's worth mentioning that this coefficient is slightly lower as the years reached its peak in terms of mortality rates (2006). These findings are not consistent with the assumptions made in the theoretical model surrounding the external factors associated with having a family member contracted with the disease during the epidemic.

This result suggests that being surrounded by family members with the disease had a negative influence on an individual's overall environment. The level of the coefficient decreased in the year 2006 implying that the population in Malawi became more aware of the surrounding effects of the disease and engaged in less risky behaviour. Furthermore, the variable, *Marital Status*, is also utilized as a covariate from prior literature. The HIV epidemic has profoundly changed the nature of partnerships and marriage in the SSA region. As the epidemic spread from high-risk groups to the general population, individuals began to face substantial risk of infection from their spouses or cohabiting partners.[50] The evidence from rural Malawi indicates that married individuals were most worried about acquiring HIV from their spouse – who they believed to be a potential source of infection.[51] With regards to how *Marital Status* influenced sexual behaviour, this covariate is positive and statistically significant across both periods of the study. Hence, a unit increase in being divorced, corresponded on average to a 10% increase in the propensity to engage in high-risk sexual behaviour at the 1% and 0.1% levels – holding all else constant. This finding aligns with the assumptions made in the theoretical model in that the likelihood of an individual engaging in high-risk sexual behaviour increased for non-married individuals. As previously noted, most literature exploring marital status in the SSA region have implicitly assumed that emerging adults hold beliefs that are either positive or negative regarding marriage.[52] This research study took an alternative view and explored the influence of marital status on resulting outcomes in the varying aspects related to the HIV epidemic. In order to further validate the results, an F-test was conducted to assess the joint significance of having a higher social standing on the propensity to engage in high-risk sexual behaviour. Moreover, testing whether or not both *Wealth Quantile* and *Marital Status* are jointly significant, i.e:

$$H_0 : \beta_5 = 0, \beta_8 = 0$$

$$H_1 : \text{at least one is different from } 0$$

While the individual covariates are individual statistically significant, the calculated F-statistic (113.157) was greater than the estimated critical value – implying the rejection of the null hypothesis and conclusion of joint significance for the variables *Wealth Quantile* and *Marital Status* on the likelihood to engage in sexual activity during the epidemic – as well as improving the overall accuracy of this baseline model. For consistency, the same test was conducted for the survey closer to the introduction of ART (2008) and the results suggest that the null hypothesis is rejected as well – implying joint significance for the variables *Wealth Quantile* and *Marital Status* at a time of heightened mortality during the epidemic.

[50] Anglewicz, Reniers, "HIV Status, Gender, and Marriage Dynamics Among Adults in Rural Malawi.", 2014
[51] Anglewicz, Kohler, "Overestimating HIV Infection.", 2009
[52] Clark, Poulin, Kohler, "Marital Aspirations, Sexual Behaviours, and HIV/AIDS in Rural Malawi.", 2009

9.2 Propensity to Seek HIV Testing

This second empirical section explores the impact of certain social determinants on the likelihood to seek HIV testing during the peak years of the epidemic. The majority of the explanatory variables chosen for this respective analysis are found in similar documented studies using the MLSFH surrounding the main data-key for the years 2004 and 2006. The purpose of this section compares how the various factors differed with section 9.1 in terms of the propensity to commit high-risk sexual behaviour – and motivates the final section of the empirical analysis surrounding how the knowledge of HIV status altered behaviour. During the epidemic, one of the biggest obstacles in controlling the spread of HIV was that a substantial number of people living with the virus do not know they were infected with the disease. Malawi like other countries in the SSA region had been severely impacted by the epidemic – with approximately 850,000 people living with the virus prior to the introduction of ART. [53] The cause for concern during this time was the lack of testing centres and awareness surrounding the disease – making early detection vital for survival. The MLSFH allows for the documentation of various VCT centres throughout northern, southern and central Malawi which is the motive for this empirical section. For consistency, standard OLS and a marginal impact from a probit regression are utilized across the specified time periods to serve as a robustness check for the dependent variable, *Tested HIV*.

Furthermore, Tables C and D (Appendix) aim to control for several social determinants outlined in section 8 of this research study. This baseline model extends over time and measures how the varying covariates changed as the period approached the introduction of ART (2008) – where testing services increased substantially. The variable, *Gender*, is positive and statistically significant during the year 2004 implying that being a male in Malawi during the epidemic influenced the likelihood of seeking testing by approximately 7% across both models in comparison to being a female. This finding aligns with the results in the previous section (9.1) as more males were being sexually active during this period and were seeking more testing during this time – which corresponds with the assumptions in the theoretical framework and prior literature. Additionally, the variable, *Age*, is statistically insignificant – but the findings in 9.1 suggest otherwise. Hence, older individuals were engaging in more high-risk sexual behaviour but were less likely to seek preventative measures for the disease during the epidemic. However, as the period approached the year 2006, older individuals were more prone to seek testing – which is consistent with the marginal effects analysis. This finding implies that as preventative strategies increased, older individuals were more likely to seek HIV testing. Along with the basic standard demographics, the regional variables *Northern Malawi* and *Central Malawi* are also controlled

[53] Mwale, "HIV/AIDS in Malawi.", 2002

for in this model to compare the likelihood between high-risk sexual behaviour (9.1) and the propensity to seek HIV testing during the disease outbreak. The results suggest that individuals living in the central region were less likely to seek testing compared to the southern region by approximately 5% on average. This region also corresponded to less individuals being exposed to high-risk sexual behaviour. In particular, this region contains the capital city, Lilongwe, which makes up the majority of the population in the country. The greater number of individuals living in this region are among the most wealthy in the country which likely had an influence on individuals not requiring testing services – which is further validated by individuals in this area being less sexually active compared to the southern region. Furthermore, individuals in Malawi living in the northern region were approximately 12% more likely to seek testing during the epidemic, holding all else constant at the 0.1% level – but were less likely to engage in high-risk sexual behaviour. This finding aligns with the marginal effects analysis from the probit regressions. Hence, it is evident that location played an important role in an individual being more susceptible to preventative awareness strategies during this time in Malawi and likely contributed to infection survival rates.

The standard demographic factors have clearly played an important role in managing HIV prevalence and high-risk sexual behaviour during the epidemic. It is clear from the first section of the results that a higher social standing influenced individuals to be less susceptible to engage risky sexual behaviour. With reference to Tables C and D, the variable, *Wealth Quantile*, is statistically positive across both periods of the study for individuals living in Malawi. This finding suggests that individuals of a higher wealth standing during the epidemic were more prone to seek HIV testing. The economic inequality has worsened significantly in Malawi in recent years. In 2004, the richest 10% of Malawian individuals consumed 22 times more than the poorest 10% of the country. In addition, Malawi's Gini coefficient showed the extent to which robust economic growth was benefiting the wealthy.[54] As a result, the suspected findings from these two tables align with prior literature. A higher association of wealth likely created more accessibility towards basic services for preventing the disease. On the other hand, the variable, *Education*, was found to be negative and significant in the year 2004 – implying that a unit increase in education level corresponded on average to a 5.2% decrease in the propensity to seek HIV testing for the disease. Furthermore, the OLS and marginal effects from the probit regression align with the varying social determinants. This finding illustrates how even individuals with the highest level of education still did not seek testing or were not aware of their own status during this time. The lack of preventative strategies seemed to be a major contributor to the high mortality rates before the introduction of ART (2008).

[54] "Annual Report", 2015

The HIV epidemic has been recognized as a disease outbreak that has impacted not just individuals – but couples and families as well. This is not only because the disease was passed on from one person to another, but also because for every person infected with HIV, there was a family and community that was also impacted by the disease.[55] For instance, the previous section of the results (9.1) illustrates the casual behavioural implications from having more families diagnosed with the disease – ultimately leading to an increase in high-risk sexual behaviour – holding all other covariates constant. In addition, the findings in Tables C & D illustrate a positive and significant coefficient on the variable, *Family History*, across both respective periods during the epidemic. Hence, a unit increase in a family member living with the disease corresponded to a 4.3% on average increase in the likelihood that a Malawian individual would seek testing at a nearby clinic. The heightened rates of mortality at this time were detrimental and having a family member living with the disease prompted more individuals to seek testing – and as the time period approached the year 2006, this result rose by approximately 1.31%. Hence, it is clear that being associated with individuals living with HIV caused more engagement in risky behaviour – and prompted the same people to seek testing during this turbulent time in Malawi. These findings correspond with the underlying assumptions made in the theoretical framework surrounding family and disease likelihood. Furthermore, the variable, *Marital Status*, is positive and significant in the year 2004 for the propensity to seek HIV testing. This result suggests that an increase unit in being divorced implied a 14.7% increase in the likelihood of testing during the epidemic – which is consistent across both periods. Hence, the relationships between individuals clearly played a vital role in actions that led to a lower likelihood of contracting the disease.

It is clear that an individual's sexual activity was a prime contributor to contracting the disease. Moreover, early diagnosis of HIV and the advances in treatment have caused an increase in the quality of life for people in the SSA region. Furthermore, the interaction term *Sexual History * Distance* is utilized due to the possibility of varying degrees of testing that took place based on a unit increase in *Sexual History* and *Distance* to the nearest health clinic in Malawi. The coefficient for *Distance* is positive and significant for the year 2004 implying that distance played no role in individuals seeking testing but as the epidemic continued this coefficient became insignificant. Furthermore, the interaction term is positive and significant in the year 2006 suggesting that sexually active individuals living over a 5km radius from their nearest testing centre still decided to seek testing during the pinnacle period of the epidemic. This result provides an interesting insight into the motive for increased testing throughout Malawi. The period after the year 2008 was rapid in terms of the number of testing centres and having more accessibility would have clearly had an impact on individuals

[55] "HIV/AIDS", 2002

improving upon their own preventative strategies.

In order to further validate the results, an F-test was conducted for both respective years to test the joint significance of the variables *Wealth Quantile* and *Marital Status*. The purpose of this test was to assess the hypothesis that having a higher social standing in Malawi likely caused individuals to be more prone to seek preventative measures against the disease – and compare with the findings in 9.1. Furthermore, the calculated F-statistic (5.55337) was greater than the estimated critical value – implying the rejection of the null hypothesis and conclusion of joint significance for the variables *Wealth Quantile* and *Marital Status* on the propensity to seek HIV testing during the epidemic – as well as improving the overall accuracy of this baseline model. For consistency, the same test was conducted for the survey closer to the introduction of ART (2008) and the results suggest that the null hypothesis is rejected as well – implying joint significance for the respected variables. This result aligns with the test surrounding having a higher social standing and partnership on a higher likelihood to be more sexually active – but more prone to test for the disease during the outbreak.

In addition to assessing the impact of specific societal variables, an alternative F-test was utilized to determine the joint significance of past sexual behaviour on the likelihood of seeking testing during the epidemic. The following test controlled for regional variables and standard demographics to determine overall statistical accuracy. Furthermore, the calculated F-statistic (66.62295) was greater than the estimated critical value – indicative of the rejection of the null hypothesis and conclusion of joint significance between the variables: *Gender*, *Age*, *Northern Malawi*, *Central Malawi* and *Sexual History* in determining the role of the varying covariates on the likelihood to seek HIV testing during the epidemic. For consistency, the same test was conducted for the survey closer to the introduction of ART (2008) and the results suggest that the null hypothesis is rejected as well – implying joint significance for the respected variables. Hence, it is evident that individuals who were more likely to engage in sexual activity were less likely to commit testing which corresponds to the lack of prevention that was occurring during this time in Malawi. This result is further validated by the negative coefficient on the variable, *Sexual History*, in the year 2006 which was not expected in the theoretical framework.

9.3 The Impact of Learning HIV Status on Changes in Sexual Behaviour

The final section of the results is motivated from past literature assessing the behavioural implications from learning your own HIV status. The study by Fedor, Kohler and Behrman (2012) assessed the impact of learning HIV status on marital stability and sexual behaviour within marriage in Malawi from 2004-2008. This research utilizes similar characteristics but specifically looks at the time period prior to the introduction

of ART (2008) which was motivated from the prior two results sections (9.1 & 9.2). It is evident that standard demographics played a vital role in influencing individuals likelihood to commit high-risk sexual behaviour and seek HIV testing. Furthermore, social status also contributed to optimal disease prevention through early detection during the HIV epidemic. Moreover, in order to further assess the impact of the management of HIV prevalence, this section specifically looks at individuals who found out their HIV status in 2004 on the likelihood of commiting high-risk sexual behaviour in the follow-up period of study (2006) – while controlling for specific demographics as well. The MLSFH documents distances (km) from each respondent's home to the nearest VCT centre in each rural area of Malawi during the years of the epidemic. Fedor, Kohler and Behrman (2012) utilized this variable to reduce the obvious self-selection bias in the survey based on individuals learning their own HIV status. This same variable is used as an instrument in this research study along with the addition of specific social determinants used in the previous two results sections. This group of respondents in the three rural areas of Malawi are also measured on the basis for being sexually active during the two years of the epidemic (2004-2006). This decision was made to further reduce bias and attempt to solve the underlying endogeneity issue to ensure that individual's deciding to seek detection for the disease had proper justification – and to assess how the knowledge of learning their status changed their sexual tendencies.

The dependent variable in this model is, *Sexual Activity*, in the year 2006 and is measured as the number of sexual partners during that follow-up year. This dependent variable was chosen under the assumption that having increased sexual activity, via more sexual partners, likely caused individuals in Malawi to be more susceptible to spread infection during the epidemic. The varying covariates in the model are similar to the first two sections of the results – with the addition of the variable, *Tested HIV*, in the year 2004. The variable, *Distance*, is an instrument for, *Tested HIV*, to account for this bias. In addition, the analysis took place for only individuals who had a presence of sexual history during this time to ensure that individuals who tested for the disease were sexual activity without any external factors influencing the decision.

With reference to Table E, the variable, *Tested HIV*, is insignificant across the respective time period suggesting the presence of a weak instrument. Due to the heterogenous effects associated with an individual choosing to seek testing, this choice clearly has endogenous traits, which do not align with the Hausmen test. Hence, the test will not be reported as this research study is not arguing that the variable, *Tested HIV*, is exogenous. Furthermore, the standard errors on the IV estimates are much larger than the OLS estimates, further justifying that the instrument is weakly correlated with the endogenous regressor. However, the self-selection bias surrounding this controversial topic in the MLSFH makes for the necessity of an instrument to

reduce this bias to a certain degree. Hence, even with the concern regarding a greater asymptotic bias with weak first stage correlation, the challenge to find a strong instrument was not present in the MLSFH, as the variable, *Distance*, was the only viable option for this research study. The first stage partial R^2 along with the F-statistic further indicate the presence of a weak instrument. While the endogenous regressor is insignificant, interesting statistical inferences can be made with regards to the sign of the coefficient. The variable, *Tested HIV*, remains positive while controlling for various covariates during the two years in the MLSFH. This result suggests that respondents who sought testing were more likely to engage in high-risk sexual behaviour from the prior year of the survey. Hence, it is clear that there were certain behavioural implications arising from actions towards HIV testing that led to potential involvement in risky active during this time.

While it is clear that certain individuals who sought testing were more likely to commit high-risk sexual behaviour, this research study also controls for specific standard demographics during the prior year of study on the likelihood of engaging in this behaviour during the epidemic. It was found in Table E that these baseline demographics utilized in the prior results sections were also statistically significant for having an impact in the propensity to engage in this behaviour in the follow-up year. The variables *Gender* and *Age* are both statistically significant at the 0.1% and 5% levels – holding all else constant. Hence, a unit increase in being an older male corresponded to an average percentage increase of 29.8% for the likelihood of engaging with more sexual partners – ultimately increasing the chances of contracting the disease. Furthermore, respondents located in the northern and central regions of Malawi in 2004 were less likely to engage in more sexual activity in the follow-up period of the survey, compared to individuals in the southern region of the country. This result aligns with the previous findings suggesting that individuals living in these regions were among the least likely to contract the disease during the epidemic. Aside from controlling for individuals that were sexually active and sought testing during the prior year of the survey, some interesting inferences are made from other social determinants that align with the previous results. The variable, *Marital Status*, is negative and significant, suggesting that respondents who were married in the previous round of the survey were less likely to engage in high-risk sexual behaviour in the follow-up year. This finding aligns with the predictions in the theoretical model surrounding the importance of marriage and relationships in managing HIV prevalence. Furthermore, the variable, *Wealth Quantile*, is negative suggesting that a higher social standing in the previous year corresponded to individuals being less likely to engage in sexual activity during the epidemic. This result aligns with the findings presented in the year 2004 and further justifies the impact how important social status was on having the best chance of surviving the HIV epidemic in Malawi.

10 Discussion

10.1 Summary

There is no denying that the HIV epidemic has been devastating for all those impacted by the disease. The status of many Malawian families has worsened and the visible effects of the epidemic have led to an acceptance that the HIV virus is a serious national health crisis – which is driven by a variety of socioeconomic factors. This research study aimed at providing a deeper understanding into the determinants associated with managing HIV prevalence and high-risk sexual tendencies. The need to assess the importance of the HIV epidemic determinants is crucial to improve effective policy responses that aid in improving the lives of individuals impacted by the infection. Specifically, there are two avenues in the literature assessing the determinants of the HIV epidemic. The first considers the outcome of improper sexual behaviour and the second emphasizes the role of environment – both contributing to the spread of infection.[56] Using the MLSFH, this research assessed which type of determinants are the most important in influencing the evolution and prevention of the HIV epidemic. The empirical application of the data showed that some important determinants were not easy to observe – due to varying privacy constraints related to the nature of the study. For this reason, the models used carry some weaknesses surrounding self-selection bias. The methodology consisted of standard OLS, marginal effects analysis, and an instrument variable approach to address the issues present in the data. The first two sections of the empirical results explored the propensity of individuals to engage in high-risk sexual behaviour and seek HIV testing. It is evident that gender discrimination and regional effects played an important role in deciding to seek HIV testing for individuals that were deemed sexually active. In addition, the findings showed that older individuals were engaging in more high-risk sexual behaviour but less likely to seek preventative measures for the disease – due to limitations surrounding preventative strategies. This result was mostly caused by the older generation in Malawi not being fully aware of the illness and its resulting consequences. Along with the basic standard demographics, specific regional variables were also controlled for and the findings suggest that individuals living in the central region were less likely to seek testing compared to the southern region by approximately 5% on average – and were less exposed to high-risk sexual behaviour. The majority of individuals living in this region during this time were among the most wealthy in the country which likely had an influence on individuals not requiring testing services – which is further validated by the significance of the other variables related to the impact of social standing during the epidemic. Moreover, family structure and relationships played a vital role in decreasing the tendency to

[56] Temah, "What Drives HIV/AIDS Epidemic in Sub-Saharan Africa?", 2009

engage in this behaviour.

The underlying story that emerged from these results is that the socioeconomic variables (*Gender*, *Wealth Quantile*, *Education*) appeared to have aligned with some of the predictions in the theoretical framework. The findings illustrated that having a higher wealth quantile corresponded to having more access to health services which likely contributed to preventative strategies. Moreover, the results also indicated the presence of a strong environment on the likelihood of contracting the infection due to the impact of family-related effects. It is evident that regional-specific environments played a crucial role in survival during the peak years of the epidemic, which ultimately stems from behavioural implications. Temah (2009) states that partner change and contact with sex workers were more frequent in certain areas of Africa which accelerated the spread of infection. Hence, it is not surprising that the results showcased that divorced individuals were most at risk for engaging with multiple sexual partners during the epidemic – due to the increased sex drive. Moreover, the final section of the results attempted to address these behavioural implications from individuals learning their HIV status in the prior years of study. The key findings illustrated that individuals who sought testing were more likely to commit high-risk sexual behaviour. The results aligned with the predictions in the theoretical model surrounding the importance of marriage and relationships in managing HIV prevalence and behavioural change throughout the respective time periods.

Regardless of the advancement in clinical trials related to HIV vaccine, there is still action that can be taken as a result of understanding the management of HIV prevalence and high-risk sexual tendencies. These results align with prior literature addressing the need for allocation of funds and interventions to fight against the spread of HIV infection in many underdeveloped countries. It is clear that many of the standard demographic variables used appeared to have strongly provoked the HIV epidemic. However, these factors are difficult to address. Moreover, socioeconomic and health-related determinants can be influenced by effective policy in many of the regions that have limited access to healthcare in SSA. Thus, increasing contraceptive use and reducing income and gender inequalities would likely lead to a reduction in the spread of HIV infection through increased preventative awareness. It was evident that individuals had little education on the implications of HIV infection – and had limited access to improvements during the epidemic. In this sense, policies aimed at empowering women through more education, economic independence and ultimately reducing income inequality in urban areas should be promoted in Malawi based on the findings presented in this research study.[57] As a result, the promotions of specific preventative strategies would aid in controlling the spread of infection for countries with limited access to certain biomedical advances and ensure a higher

[57] Temah, "What Drives HIV/AIDS Epidemic in Sub-Saharan Africa?", 2009

quality of life for individuals impacted by the disease.

10.2 Limitations

This research utilized the MLSFH which was selected to represent the rural population of Malawi and was the primary data used in this study. Some limitations of the MLSFH were mentioned in the Cohort Profile as part of a study by the International Journal of Epidemiology.[58] The first fault in the survey corresponds to the design as it is not a national representative sample due to the high costs associated with managing this cohort. Hence, specific urban areas are not reflected in this research study. There are only three research sites used in the MLSFH which are described as northern, central and southern Malawi in this study (Balaka, Mchinji and Rumphi) – which does not reflect the entire population of Malawi and places a constraint on this analysis. In addition, another concern in the MLSFH surrounds attrition as a result of mortality, absences and migration within tracking respondents across the time period of the epidemic. The majority of the respondents were tracked and re-surveyed in an attempt to reduce the self-selection bias. In addition, the MLSFH reconstructed its efforts to improve the attrition in the survey by following respondents who left the MLSFH waves – but did not cover the most recent waves. As a result, this research study was only able to document respondents from the years prior to the introduction of ART in the year 2008. The data collection and cleaning is still ongoing for the year 2010.

In order to account for the obvious self-selection bias in the MLSFH, this research study utilized an instrument to reduce the attrition present in this study surrounding managing HIV prevalence and high-risk sexual behaviour. The majority of the survey questions in the MLSFH focus on sexual tendencies in Malawi. As a result, this research study is subject to measurement error as the respondents could have systematically lied. Hence, this study utilized an instrument to reduce this subjective bias and improve the statistical accuracy of the study. However, the instrument is regarded as weak as there is little correlation with the endogenous regressor leading to more asymptotic bias with the estimated coefficients. Moreover, future analysis is required to counteract the estimated coefficients used in the third section of this study. Furthermore, this research only focused on one particular country (Malawi) in the SSA region during the epidemic. In order to more accurately measure and account for what influenced individuals to manage the spread of infection during this time, more countries need to be explored to justify the findings in this research study.

[58] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015

10.3 Future Work

Despite this research focusing on the pinnacle years of the HIV epidemic, it is worth exploring the impact of these factors after the introduction of ART in 2008. The immense loss of life across Malawi during this time prompted the implementation of many preventative strategies in an effort to increase life expectancy. Hence, understanding the high-risk behavioural impact throughout these years in comparison to before the year 2008 would provide a greater understanding of the effects associated with risk management during the epidemic. In addition, measuring the impact of individuals in Malawi learning their HIV status before and after this treatment would also be a rich addition to the study. While it is obvious that the propensity to seek HIV testing increased throughout this time, the resulting behavioural implications from learning your test result before/after ART would be an intriguing approach to the study. The presumed assumption would be that if individuals were aware that ART reduces transmission risk dramatically, then they may actually engage in more risky behaviour. The MLSFH does document respondents up to the year 2010. However, the data is fairly incomplete – making the analysis difficult to conduct when relying solely on the MLSFH. Hence, an expansion to the data set would be needed for this future study.

The MLSFH provides essential insights into the strategies of prevention that women and men in rural Malawi were using to reduce their HIV infection risks.[59] The MLSFH provides documentation of HIV testing that was conducted at home, i.e. HTC – which began in the year 2004. Starting in 2006, the MLSFH used home-based rapid HIV testing procedures among their respondents. Hence, a comparative study between the two methods of testing is an avenue for future work for measuring the propensity to test and the behavioural implications from learning their status.

Another possible avenue would be to explore the generational impact of individuals learning their own HIV status on the impact of their children. It was documented in this research study the influence of family history on engaging and seeking testing in Malawi during the epidemic. The MLSFH has data on children's outcomes which are matched and followed throughout the various survey rounds. The majority of the variables are categorical representing health status, mortality, and education levels. Hence, it is worth exploring how the knowledge gained from learning your own HIV status impacts your own child's outcomes. In addition, this perspective could be explored for years before and after the introduction of ART to further assess the implications of increased preventative strategies and awareness during the epidemic.

[59] Kohler, Watkins, Angelwicz, "Cohort Profile: MLSFH", 2015

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12 Appendix

12.1 High-Risk Sexual Behaviour

Table A: 2004 Sexual Behaviour (OLS)

	(1)	(2)	(3)	(4)
	Sexual Activity	Sexual Activity	Sexual Activity	Sexual Activity
Gender	0.524***	0.521***	0.507***	0.527***
	(0.0297)	(0.0294)	(0.0305)	(0.0317)
Age	0.0179	0.0451	0.0563	0.0561
	(0.0349)	(0.0343)	(0.0356)	(0.0364)
Northern Malawi		-0.249***	-0.210***	-0.230***
		(0.0335)	(0.0374)	(0.0395)
Central Malawi		-0.103**	-0.0938**	-0.107**
		(0.0348)	(0.0361)	(0.0378)
Education			-0.0185	-0.0223
			(0.0407)	(0.0419)
Wealth Quantile			-0.0641**	-0.0680**
			(0.0208)	(0.0215)
Family History				0.0585*
				(0.0228)
Marital Status				0.181***
				(0.0537)
Constant	0.507***	0.606***	0.739***	0.533***
	(0.0308)	(0.0358)	(0.0925)	(0.114)
N	1918	1918	1812	1729
R^2	0.153	0.177	0.177	0.185

Standard errors in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table B: 2006 Sexual Behaviour (OLS)

	(1)	(2)	(3)	(4)
	Sexual Activity	Sexual Activity	Sexual Activity	Sexual Activity
Gender	0.262***	0.263***	0.254***	0.265***
	(0.0145)	(0.0142)	(0.0152)	(0.0152)
Age	0.0246**	0.0260**	0.0293**	0.0256*
	(0.00916)	(0.00903)	(0.0100)	(0.0100)
Northern Malawi		-0.152***	-0.183***	-0.213***
		(0.0151)	(0.0189)	(0.0198)
Central Malawi		-0.0868***	-0.105***	-0.129***
		(0.0164)	(0.0176)	(0.0179)
Wealth Quantile			0.0190	0.0205*
			(0.00976)	(0.00979)
Education			0.0335	0.0353
			(0.0184)	(0.0183)
Family History				0.0450***
				(0.0105)
Marital Status				0.0621**
				(0.0225)
Constant	1.018***	1.094***	1.048***	0.961***
	(0.00878)	(0.0134)	(0.0216)	(0.0336)
N	2862	2862	2601	2585
R^2	0.135	0.164	0.168	0.178

Standard errors in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

12.2 Propensity to Seek HIV Testing

Table C.1: 2004 Propensity to Test (Margins)

	(1)	(2)	(3)	(4)	(5)
	Tested HIV	Tested HIV	Tested HIV	Tested HIV	Tested HIV
Gender	0.0701***	0.0740***	0.0635***	0.0850***	0.0846***
	(0.0188)	(0.0183)	(0.0188)	(0.0197)	(0.0207)
Age	0.00547	-0.0166	-0.00275	-0.0134	-0.000459
	(0.0253)	(0.0246)	(0.0254)	(0.0264)	(0.0287)
Northern Malawi		0.158***	0.118***	0.117***	0.121***
		(0.0207)	(0.0234)	(0.0251)	(0.0261)
Central Malai		-0.0267	-0.0448	-0.0505	-0.0478
		(0.0243)	(0.0251)	(0.0268)	(0.0291)
Education			-0.0501*	-0.0508*	-0.0392
			(0.0237)	(0.0242)	(0.0252)
Wealth Quantile			0.04443***	0.0380**	0.0422**
			(0.0133)	(0.0135)	(0.0139)
Family History				0.0231	0.0350*
				(0.0148)	(0.0153)
Marital Status				0.119**	0.151***
				(0.0363)	(0.0390)
Sexual History					0.0238
					(0.0269)
Distance					0.0223
					(0.0142)
N	1918	1918	1812	1729	1545

Standard errors in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table C.2: 2004 Propensity to Test (OLS)

	(1)	(2)	(3)	(4)	(5)
	Tested HIV	Tested HIV	Tested HIV	Tested HIV	Tested HIV
Gender	0.0713***	0.0760***	0.0661***	0.0864***	0.0862***
	(0.0195)	(0.0189)	(0.0195)	(0.0201)	(0.0211)
Age	0.00517	-0.0167	-0.00402	-0.0148	-0.00226
	(0.0243)	(0.0236)	(0.0238)	(0.0247)	(0.0258)
Northern Malawi		0.173***	0.134***	0.134***	0.138***
		(0.0229)	(0.0257)	(0.0275)	(0.0284)
Central Malawi		-0.0234	-0.0381	-0.0441*	-0.0418
		(0.0201)	(0.0201)	(0.0217)	(0.0231)
Education			-0.0566*	-0.0582*	-0.0452
			(0.0286)	(0.0296)	(0.0305)
Wealth Quantile			0.0453**	0.0392**	0.0438**
			(0.0140)	(0.0142)	(0.0146)
Family History				0.0250	0.0370*
				(0.0160)	(0.0167)
Marital Status				0.129**	0.165***
				(0.0420)	(0.0460)
Sexual History					0.0886
					(0.0517)
Distance					0.0643*
					(0.0323)
Sexual History * Distance					-0.0500
					(0.0358)
Constant	0.176***	0.137***	0.164*	0.0263	-0.172
	(0.0218)	(0.0234)	(0.0642)	(0.0829)	(0.105)
N	1918	1918	1812	1729	1545
R^2	0.077	0.054	0.0681	0.0796	0.0904

Table D.1: 2006 Propensity to Test (Margins)

	(1)	(2)	(3)	(4)	(5)
	Tested HIV	Tested HIV	Tested HIV	Tested HIV	Tested HIV
Gender	-0.00751	-0.00474	-0.0235	-0.0120	-0.0104
	(0.0186)	(0.0180)	(0.0193)	(0.0195)	(0.0206)
Age	0.0357**	0.0212	0.0278*	0.0256	0.00314
	(0.0132)	(0.0129)	(0.0139)	(0.0140)	(0.0147)
Northern Malawi		0.152***	0.118***	0.119***	0.0971***
		(0.0257)	(0.0234)	(0.0273)	(0.0300)
Central Malai		-0.0868***	-0.0448	-0.117***	-0.139
		(0.0221)	(0.0251)	(0.0232)	(0.0250)
Education			0.0405	0.0358	0.0402
			(0.0234)	(0.0235)	(0.0243)
Wealth Quantile			0.0429**	0.0395**	0.0246
			(0.0136)	(0.0136)	(0.0142)
Family History				0.0630***	0.0563**
				(0.0155)	(0.0162)
Marital Status				0.0450	0.00237
				(0.0341)	(0.0357)
Sexual History					-0.0303
					(0.0240)
Distance					-0.00468
					(0.0154)
N	2859	2859	2859	2584	2232

Standard errors in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table D.2: 2006 Propensity to Test (OLS)

	(1)	(2)	(3)	(4)	(5)
	Tested HIV	Tested HIV	Tested HIV	Tested HIV	Tested HIV
Gender	-0.00723	-0.00487	-0.0240	-0.0127	-0.0103
	(0.0185)	(0.0181)	(0.0193)	(0.0196)	(0.0206)
Age	0.0359**	0.0228	0.0301*	0.0279*	0.00655
	(0.0133)	(0.0131)	(0.0141)	(0.0142)	(0.0151)
Northern Malawi		0.193***	0.143***	0.110***	0.0862**
		(0.0207)	(0.0255)	(0.0271)	(0.0293)
Central Malawi		-0.0845***	-0.0945***	-0.125***	-0.148***
		(0.0226)	(0.0243)	(0.0254)	(0.0280)
Education			0.0446	0.0396	0.0457
			(0.0251)	(0.0253)	(0.0266)
Wealth Quantile			0.0419**	0.0386**	0.0222
			(0.0136)	(0.0135)	(0.0141)
Family History				0.0617***	0.0550***
				(0.0152)	(0.0159)
Marital Status				0.0434	0.00856
				(0.0336)	(0.0358)
Sexual History					-0.0569*
					(0.0267)
Distance					-0.0553
					(0.0293)
Sexual History * Distance					0.0690*
					(0.0342)
Constant	0.593***	0.570***	0.489***	0.427***	0.615***
	(0.0169)	(0.0211)	(0.0315)	(0.0508)	(0.0625)
N	2859	2859	2598	2584	2232
R^2	0.0026	0.0588	0.0620	0.0699	0.0683

Standard errors in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

12.3 Implications from Learning HIV Status

Table E: Sexual Behavioural Implications (2SLS)

	(1)	(2)	(3)
	Sexual Activity	Sexual Activity	Sexual Activity
Tested HIV	0.643	0.117	0.0431
	(0.971)	(0.647)	(0.626)
Gender	0.321***	0.282***	0.291***
	(0.0503)	(0.0297)	(0.0298)
Age	0.00191	0.00192	0.00196*
	(0.00100)	(0.000983)	(0.000950)
Northern Malawi	-0.118	-0.232*	-0.269**
	(0.188)	(0.112)	(0.0956)
Central Malawi	-0.0388	-0.132	-0.153*
	(0.124)	(0.0804)	(0.0685)
Education Level		0.0794*	0.0753*
		(0.0372)	(0.0370)
Wealth Quantile		-0.00762	-0.00372
		(0.00970)	(0.00901)
Family History			0.0374
			(0.0262)
Marital Status			-0.220**
			(0.0800)
Constant	0.931**	1.072***	1.277***
	(0.316)	(0.240)	(0.290)
N	1547	1165	1157
R^2	–	0.177	0.206

Standard errors in parentheses

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$