Baiting the hook: Fish scarcity, gendered division of labour, and the fish-for-sex trade

Abstract

Transactional sex in sub-Saharan Africa's fishing communities, driven by the highly gendered organisation of production, is widely recognised as a key driver of HIV transmission in lakeshore areas. This longitudinal study investigates the economic drivers of the trade and its impact on sexual health outcomes. Specifically, the impact of regional and district fish market shocks and comparable maize shocks on facility-level sexual health outcomes are examined in Tanzania's shoreline communities. Following unfavourable shocks to the fish market, such as high prices or low amounts of fish captured, this paper finds that new HIV cases, newly pregnant women attending antenatal clinic, and the number of people treated for syphilis increases with proximity to the shoreline, supporting the hypothesis that the fish-for-sex trade intensifies when fish supply is relatively scarce. Further, the observed increase in new HIV + cases is driven by new cases in women. Contrasting effects are observed following maize price shocks, where facilities see an increase in both male and female new HIV cases following a favourable price shock. These findings highlight the role that gender-based organisation of production plays in shaping sexual health inequalities following shocks to a good.

1. Introduction

The very first HIV cases on the continent were recorded around Lake Victoria. Since the epidemic's inception, HIV/AIDS has disproportionately burdened fishing communities, with most lake and seashore areas having prevalence and incidence rates far surpassing national averages (Bulstra et al., 2020; Opio et al., 2013). A rich literature identifies transactional sex as a significant factor driving this disparity (Dunkle et al., 2004; Kwena et al., 2012; Wamoyi et al.,2016; UNAIDS, 2018). Highly gendered division of labour within the fishing industry creates an environment conducive to transactional sex, as women engaged in processing and trading must acquire fish from predominantly male fishermen (Béné & Merten, 2008; Lwenya & Ernest, 2012; MacPherson et al., 2012; Merten & Haller, 2007). Previous qualitative studies have examined the role of declining fish access in these Fish-for-Sex relationships, where periods of acute fish scarcity can increase entry into transactional sex arrangements and further alter power dynamics and duration of existing relationships (Fiorella et al.,2015; Fiorella et al., 2019). A wealth of economic literature identifies the role of transactional sex as a coping mechanism amidst periods of food insecurity (Gong et al., 2019; LoPiccalo et al., 2016; Robinson & Ethan, 2011). However, there is a notable gap in quantitative research at a wider population level examining these relationships between scarcity, transactional sex and consequent health outcomes.

This paper builds on existing literature by adopting a longitudinal, national based approach to investigate whether transactional sex increases in shoreline communities following months of fish scarcity. It aims to substantiate and extend findings from prior studies focused on specific communities to provide a comprehensive understanding of the economic drivers of transactional sex and consequent sexual health inequalities. Secondly, this study delves further into the nature of the economic inequality posed by a highly gendered division of labour by comparing health outcomes following maize shocks with those following fish shocks. Maize production isn't concentrated in any particular region and production is typically shared between the sexes (Petro et al., 2015; Voss et al., 2021). A burgeoning literature is tying transactional sex to the gender based inequality characteristic of the HIV/AIDS epidemic in the region (Majola, 2011; Sia et. Al, 2016; Wamoyi et al.,2016; UNAIDS, 2018). This study finally investigates this translation of inequalities by examining differences in sexual health outcomes by gender following fish and maize shocks.

The paper uses monthly sexual health data recorded in Tanzanian health facilities, regional fish and maize price data from the World Food Programme, and monthly district level data on the weight of fish captured from the Ministry of Livestock and Fisheries. The Ministry of Health Tanzania (MOH) has coordinates for facilities on its health facility registry, enabling the employment of a fixed effects method that tests for the differential effect of fish market shocks on a facility's health outcomes with proximity to the shoreline.

2.Background

Tanzania is located in East Africa and has a population of 58 million people, 1.7 million of whom currently live with HIV. Geographically, the country is divided into 31 regions which are subdivided into 184 districts. The main bodies of water include Lake Victoria, Lake Tanganyika, Lake Malawi (Nyasa) and Lake Rukwa. Whilst the country has made significant progress in prevention and treatment over the last two decades, still 27,000 HIV/AIDS related deaths were recorded in 2019. In Tanzania, as in much of Sub Saharan Africa, there are large geographical and gender disparities, with HIV prevalence among women 6.2% almost double that in men 3.1%; (UNAIDS, 2021).

The status of the HIV epidemic in Tanzania, as in much of the region, is 'generalized', meaning that prevalence is relatively high across the general population, and although sub populations may be driving transmission, sexual networking in the general population is enough to sustain an epidemic (Tanzer et al., 2019). However, the use of geospatial techniques reveals patterns of clustered micro epidemics across the region, which are often close to areas of very low prevalence (Bulstra et al., 2020; Dwyer-Lindgren et al., 2019). Figure 1 shows the number of people living with HIV at the 5x5km level (left) and corresponding prevalence among adults aged 15-49 years (right). These clustered micro epidemics are particularly evident around Lake Victoria and Lake Malawi. Tanzania’s fishing community is believed to have a prevalence double that of the general population whilst Uganda’s has an estimated incidence rate 3-4 times higher than the national adult average (IOM Uganda, 2014)

FIGURE 1

Caption: Institute for Health Metrics and Evaluation (IHME). Africa HIV Prevalence Geospatial Estimates 2000-2017. Seattle, USA : IHME, 2019

Why then are these communities particularly vulnerable? Higher rates of mobility are common in the industry, with fisherman frequently moving between fishing sites, increasing their exposure to diverse sexual networks, and consequently, the risk of HIV transmission (Camlin et al., 2014; Kissling et al., 2005; Kwena et al., 2014; Seeley & Allison, 2005). Unlike many agricultural workers in poor coastal villages, fishermen receive daily cash payments. They experience substantial variability in disposable income, and significant amounts of idle time during their work days. These factors lead many fishermen to engage in high-risk behaviours, such as sex with multiple partners, unprotected sex, and substance abuse (Allison & Seeley, 2004; Béné & Merten, 2008; Kissling et al., 2005). Vulnerabilities to substance abuse are further exacerbated by the additional risks inherent in the fishing occupation, such as weather changes and drowning. For example, alcohol often serves as a coping mechanism for dealing with the occupational stressors faced (Allison & Seeley, 2004; Kwiringa et al., 2019; Seeley & Allison, 2005; Tumwesigye et al., 2012). Finally, transactional sex, referred to as the Fish-for-Sex trade (Sex-for-Fish or Jaboya trade in Kenya), is a pivotal factor driving HIV transmission in shoreline areas.

Why does the fish-for-sex trade exist? Gendered division of labour is the norm in Sub Saharan Africa’s fishing industry. Fishermen are almost exclusively male whilst women are dominant in processing, preparing and trading fish on the shore (Allison & Seeley, 2004; Béné & Merten, 2008; Kissling et al., 2005). These activities typically have a smaller profit margin than fishing and are often the sole source of income (MacPherson et al., 2012). Since these traders must purchase from fisherman, transactional sex arrangements to secure fish supply or gain access to favourable prices are common. Arrangements have been reported to be initiated by both men and women (Béné & Merten, 2008; Chatterji et al., 2005; MacPherson et al., 2012). Whilst many serve as short-lived relationships to gain access to basic needs, arrangements can take the form of a longer-term relationship, presenting favourable opportunities for traders to secure a dependable supply of fish from full time fisherman (Béné & Merten, 2008; Fiorella et al.,2015; Merten & Haller, 2007). However, the relationships in this trade cover a spectrum of forms and are multifaceted in nature. Avoiding a narrowed interpretation is wise when examining the dynamics of the trade, considering the diverse motivations and constraints that shape these transactions(Béné & Merten, 2008; Stoebenau et al.,2016).

3.Empirical Strategy

A fixed effects model is used to investigate the relationship between regional and district fish market shocks and facility level sexual health outcomes. Monthly shocks to the price of fish in a region, and monthly shocks to the weight of fish captured in select shoreline districts are examined. This approach assumes that discrete regional or district level shocks are i.i.d, serially uncorrelated across months and that, conditional on maize prices, fish market shocks are uncorrelated with other time varying determinants of monthly sexual health outcomes that may vary across regions. This assumption is discussed in more depth below (3.3 Shocks). The following model captures the effects of regional fish market shocks on facility level sexual health outcomes by distance from the shoreline:

$$Y_{i,r,t} = \alpha + \beta D_i + \sum_{j=0}^{4}\left[\rho_j (upshock)_{r,t-j} + \gamma_j (upshock)_{r,t-j} * D_i\right] \quad (1)$$

$$+ \sum_{j=0}^{4}\left[\delta_j (upshock)_{r,t-j} + \eta_j (upshock)_{r,t-j} * D_i\right]$$

$$+ \sum_{j=0}^{4} \phi_j (maizeprice)_{r,t-j} + \mu_t + \nu_r + \epsilon_{irt}$$

where D_i is the distance of facility i from the shoreline, $(upshock)_{r,t-j}$ and $(downshock)_{r,t-j}$ are dummies for upward and downward shocks to the fish market price in region r at time t-j. The month fixed effects μ_t control for time varying factors affecting both the outcome and explanatory variables, whilst regional fixed effects ν_r control for unobserved heterogeneity across regions that may be correlated with outcome and explanatory variables. A regional fixed effect is appropriate since price data is regional, and health policies are typically implemented at the regional level.

To examine the effects of district fish weight shocks on facility level sexual health outcomes, a similar model is employed where shocks are at the district level, and district and regional fixed effects are added separately.

The cumulative effect of multiple shocks are further investigated using the following model:

$$Y_{i,r,t} = \alpha + \beta D_i + \rho\left[\sum_{j=0}^{4}(upshock)_{r,t-j}\right] + \gamma\left[\sum_{j=0}^{4}(upshock)_{r,t-j}\right] * D_i + \tag{2}$$

$$\delta\left[\sum_{j=0}^{4}(downshock)_{r,t-j}\right] + \eta\left[\sum_{j=0}^{4}(downshock)_{r,t-j}\right] * D_i +$$

$$+ \textstyle\sum_{j=0}^{4} \phi_j (maizeprice)_{r,t-j} + \mu_t + \nu_r + \epsilon_{irt}$$

where ρ captures the effect of an additional upward shock month, δ captures the effect of an additional downward shock month, and γ and η coefficients capture the differential effect of an additional shock month with distance from the shoreline.

Lag Order Selection

Four lags of explanatory variables are included for two reasons. Firstly, PEP (Post-Exposure Prophylaxis) should be started no later than 72 hours after a possible exposure to HIV and should be taken for 28 days (). The

Ministry of Health (MOH) Tanzania recommends taking an HIV test 6 and 12 weeks after finishing PEP treatment. This means a facility might record someone HIV positive 3-4 months after exposure, though those who lack access or are unwilling to start PEP may go to their local health facility for testing earlier. HIV is detectable from around 10-18 days after exposure depending on the testing method.

Secondly, syphilis tests conducted at ANC, the total number of people treated for syphilis, and the number of first visits recorded at facility antenatal care (ANC) clinics are examined. The MOH recommends attending ANC for the first time within the first trimester (3 months) of pregnancy (Ministry of Health Tanzania, 2019).

Inclusion of Maize Price Controls

In Sub-Saharan Africa, the price of maize is commonly regarded as a reliable economic indicator for assessing the performance of the agricultural sector and, consequently, the overall economic conditions in the region. Maize prices make a suitable control in fish price regressions since they may be correlated with both fish prices and sexual health outcomes. Including maize price takes into account increases in transactional sex that may occur in times of economic hardship, whilst attempting to control for other regional macroeconomic variables that may be correlated with both health outcomes and fish market shocks. The assumption then is that, conditional on maize prices, a shock in the price of another commodity should not induce a change in sexual health outcomes over and above that induced by maize prices. This is not a concern when using the weight of fish captured, since fish supply shocks are isolated.

Shock Definition

The primary definition of an upward fish price shock in month t in region r is the fish price in that month being 1.5 standard deviations above the mean in that region over the time period. Downward shocks are defined similarly. Weight of fish captured is at the district level, hence upward shock months are those months where the weight of fish captured in district d is over 1.5 standard deviations of the district mean. All fish price and weight data is used to calculate region/district averages regardless of whether health data is missing in these months.

There are two concerns that one may have with using fish prices. Firstly, a note on volatility- fish prices in watershore regions are more volatile than inland regions. Since the contributing factors to fish price volatility are largely down to geography and a more diverse set of regions supplying the inland fish markets- all time invariant factors- the regional fixed effects take this into account. Further, the sample of health facilities includes only those within 40 km of the shoreline, which are within lake and seashore regions (except some facilities in Shinyanga). Secondly, one may be concerned that demand factors influencing local fish prices may also be correlated with sexual health outcomes. However, recent literature suggests that the number of buyers in an onshore market plays a minimal role in price determination of fish in the region (Sambuo et al., 2021), indicating that supply factors predominantly determine fish prices in this setting. We then rely on the assumption that both environmental factors and fishermen supply incentive factors are independent of sexual health outcomes. This is likely to hold in the presence of regional fixed effects, time fixed effects and maize price controls. Using weight shocks addresses endogeneity problems by isolating supply shocks, but the data is limited (see data section).

4.Data

The World Food Programme Price Database

The World Food Programme collects monthly data on the price of fresh fish and (retail) white maize (TZS per KG) by region. Fish price data is recorded from 01/2016 to 12/2019, though many regions do not have fish prices recorded beyond 3/2019. Maize price data is collected from 2006. Figures 4 and 5 in the appendix give fish and maize price statistics, including the number of shocks identified for each region in the sample.

Ministry of Livestock and Fisheries, Tanzania

Annual fisheries statistical reports were published in 2019 and 2020. Both contain data on the weight (in Metric Tonnes) and Value (in '000s Tsh) of fish captured monthly for 25 shoreline districts within 11 shoreline regions. Unfortunately, the weight/value of fish captured is not recorded for regions around Lake Victoria- an area where the fish-for-sex trade is well documented. There are only 3 months in 2019 where both fish price and weight/value data is collected, preventing the use of weight/value as a supply shifter in an instrumental variables approach. Figure 6 in the appendix gives captured weight statistics, including the number of shocks identified for each district in the sample.

Ministry of Health, Tanzania

The Ministry of Health Tanzania (MOH) disseminates a variety of facility based health indicators through the Health Management Information System (HMIS) portal. The portal was scraped to collect outcome variables, all of which are collected monthly by facility. Health facility coordinates were obtained from the MOH Health Facility Registry, and the minimum distance from each facility to the main bodies of water and seashore was calculated using ArcGIS. Each facility is uniquely identified with an MOH UID. Health data was collected between 2016 and 2019 since fish price data began in 2016, and protocols adopted during the outbreak of COVID-19 meant that HIV/ART data was not collected in 2020.

In efforts to enforce validation, the MOH does not store a zero data value for most health indicators, labelling missing and zero values the same. To overcome this, health indicators not directly of interest to this paper were collected, and a rubric was followed to eliminate missing data based on whether a facility had recorded other indicators in the same month. Three of these other health indicators do store a zero value- the number of new outpatients, and the number of births occurring at a facility, and the number of malaria cases- making it easier to identify whether a '0' is likely to be missing or genuine. Note that even for small facilities, the number of new births and outpatients is unlikely to be zero. Data where the monthly number of births and total attendance in outpatients for a facility is missing, and all other health indicators are recorded as 0/missing (or health indicators have never been recorded for that facility), were eliminated. Table 9 in the appendix gives the percentage of original values removed. Whilst this gives confidence that the vast majority of missing data has been removed, it is possible that a small number of '0' values are still incorrectly labelled.

The sample is restricted further to observations post 10/2016, since almost all facilities are missing all sexual health indicators for months 5-9 of 2016.

5.Hypothesis

Anticipating the repercussions of fish market shocks on shoreline communities, the hypothesis is that an upward shock in fish prices or downward shock in fish weight will trigger an increase in transactional sex. This should be detected by a rise in new HIV cases, an increase in attendance at ANC clinics by newly pregnant women, and a heightened number of people undergoing syphilis treatment. The hypothesis most crucially, is that these increases will diminish with increasing distance from the shoreline. Moreover, a temporal delay in observing these effects is anticipated due to factors such as testing periods, discovering pregnancy status, and attending antenatal clinics. In line with the specified model (1) $\rho_i > 0$ and $\gamma_i > 0$ for some $i > 0$ (i).

Conversely in the case of downward price shocks (upward weight shocks), where reduced competition between traders is anticipated to diminish the incentive for engaging in transactional sex, we would then expect $\delta > 0$ and $\eta > 0$ for some $i > 0$ (ii). However, it is important to note that no new inductions into unsafe sex are postulated even if the prevalence of unsafe sex where to increase. Additional factors may influence this scenario. Fishermen, known for engaging in high-risk sexual behaviour, might intensify such behaviours with increased idle time and larger disposable incomes during prosperous times. However, the assumption posits that fishermen might direct these high-risk behaviours toward a different subset of the population, likely full-time sex workers, rather than women employed in the fishing industry. In this context, if an effect on sexual health outcomes is observed, it is anticipated to align with (i) but with a smaller magnitude.

The situation becomes less clear with testing. Syphilis tests are conducted at antenatal clinics, and the Ministry of Health recommends screening all pregnant women at their first ANC clinic visit, although resource constraints exist in some facilities. With more women attending antenatal clinics, an increase in syphilis tests is expected, mirroring the effect in case (i). However, HIV testing is conducted across all clinical areas in various types of facilities, with the majority being voluntary testing. While most HIV testing is free and provided in government-run facilities, some private healthcare facilities charge a testing fee. Economic factors may influence an individual's incentive to test for HIV following a fish market shock, with potential barriers to testing in the presence of an economic shock.

6.Results

The effects of upward and downward shocks to the fish price on HIV + cases, ANC First Visits, the total number of people treated for syphilis infection, and ANC syphilis Tests are tested in Table 1 according to the main specification (1). New HIV cases, ANC first visits, and the number of people treated for syphilis are all increasing with proximity to the shoreline following an upward price shock. Three months following an upward fish price shock, the average facility at median distance (approximately 11km) from the shoreline records an 3.9% increase in new HIV positive cases. What's more, the effect of an upward shock is increasing with proximity to the shoreline. For every additional kilometer closer to the waterfront, an extra 0.2% New HIV + cases are recorded. The average facility at shoreline sees a 6.1% increase in new HIV positive cases (8.7% more positive cases than median distance facilities not experience a shock). This differential impact of an upward shock is depicted in figure 2. The blue line indicates the preexisting relationship between shoreline proximity and New HIV + cases. The significance of the differential impact by distance is demonstrated by the steeper gradient of the red line. If the interaction term on "upshockXdistancemed" were not significant, the gradient of the red and blue would be identical. The intersection of the red and blue lines gives us the distance at which a facility would be sheltered from the impacts of an upward shock in the fish market. With New HIV + cases, this distance is around 29km.

Similarly, whilst the effect of an upward shock on ANC first visits for facilities at median distance is not significantly different zero (however negative), the interaction term is (Table 1, col 4). Antenatal care first visits are increasing with proximity to the shoreline two months following an upward shock in the fish market. For every kilometer closer to the waterfront, the number of ANC first visits increases by 0.6%. The average facility at shoreline sees a 6.6% increase in ANC first visits relative to facilities not experiencing a shock. Figure 2 illustrates this differential impact by distance. As expected, the blue line is flat, since there is no relationship between distance from the shoreline and ANC first visit attendances holding all else constant. The downward shift in the red line indicates the negative impact of the upward shock on attendances (albeit insignificantly different from zero), with the steeper gradient demonstrating that attendees is increasing with proximity to the waterfront. Whilst we see no significant effect of upward shocks on the number of syphilis tests conducted at ANC (col 6), the total number of people treated for syphilis is increasing slightly with proximity to the shoreline four months following an upward shock (col 5). The diminishing effect by distance on new HIV cases, newly pregnant ANC attendees, and the number of people treated for syphilis following an upward price shock indicates an increase in sex occurring closer to the waterfront, supporting the hypothesis of more transactional sex between fisherman and traders at the shoreline.

Moving to downward price shocks, the average facility sees 9.1% fewer ANC first visit attendees and 3.9% fewer New HIV + cases the month after a downward shock, regardless of their proximity to the shoreline (the interaction is not significant, though negative in direction). Looking at syphilis tests conducted at antenatal clinics, the average facility at median distance conducts 27% fewer tests three months following a downshock, and for every kilometer closer to the waterfront, the number of tests conducted diminishes by a further 1%. The average shoreline facility conducts 38% fewer tests following a downward shock (44.6% fewer tests than the median distance facility not experiencing a shock).

No such results are found when looking at the number of HIV tests taken (Table 6 in Appendix), giving confidence that the observed increase in new HIV cases is not simply the result of those closer to the shoreline taking more tests. In contrast to new HIV + cases, less HIV tests are being taken three months after an upward price shock- an effect that is not significant by distance.

The cumulative impact of shock months on the outcome variables are further examined(Table 7 in Appendix). No significant impact of cumulative shock months on new HIV + cases or ANC syphilis tests are found. In other words, there is no difference in New HIV cases or ANC syphilis tests conducted at a facility in a region experiencing four consecutive shock months relative to a facility in a region experiencing one shock month. We see a cumulative effect however with the number of people tested for syphilis, treated for syphilis and ANC first visits, though the interaction with distance is not significant with the number treated for syphilis. The median distance facility sees 5% fewer ANC first visits, but the average waterfront facility sees an additional 2.2% visits relative to the median distance facility with an additional upward shock month. On the contrary, the average median distance facility conducts 19% less syphilis tests with an additional downward shock month. This amount further decreases by 0.6% for every kilometer closer to the shoreline.

FIGURE 2

Caption: (Top) gives the predictive marginal treatment effects of an upward shock three months ago on New HIV + cases by proximity to the shoreline. (Middle) gives predictive marginal treatment effects of an upward shock two months ago on the number of first visits at ANC. (Bottom) gives predictive *marginal treatment effects of downward shock three months ago on syphilis tests taken at ANC*

Secondly, supply shocks are isolated by testing for the effects of upward and downward shocks to the weight of fish captured in select shoreline districts (Table 2). As discussed in the data section, this approach does not have the same statistical power given that there is only one year of data, and 25 shoreline districts in 11 regions. The sample now includes all facilities within shoreline districts (the median distance is approximately 13km). Syphilis is not included here since the majority of clinics are missing syphilis treatment data for the last three months of 2019. Nonetheless, we see the same pattern as with fish price shocks. Note that "downshock" in fish weight should have the same effect as "upshock" in fish price. Although the median distance facility sees no significant effect, new HIV positive cases are significantly increasing with proximity to the shoreline two months following an unfavourable (downward) shock in the fish weight captured. Similarly, ANC first visits are increasing with proximity to the shoreline four months following an unfavourable shock. Whilst not significant, the interaction terms are in the same direction three and four months following an unfavourable shock.

Heterogeneity in New HIV Positive Cases

The effects of upward and downward fish price shocks are tested separately on male New HIV + cases and female new HIV+ cases identified at ANC clinic. Strikingly, we see that new HIV cases in men are decreasing with proximity to the shoreline four months following an unfavourable shock (Table 3, Figure 3). However, ANC HIV + cases are increasing with proximity to the shoreline three months following an unfavourable shock. Hence, the observed increase in total new HIV+ cases is being driven by new cases in women.

Why then might male new HIV + cases be decreasing with proximity to the shoreline? Table 6 in the appendix gives the number of HIV tests taken by gender. Notably, there is no significant change in the number of tests taken by men with proximity to the shoreline following an upward (unfavourable) shock. This observed decrease in new HIV + cases is not driven by changes in testing behaviour. One plausible explanation could be that fishermen are less likely to engage in higher-risk sexual behaviours, such as drug abuse, alcohol consumption, and transactional sex with sex workers, when the supply of fish is scarce. Whilst fishermen are participating in the uptick of transactional sex relationships in the fishing industry after an unfavourable fish market shock, it is the women in the industry who are induced into transactional exchanges, not the fishermen.

The observed decrease in new HIV cases one month after a favourable shock (downshock) however could be explained by changes in testing behaviour. 12.1% less tests are taken at shoreline facilities the month following a downward shock (1.1% fewer tests for every kilometer moved closer to the shore). Men closer to the shoreline are testing less the month after a favourable shock in the fish market.

FIGURE 3:

Caption:Predictive marginal treatment effects of an upward shock three months ago on new male HIV + cases and new female ANC HIV + cases by proximity to the shoreline

Table 1: Effect of Fish Price Shocks on Sexual Health Outcomes

Table 2: Effect of Captured Fish Weight Shocks on Sexual Health Outcomes

Table 3: Effect of Fish Price Shocks on New HIV Cases by Gender

6. Further Results and Robustness Checks

Health outcomes following maize shocks are compared with those following fish shocks to further understand the nature of the economic inequality posed by a highly gendered division of labour. Sexual health outcomes by distance from the shoreline are examined following upward and downward shocks in maize price (Table 4). Whilst we may find that higher maize prices have a significant effect on sexual behaviour, particularly closer to the shoreline where risky behaviour is more common, we do not expect the same direction as observed with fish shocks. Conditional on fish prices, we do not anticipate a rise in HIV cases closer to the shoreline following upward maize price shocks. Higher maize prices should not induce more transactional sex closer to the shoreline.

The opposite effect is observed. When maize prices are exceptionally low, there is an uptick in new HIV cases and ANC first visits in proximity to the waterfront. Four months following a downward maize price shock, shoreline facilities experience a 12.5% increase in new HIV cases (14% more than median distance facilities not experiencing a shock). Similarly, when maize prices are high, there is a decrease in both new HIV cases and new mothers attending ANC near the waterfront. Notably, increased sexual activity is observed when maize prices are low- when things are going well. This heightened sexual activity is characterised as consumption sex, indicating that it is not transactional but rather a manifestation of higher-risk sexual behaviour. What’s more, this effect is observed in both new male HIV cases and new female ANC cases.

Could it be the case that transactional sex is taking place somewhere else in the presence of upward maize shocks? No- for two reasons. Firstly, maize is a staple crop across the region and is not grown in any specific location- 45% of Tanzanian land is used in maize cultivation. Secondly, there is no gendered division of labour in maize cultivation. Whilst women may prepare maize more frequently than men, production and retail activities are often shared between the sexes (Petro et al. 2015; Voss et al. 2021). The observed effect is more plausibly attributed to a higher risk sub population engaging in increased risky behaviour when experiencing less economic hardship.

A number of further robustness checks are conducted. Firstly, malaria cases are examined following upward and downward fish shocks (Table 5) as malaria is a non-sexual health outcome. We can think of some examples where fish market shocks may effect malaria outcomes. For example, economic conditions may make people more or less likely to take preventative measures such as sleeping under a bed net, or more likely to treat malaria at home. However, these effects should be small in magnitude, and most crucially, should not be heterogeneous with proximity to the shoreline. Secondly, the number of ANC attendees who are over 12 weeks pregnant, as opposed to ANC first visits who are in the first trimester, are examined. Again, whilst we may observe main effects from fish market shocks, since women may be less likely to visit clinics in shock months for example, we should not see a heterogeneous effect of fish market shocks by proximity to the waterfront before 3 months.

There are more Malaria cases observed in downward shock months, and four months following upward shock months, but none of these effects are heterogeneous with proximity to the shoreline. Further, there is a slight heterogeneous effect of the number of ANC attendees over 12 weeks pregnant three months following an upward shock which is consistent with the main results- more women are attending closer to the shoreline. However, we see no effect before three months, and no effect of downward shocks.

Finally, for those dissatisfied with log transformations on skewed count variables, the main specification is included using Poisson maximum likelihood estimation instead of OLS in the appendix (Table 8). The results are robust to this alternative estimation method, where sexual health outcomes are increasing with proximity to the shoreline three and four months following an upward price shock.

Table 4: Effect of Maize Price Shocks on Sexual Health Outcomes

Table 5: Effect of Fish Price Shocks on Malaria Cases and ANC Visits >12 Weeks

7. Discussion and Policy Implications

This study examines sexual health outcomes following fish and maize market shocks in Tanzania's shoreline communities. Three key results are identified. First, the fish-for-sex trade intensifies during periods of fish scarcity. New HIV cases, the number of newly pregnant women attending ANC, and the number of people treated for syphilis is increasing with proximity to the shoreline following unfavourable shocks in the fish market. The average shoreline facility sees 8.7% more HIV positive cases three months following an upward fish price shock, and 6.6% more newly pregnant women attending ANC two months following a shock relative to the median distance facility. Second, this increase in new HIV cases is driven by new cases in women. Third, the opposite effect is observed following maize price shocks, where facilities see an increase in both male and female new HIV cases following a downward price shock. These results describe how an economic inequality is translating into a health inequality. Within the same population, the effect of price shocks to a good depends on the organisation of production of that good. When men and women contribute equally to production, sexual health outcomes are shared across the genders. However, when production is highly gendered, women shoulder the burden.

This study builds upon and supports existing qualitative literature that identifies economic vulnerability as a motivation for entering into fish-for-sex relationships (Béné & Merten, 2008; MacPherson et al., 2012; Merten & Haller, 2007; Stoebenau et al.,2016) It contributes to the growing body of work exploring the association between transactional sex and the gender-based HIV inequality characteristic of Sub-Saharan Africa (Majola, 2011; Sia et. Al, 2016; Wamoyi et al.,2016; UNAIDS, 2018). Previous findings specifically linking declining fish access to transactional sex are further substantiated, where acute fish scarcity increases engagement in jaboya relationships (Fiorella et al.,2015). However, it is important to note that this paper, while providing valuable population-based evidence, offers a somewhat broad perspective on short-term outcomes following fish market shocks. It cannot capture nuanced and evolving nature of fish-for-sex relationships, and the long-term impact of fish scarcity remains unexplored.

Limitations

Whilst confidence is held that most of the missing data has been eliminated in the outcome variables (see 4.Data and appendix), it is possible that a small number of ‘0’ values remain incorrectly labelled. Data on the weight and value of fish captured is limited. There is only one year available and the data is restricted to 25 shoreline districts within 11 shoreline regions. Most notably, the captured fish weight data does not cover regions around Lake Victoria, an area where the fish-for-sex trade is well documented. Missing syphilis treatment data in 2019 also prevents the inclusion of syphilis into weight regressions. Further, there is not enough captured fish weight data to warrant an instrumental variables approach with fish prices, and so endogeneity concerns with fish price regressions may not entirely be appeased (see 3.Shocks).

Policy Implications

The findings of this paper indicate that transactional sex in fishing communities increases following unfavourable shocks in the fish market, and that women are shouldering the burden of new HIV cases. Given the high prevalence and incidence rates of HIV in these communities, and the prominent role that the fish-for-sex trade plays in driving them, it is important that governments and international organisations mobilise to combat the harmful consequences of gender-driven market dynamics in the industry. This is particularly important in the face of climate change, where the frequency and severity of supply shocks will further intensify.

A noteworthy community-based micro-intervention involves establishing cooperative structures, such as the Titukulane("uplift each other" in Chichewa) groups recently funded by USAID and implemented by Care Malawi (CARE, 2021). Consisting of around 30 women each, these groups pool resources for collective fish procurement, effectively shifting bargaining power away from fishermen and making it harder to assert coercive demands. Additionally, these groups are provided with resources to encourage micro enterprises and diversification of income sources, reducing reliance on the fish trade and increasing food security. Some cooperatives are allocated small plots of land for growing crops like maize, soya beans, and fruit, while others receive livestock for joint husbandry. Beyond economic aspects, the cooperative structure functions as a valuable platform for spreading sexual health information and allows women to collaboratively tackle more extensive issues, such as gender-based violence. This community driven and externally supported initiative offers a practical pathway to empower women and reshape market dynamics within the fishing industry.

8.Conclusion

The highly gendered organisation of labour within the fishing industry creates an environment conducive to transactional sex, as women engaged in processing and trading must acquire fish from predominantly male fishermen. This article examines facility-level sexual health outcomes following fish and maize market shocks in Tanzania’s shoreline communities. It finds that new HIV cases, the number of newly pregnant women attending antenatal clinic (ANC), and the number of people treated for syphilis is increasing with proximity to the shoreline following unfavourable shocks in the fish market. This increase in new HIV cases is driven by new cases in women. The opposite effect is observed following maize price shocks, where facilities see an increase in both male and female new HIV cases following a favourable price shock. This demonstrates the translation of an economic inequality into a health inequality. Within the same population, the effect of price shocks to a good differs with the organisation of production of that good. In the case of maize, where men and women contribute equally to production, sexual health outcomes are shared across the genders. However, when production is highly gendered as in the fish market, women shoulder the burden. Exploration into other industries with gendered division of labour such as the timber an mining industries would provide additional insight into this relationship between organisation of production and transactional sex. Further research into the complex factors driving high risk sexual behaviour in this sub population is crucial in the global fight to end AIDS.

Appendix

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Figure 1:

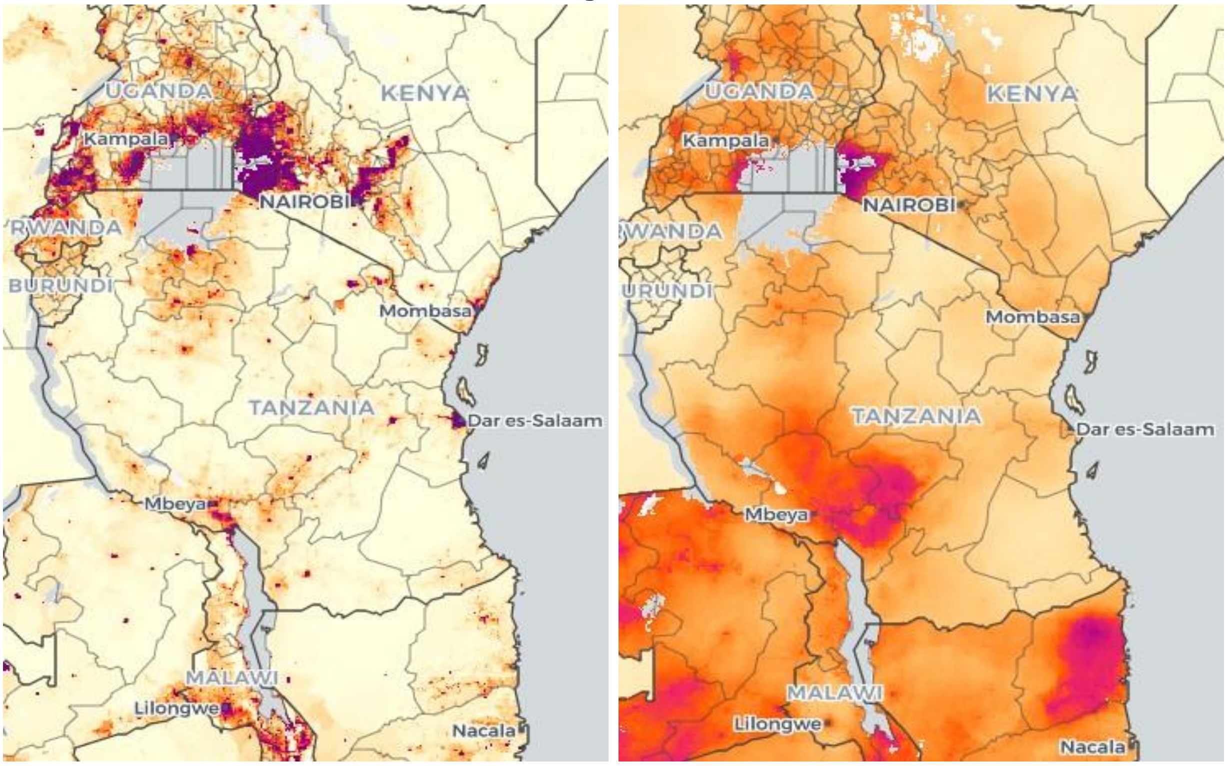

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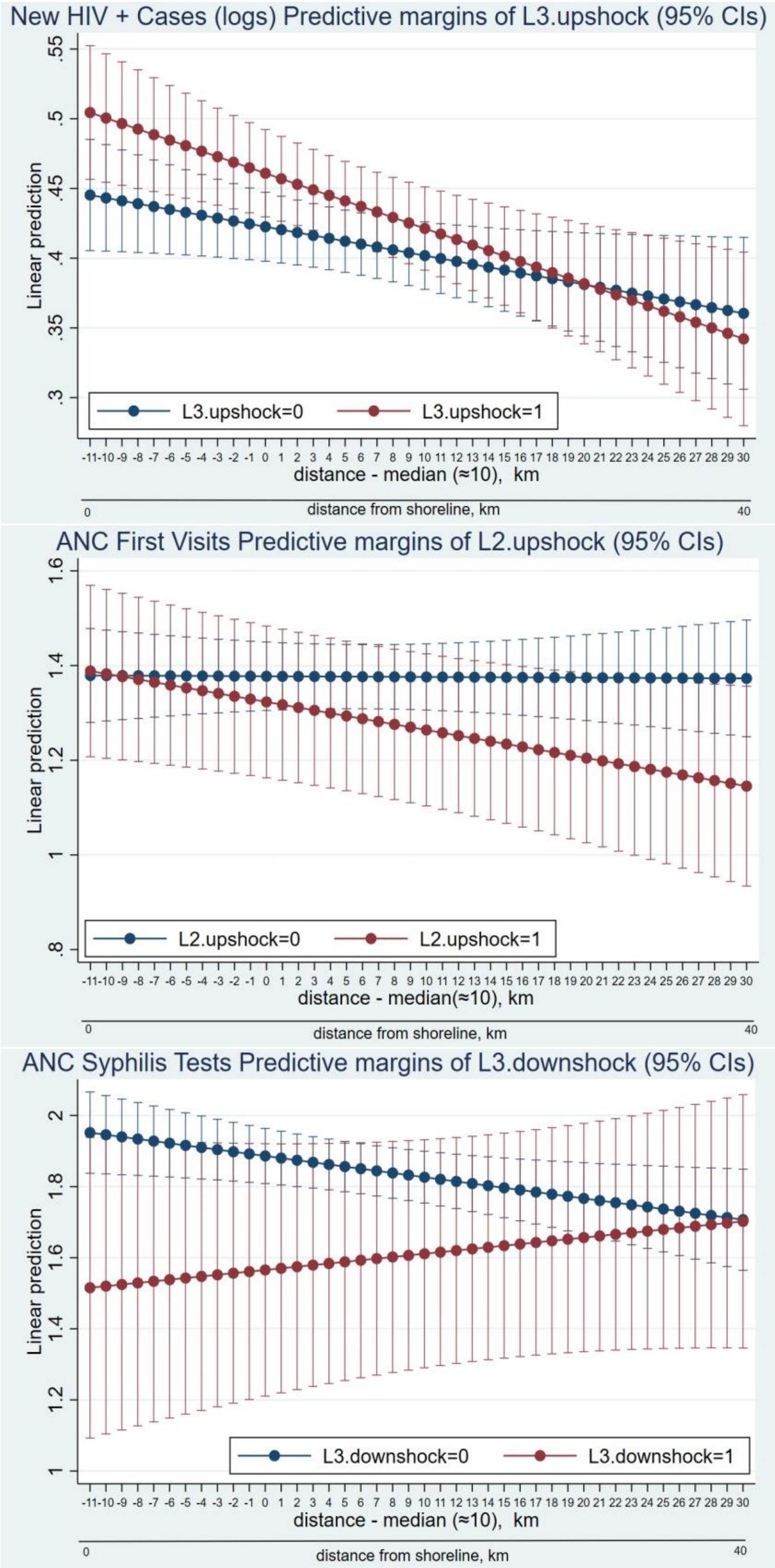
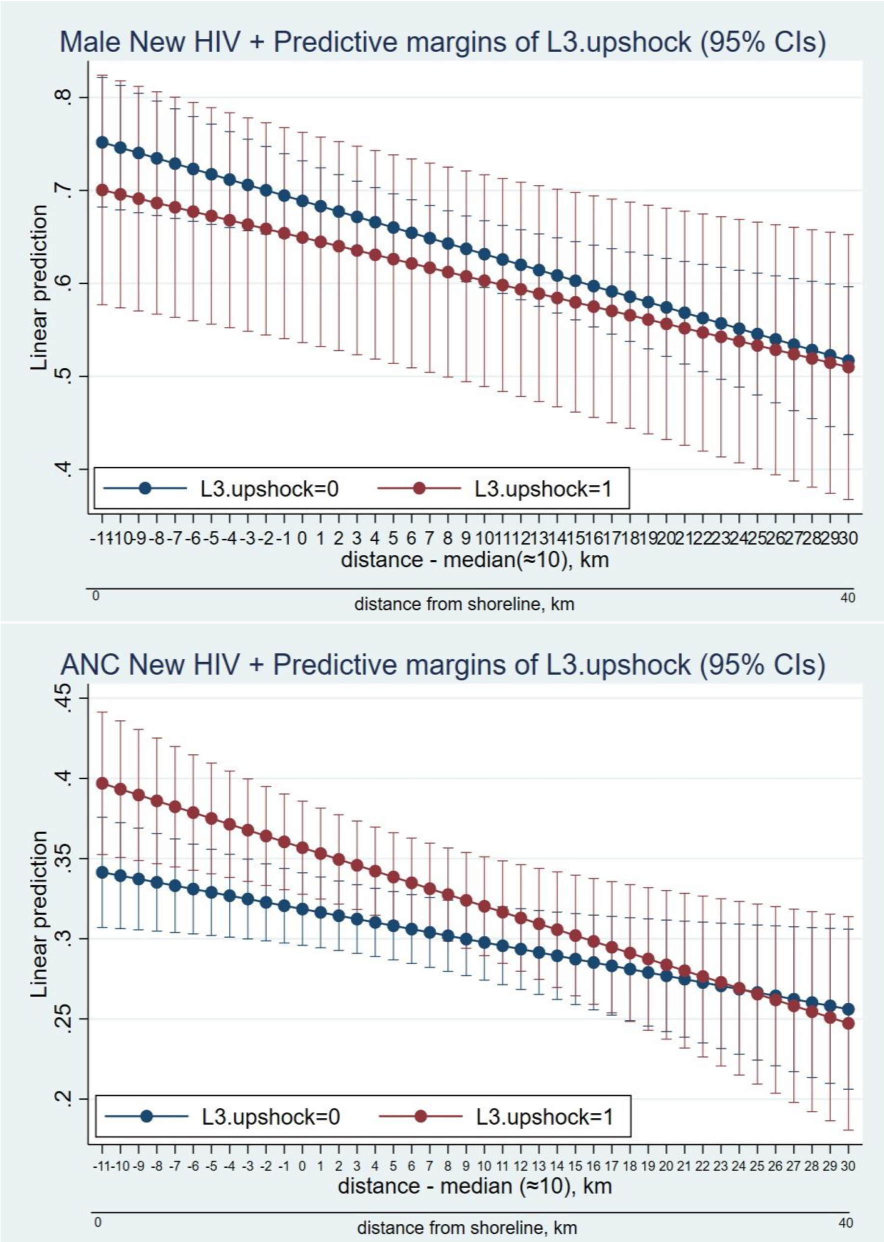
Figure 2:



(Top) gives the predictive marginal treatment effects of an upward shock three months ago on New HIV + cases by proximity to the shoreline. (Middle) gives predictive marginal treatment effects of an upward shock two months ago on the number of first visits at ANC . (Bottom) gives predictive marginal treatment effects of downward shock three months ago on syphilis tests taken at ANC

Figure 3:



Predictive marginal treatment effects of an upward shock three months ago on New Male HIV + cases and New ANC HIV + cases by proximity to the shoreline

Table 1: Effect of Fish Price Shocks on Sexual Health Outcomes

VARIABLES	New HIV + (1)	(2)	(3)	ANC First Visits (4)	Total Syph Treated (5)	ANC Syph Tests (6)
distancemed	-0.00225**	-0.00240**	-0.00241**	-0.000127	-0.000952	-0.00618**
	(0.00106)	(0.00106)	(0.00106)	(0.00222)	(0.000660)	(0.00277)
upshock	0.00317	0.0248	0.0246	-0.0449	-0.0271	-0.0582
	(0.0211)	(0.0288)	(0.0301)	(0.0554)	(0.0226)	(0.0891)
upshockXdistancemed	0.00195	0.00262*	0.00261	-0.000473	0.000833	0.000305
	(0.00115)	(0.00153)	(0.00154)	(0.00231)	(0.000706)	(0.00342)
L.upshock	0.00801	-0.00485	-0.00572	0.0419	0.0140	0.0526
	(0.0140)	(0.0140)	(0.0174)	(0.0465)	(0.0195)	(0.0693)
L.upshockXdistancemed	-0.00182*	-8.03e-05	3.22e-05	-0.00163	0.00124*	0.00218
	(0.000957)	(0.00156)	(0.00160)	(0.00234)	(0.000722)	(0.00327)
L2.upshock		-0.0309**	-0.0315**	-0.0542	0.0218	-0.0295
		(0.0130)	(0.0125)	(0.0763)	(0.0253)	(0.0887)
L2.upshockXdistancemed		-0.000571	-0.000503	-0.00579**	0.000397	0.00235
		(0.00114)	(0.00112)	(0.00226)	(0.000714)	(0.00245)
L3.upshock		0.0398***	0.0384***	-0.0891	-0.00753	-0.0820
		(0.00708)	(0.00975)	(0.0694)	(0.0162)	(0.0733)
L3.upshockXdistancemed		-0.00181**	-0.00189**	-0.00242	-0.000245	-0.00139
		(0.000694)	(0.000776)	(0.00148)	(0.000774)	(0.00402)
L4.upshock		-0.00368	-0.00252	-0.0943	-0.0208	-0.0491
		(0.0187)	(0.0172)	(0.0919)	(0.0134)	(0.0887)
L4.upshockXdistancemed		0.000307	0.000274	0.00227	-0.00125*	-0.00535
		(0.00101)	(0.00104)	(0.00181)	(0.000703)	(0.00424)
downshock	-0.0184*	-0.0150	-0.0146	0.000156	-0.0561***	-0.341***
	(0.00976)	(0.0104)	(0.0133)	(0.0418)	(0.0140)	(0.0883)
downshockXdistancemed	0.00100	0.00121	0.00122	0.000907	-0.000118	0.00638
	(0.00185)	(0.00195)	(0.00198)	(0.00342)	(0.00129)	(0.00431)
L.downshock	-0.0383**	-0.0401***	-0.0402**	-0.0952**	-0.00790	-0.177*
	(0.0157)	(0.0133)	(0.0150)	(0.0448)	(0.0278)	(0.0961)
L.downshockXdistancemed	0.00218	0.00155	0.00165	-0.00105	0.000485	0.00467

	(0.00156)	(0.00151)	(0.00158)	(0.00251)	(0.00113)	(0.00309)
L2.downshock		-0.00272	-0.00272	-0.0570	-0.0311	-0.184*
		(0.0185)	(0.0189)	(0.0391)	(0.0190)	(0.101)
L2.downshockXdistancemed		0.00265	0.00259	0.00143	0.000555	0.00622
		(0.00329)	(0.00338)	(0.00268)	(0.000942)	(0.00458)
L3.downshock		0.0114	0.0120	-0.0418	-0.0713**	-0.321*
		(0.0174)	(0.0187)	(0.0769)	(0.0280)	(0.179)
L3.downshockXdistancemed		0.000580	0.000602	0.00383	0.000266	0.0105**
		(0.00276)	(0.00286)	(0.00286)	(0.00147)	(0.00457)
L4.downshock		-0.00227	-0.00218	0.0235	-0.0414*	-0.0236
		(0.0219)	(0.0233)	(0.0668)	(0.0206)	(0.225)
L4.downshockXdistancemed		0.000479	0.000517	-0.00108	0.000945	-0.000359
		(0.00138)	(0.00143)	(0.00271)	(0.00134)	(0.00772)
Constant	0.416***	0.425***	0.445***	1.213***	0.174***	1.783***
	(0.0217)	(0.0124)	(0.0314)	(0.126)	(0.0399)	(0.254)
Observations	50,464	46,176	46,176	46,844	31,402	45,792
R-squared	0.090	0.094	0.095	0.253	0.113	0.249
Maize Price Controls	YES	NO	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses. Standard errors clustered at the district-month level
*** p<0.01, ** p<0.05, * p<0.1

Estimated using OLS. Each observation is a facility-month record. Outcome variables are log transformed. Distmed is the distance of a facility from the shoreline minus the median distance of the sample ($11km$). "L4.upshockXdistancemed" gives the interaction effect of an upward shock 4 months ago with Distmed. Months span from 10/2016-03/2019

Table 2: Effect of Captured Fish Weight Shocks on Sexual Health Outcomes

(WEIGHT SHOCKS)	(New HIV +)		(ANC First Visits)	
VARIABLES	(7)	(8)	(9)	(10)
distancemed	0.000592	-0.000261	0.00522***	0.000434
	(0.000682)	(0.000835)	(0.00108)	(0.00247)
downshock	-0.0154	0.000509	0.0274	0.0898
	(0.0287)	(0.0242)	(0.0423)	(0.0777)
downshockXdistancemed	-0.00250***	-0.00151*	-0.00767***	-0.00427
	(0.000659)	(0.000693)	(0.00219)	(0.00232)
L.downshock	-0.0276	-0.0165	-0.0386	0.00737
	(0.0335)	(0.0359)	(0.0527)	(0.0546)
L.downshockXdistancemed	-0.000467	0.000802	-0.00356	0.000506
	(0.00181)	(0.00160)	(0.00274)	(0.00278)
L2.downshock	-0.0234	-0.0223	-0.00778	-0.0255
	(0.0177)	(0.0242)	(0.0381)	(0.0759)
L2.downshockXdistancemed	-0.00244***	-0.00155*	-0.00139	0.00128
	(0.000592)	(0.000766)	(0.00121)	(0.00195)
L3.downshock	-0.0405	-0.0409	-0.0218	-0.0601
	(0.0234)	(0.0238)	(0.0468)	(0.0696)
L3.downshockXdistancemed	-0.00159	-0.00111	-0.00588*	-0.00407
	(0.00121)	(0.00117)	(0.00279)	(0.00353)
L4.downshock	-0.0173	-0.00480	0.0132	0.00497
	(0.0150)	(0.0234)	(0.0328)	(0.103)
L4.downshockXdistancemed	-0.000570	-0.000792	-0.00534**	-0.00699**
	(0.00104)	(0.000930)	(0.00174)	(0.00271)
upshock	0.0107	-0.00101	-0.0597	-0.0774
	(0.0271)	(0.0365)	(0.0346)	(0.0556)
upshockXdistancemed	0.000385	0.00134	-0.00223	0.000155
	(0.00102)	(0.000909)	(0.00238)	(0.00281)
L.upshock	-0.0408*	-0.0485	-0.0517	-0.116*
	(0.0210)	(0.0276)	(0.0395)	(0.0560)
L.upshockXdistancemed	0.000545	0.000793	0.00109	0.00109
	(0.000795)	(0.000887)	(0.00203)	(0.00249)
L2.upshock	0.0112	0.0162	0.00450	-0.0302
	(0.0171)	(0.0151)	(0.0309)	(0.0442)

L2.upshockXdistancemed	0.00117	0.00104	-0.00366	-0.00452
	(0.00197)	(0.00212)	(0.00227)	(0.00255)
L3.upshock	0.0255	0.0213	-0.00659	-0.0711
	(0.0159)	(0.0232)	(0.0386)	(0.0463)
L3.upshockXdistancemed	0.00244*	0.00225	-0.00278	-0.00410
	(0.00104)	(0.00120)	(0.00204)	(0.00274)
L4.upshock	-0.00386	0.00720	-0.0112	-0.00416
	(0.0215)	(0.0344)	(0.0383)	(0.0497)
L4.upshockXdistancemed	0.00153	0.000953	-0.00182	-0.00773
	(0.000889)	(0.00156)	(0.00248)	(0.00443)
Constant	0.275***	0.277***	1.595***	1.638***
	(0.00468)	(0.0168)	(0.0142)	(0.0670)
Observations	7,219	7,219	7,309	7,309
R-squared	0.084	0.068	0.237	0.179
Region FE	NO	YES	NO	YES
District FE	YES	NO	YES	NO
Month FE	YES	YES	YES	YES

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

Estimated using OLS. Each observation is a facility-month record. Outcome variables are log transformed. Distmed is the distance of a facility from the shoreline minus the median distance of the sample ($13km$). "L4.upshockXdistancemed" gives the interaction effect of an upward shock 4 months ago with Distmed. Months span from 01/2019-12/2019

Table 3: Effect of Fish Price Shocks on New HIV Cases by Gender

	(New HIV + MALE)	(ANC HIV +)
VARIABLES	(11)	(12)
distancemed	-0.00678***	-0.00242**
	(0.00169)	(0.000943)
upshock	-0.108***	0.0159
	(0.0349)	(0.0217)
upshockXdistancemed	0.00442	0.00240*
	(0.00268)	(0.00135)
L.upshock	0.0265	-0.00524
	(0.0245)	(0.0130)
L.upshockXdistancemed	0.00193	0.00122
	(0.00290)	(0.00143)
L2.upshock	-0.0197	-0.0363***
	(0.0413)	(0.0102)
L2.upshockXdistancemed	-0.000439	-0.000215
	(0.00268)	(0.000812)
L3.upshock	-0.0394	0.0382***
	(0.0612)	(0.00924)
L3.upshockXdistancemed	0.00108	-0.00157**
	(0.00128)	(0.000738)
L4.upshock	-0.0668	-6.56e-05
	(0.0497)	(0.0138)
L4.upshockXdistancemed	0.00485***	0.000439
	(0.00166)	(0.00105)
downshock	0.0206	-0.00228
	(0.0486)	(0.0132)
downshockXdistancemed	-0.00116	0.000854
	(0.00328)	(0.00191)
L.downshock	-0.0200	-0.0383***
	(0.0295)	(0.0127)
L.downshockXdistancemed	0.00522**	0.00134
	(0.00247)	(0.00120)
L2.downshock	0.0240	0.0207
	(0.0303)	(0.0180)
L2.downshockXdistancemed	-0.00271	0.000902

	(0.00360)	(0.00238)
L3.downshock	-0.0696*	0.000526
	(0.0343)	(0.0180)
L3.downshockXdistancemed	0.00685	0.000482
	(0.00465)	(0.00226)
L4.downshock	0.0471	0.0239
	(0.0555)	(0.0198)
L4.downshockXdistancemed	0.00172	5.37e-05
	(0.00515)	(0.00120)
Constant	0.839***	0.348***
	(0.0471)	(0.0273)
Observations	25,585	43,655
R-squared	0.208	0.100
Maize Price Controls	YES	YES
Region FE	YES	YES
Month FE	YES	YES

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

Estimated using OLS. Each observation is a facility-month record. Outcome variables are log transformed. Distmed is the distance of a facility from the shoreline minus the median distance of the sample ($11km$). "L4.upshockXdistancemed" gives the interaction effect of an upward shock 4 months ago with Distmed. Months span from 10/2016-03/2019

Table 4: Effect of Maize Price Shocks on Sexual Health Outcomes

VARIABLES	(New HIV + Cases) (13)	(ANC First Visits) (14)	(New HIV + MALE) (15)	(ANC New HIV +) (16)
distancemed	-0.00239**	-0.000269	-0.00630***	-0.00231**
	(0.00107)	(0.00247)	(0.00183)	(0.000929)
upshock	0.0893***	0.0620	-0.0463*	0.0654***
	(0.0255)	(0.0662)	(0.0248)	(0.0200)
upshockXdistancemed	-0.00195	-0.00348	0.00154	-0.00134
	(0.00133)	(0.00251)	(0.00171)	(0.000945)
L.upshock	-0.0232*	-0.0521*	-0.127***	-0.0161
	(0.0135)	(0.0284)	(0.0306)	(0.0122)
L.upshockXdistancemed	0.00300**	0.00450***	0.00265	0.00181
	(0.00126)	(0.00111)	(0.00206)	(0.00107)
L2.upshock	-0.0279*	0.0266	-3.62e-05	-0.0322***
	(0.0147)	(0.0247)	(0.0464)	(0.0103)
L2.upshockXdistancemed	0.00109	-0.00107	0.000583	0.00123
	(0.00155)	(0.00157)	(0.00197)	(0.00148)
L3.upshock	-0.0215	-0.0267	-0.0746	-0.0157
	(0.0192)	(0.0229)	(0.0451)	(0.0119)
L3.upshockXdistancemed	-0.00121	-0.00160	0.00125	-0.000832
	(0.00128)	(0.00199)	(0.00138)	(0.000963)
L4.upshock	-0.0106	0.0362	-0.0346	-0.00753
	(0.00939)	(0.0382)	(0.0353)	(0.00641)
L4.upshockXdistancemed	0.00118	0.000998	0.000313	0.000987*
	(0.000810)	(0.00199)	(0.00126)	(0.000550)
downshock	0.0185	0.226***	0.0655	0.00108
	(0.0174)	(0.0580)	(0.0420)	(0.0188)
downshockXdistancemed	-0.00573***	-0.00416	-0.00533	-0.00502***
	(0.00177)	(0.00520)	(0.00435)	(0.00160)
L.downshock	0.0594*	0.195	0.130*	0.0615**
	(0.0302)	(0.120)	(0.0671)	(0.0250)
L.downshockXdistancemed	-0.00675***	-0.00414	-0.00514	-0.00467*
	(0.00223)	(0.00444)	(0.00334)	(0.00230)
L2.downshock	0.0394	0.223*	0.0512	0.0316*
	(0.0293)	(0.124)	(0.0495)	(0.0167)
L2.downshockXdistancemed	-0.00310*	-0.00655	-0.00355	-0.00314

	(0.00177)	(0.00514)	(0.00366)	(0.00204)
L3.downshock	0.0513**	0.217*	-0.0243	0.0399**
	(0.0228)	(0.121)	(0.0338)	(0.0177)
L3.downshockXdistancemed	-0.00171	-0.00192	0.00225	-0.00370**
	(0.00158)	(0.00365)	(0.00342)	(0.00133)
L4.downshock	0.0679***	0.243*	0.0208	0.0671***
	(0.0236)	(0.125)	(0.0370)	(0.0188)
L4.downshockXdistancemed	-0.00485**	-0.00485	-0.0108**	-0.00367**
	(0.00176)	(0.00319)	(0.00396)	(0.00154)
Constant	0.339***	1.609***	1.098***	0.253***
	(0.0502)	(0.214)	(0.130)	(0.0579)
Observations	46,419	46,844	25,585	43,939
R-squared	0.096	0.253	0.210	0.100
Fish Price Controls	YES	YES	YES	YES
Region FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES

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

Estimated using OLS. Each observation is a facility-month record. Outcome variables are log transformed. Distmed is the distance of a facility from the shoreline minus the median distance of the sample ($11km$**). "L4.upshockXdistancemed" gives the interaction effect of an upward shock 4 months ago with Distmed. Months span from 10/2016-03/2019**

Table 5: Effect of Fish Price Shocks on Malaria Cases and ANC Visits >12 Weeks

VARIABLES	(Malaria Cases) (17)	(ANC Attendees >12 weeks) (18)
distancemed	0.00406	0.00258
	(0.00587)	(0.00224)
upshock	0.119	0.154
	(0.139)	(0.124)
upshockXdistancemed	0.00585	-0.00285
	(0.00752)	(0.00418)
L.upshock	-0.00759	0.0191
	(0.0983)	(0.0636)
L.upshockXdistancemed	0.00392	0.00284
	(0.00653)	(0.00346)
L2.upshock	-0.0909	-0.109
	(0.0659)	(0.0685)
L2.upshockXdistancemed	0.000328	-0.00137
	(0.00419)	(0.00353)
L3.upshock	0.0685	0.0241
	(0.0713)	(0.0492)
L3.upshockXdistancemed	0.00606	-0.00367*
	(0.00601)	(0.00201)
L4.upshock	0.106*	0.0337
	(0.0567)	(0.0591)
L4.upshockXdistancemed	0.00719	0.00390
	(0.00710)	(0.00297)
downshock	0.203**	0.0611
	(0.0815)	(0.0596)
downshockXdistancemed	0.00617	0.00143
	(0.00759)	(0.00347)
L.downshock	0.112	-0.138
	(0.0944)	(0.120)
L.downshockXdistancemed	-0.000534	0.000718
	(0.00652)	(0.00324)
L2.downshock	0.0142	-0.125
	(0.139)	(0.140)

L2.downshockXdistancemed	0.00876	0.00184
	(0.00696)	(0.00434)
L3.downshock	-0.00503	0.0585
	(0.0689)	(0.0687)
L3.downshockXdistancemed	0.0109	0.00153
	(0.00741)	(0.00403)
L4.downshock	-0.0468	-0.0806
	(0.0480)	(0.0556)
L4.downshockXdistancemed	0.00885	0.00516
	(0.00888)	(0.00445)
Constant	3.598***	2.332***
	(0.148)	(0.132)
Observations	27,482	45,295
R-squared	0.186	0.312
Maize Price Controls	YES	YES
Region FE	YES	YES
Month FE	YES	YES

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

Estimated using OLS. Each observation is a facility-month record. Outcome variables are log transformed. Distmed is the distance of a facility from the shoreline minus the median distance of the sample ($11km$). "L4.upshockXdistancemed" gives the interaction effect of an upward shock 4 months ago with Distmed. Months span from 10/2016-03/2019

Appendix

Table 6: Effect of Fish Price Shocks on HIV Tests

VARIABLES	HIV Tests	HIV Tests Male
	(19)	(20)
distancemed	-0.00409	-0.00547**
	(0.00262)	(0.00238)
upshock	-0.171***	-0.155***
	(0.0509)	(0.0500)
upshockXdistancemed	0.00191	0.00127
	(0.00398)	(0.00359)
L.upshock	0.127	0.116
	(0.0813)	(0.0773)
L.upshockXdistancemed	-0.00676	-0.00461
	(0.00550)	(0.00519)
L2.upshock	-0.132	-0.117
	(0.0938)	(0.0927)
L2.upshockXdistancemed	0.00884	0.00838
	(0.00539)	(0.00603)
L3.upshock	-0.162**	-0.130*
	(0.0767)	(0.0635)
L3.upshockXdistancemed	-0.000325	-0.00148
	(0.00387)	(0.00283)
L4.upshock	-0.00254	-0.0271
	(0.0799)	(0.0768)
L4.upshockXdistancemed	0.00382	0.00180
	(0.00493)	(0.00420)
downshock	0.142*	0.144**
	(0.0737)	(0.0607)
downshockXdistancemed	-0.00354	-0.00508
	(0.00591)	(0.00574)
L.downshock	-0.0282	-0.0522
	(0.0611)	(0.0503)
L.downshockXdistancemed	0.00976**	0.0107**
	(0.00381)	(0.00386)
L2.downshock	0.0286	-0.00536

	(0.0641)	(0.0578)
L2.downshockXdistancemed	-0.00394	-0.000921
	(0.00322)	(0.00288)
L3.downshock	-0.00602	0.0148
	(0.0575)	(0.0643)
L3.downshockXdistancemed	0.00479	0.00291
	(0.00419)	(0.00398)
L4.downshock	0.311***	0.288***
	(0.0832)	(0.0676)
L4.downshockXdistancemed	0.00115	0.00171
	(0.00519)	(0.00531)
Constant	4.152***	3.368***
	(0.122)	(0.133)
Observations	27,756	27,737
R-squared	0.297	0.260
Maize Price Controls	YES	YES
Region FE	YES	YES
Month FE	YES	YES

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

Estimated using OLS. Each observation is a facility-month record. Outcome variables are log transformed. Distmed is the distance of a facility from the shoreline minus the median distance of the sample ($11km$). "L4.upshockXdistancemed" gives the interaction effect of an upward shock 4 months ago with Distmed. Months span from 10/2016-03/2019

Table 7: Cumulative Effects of Fish Price Shocks on Sexual Health Outcomes

VARIABLES	New HIV +	ANC First Visits	Total Syph Treated	ANC Syph Tests
	(21)	(22)	(23)	(24)
distancemed	-0.00240**	-4.28e-05	-0.00100	-0.00637**
	(0.00106)	(0.00222)	(0.000658)	(0.00277)
sumupshocks	0.00442	-0.0529***	-0.00174	-0.0347
	(0.00527)	(0.0184)	(0.00686)	(0.0253)
sumupshocksXdistancemed	-3.96e-05	-0.00158*	0.000131	-0.000341
	(0.000412)	(0.000892)	(0.000312)	(0.00148)
sumdownshocks	-0.0105	-0.0388	-0.0412***	-0.213***
	(0.00781)	(0.0262)	(0.00976)	(0.0703)
sumdownshocksXdistancemed	0.00139	0.000611	0.000472	0.00562*
	(0.00100)	(0.00220)	(0.000514)	(0.00293)
Constant	0.441***	1.215***	0.176***	1.781***
	(0.0308)	(0.129)	(0.0384)	(0.251)
Observations	46,176	46,844	31,402	45,792
R-squared	0.094	0.253	0.112	0.248
Maize Price Controls	YES	YES	YES	YES
Region FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES

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

Estimated using OLS. Each observation is a facility-month record. Outcome variables are log transformed. Distancemed is the distance of a facility from the shoreline minus the median distance of the sample ($11km$). ”sumupshocks” and ”sumdownshocks” sum the number of upward and downward shock months over the previous 4 months. ”sumupshocksXdistancemed” gives the interaction with distancemed Months span from 10/2016-03/2019

Table 8: Effect of Fish Price Shocks on Sexual Health Outcomes (Poisson)

VARIABLES	New HIV +	ANC First Visits	Total Syph Treated	ANC Syph Tests
	(25)	(26)	(27)	(28)
distancemed	-0.00528	-0.000791	-0.00565	-0.00311
	(0.00373)	(0.00318)	(0.00463)	(0.00315)
upshock	0.239*	0.0392	0.250	0.00986
	(0.141)	(0.0635)	(0.155)	(0.0607)
upshockXdistancemed	0.00774	0.00104	0.0101	0.000636
	(0.00705)	(0.00518)	(0.00653)	(0.00463)
L.upshock	-0.0409	0.0967	0.230*	0.0651
	(0.112)	(0.0636)	(0.118)	(0.0874)
L.upshockXdistancemed	0.00300	-0.00539	0.00475	0.00157
	(0.00742)	(0.00392)	(0.00645)	(0.00459)
L2.upshock	-0.148	-0.0576	-0.0505	-0.0404
	(0.0907)	(0.0744)	(0.164)	(0.0784)
L2.upshockXdistancemed	-0.00277	-0.00565	0.000857	0.00255
	(0.00760)	(0.00454)	(0.00746)	(0.00424)
L3.upshock	0.0598	-0.0603	-0.0524	-0.119*
	(0.0752)	(0.0787)	(0.0975)	(0.0706)
L3.upshockXdistancemed	-0.0106**	-0.00167	2.84e-05	-0.00255
	(0.00492)	(0.00259)	(0.00875)	(0.00558)
L4.upshock	-0.00553	0.0120	0.0257	-0.0950
	(0.0563)	(0.124)	(0.0736)	(0.101)
L4.upshockXdistancemed	0.00199	0.000691	-0.0142**	-0.00667
	(0.00488)	(0.00275)	(0.00703)	(0.00568)
downshock	-0.103	-0.0224	-0.309***	-0.118
	(0.0773)	(0.0335)	(0.0918)	(0.0860)
downshockXdistancemed	0.00721	0.000594	-0.00527	0.00247
	(0.0109)	(0.00527)	(0.0138)	(0.00540)
L.downshock	-0.162*	-0.0866	0.0584	-0.0841
	(0.0874)	(0.0581)	(0.202)	(0.101)
L.downshockXdistancemed	-0.00219	0.00165	-0.000643	0.00274
	(0.00588)	(0.00404)	(0.00993)	(0.00336)
L2.downshock	0.0436	-0.0943*	-0.0605	-0.0730

	(0.0944)	(0.0535)	(0.174)	(0.110)
L2.downshockXdistancemed	0.00776	0.00401	0.00320	0.00451
	(0.0123)	(0.00387)	(0.0113)	(0.00445)
L3.downshock	0.0489	-0.0359	-0.420	-0.174
	(0.108)	(0.0700)	(0.270)	(0.151)
L3.downshockXdistancemed	0.00278	0.00373	-0.000967	0.00756
	(0.00962)	(0.00396)	(0.0145)	(0.00594)
L4.downshock	-0.116*	0.0323	-0.209	0.188
	(0.0654)	(0.105)	(0.136)	(0.168)
L4.downshockXdistancemed	-0.000182	0.00143	0.00410	-0.00391
	(0.00501)	(0.00471)	(0.0134)	(0.00511)
Constant	0.0985	2.071***	-0.600***	2.841***
	(0.158)	(0.0995)	(0.199)	(0.245)
Observations	46,176	46,844	31,402	45,792
Maize Price Controls	YES	YES	YES	YES
Region FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES

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

Estimated via Poisson Maximum Likelihood. Each observation is a facility-month record. Distancemed is the distance of a facility from the shoreline minus the median distance of the sample ($11km$**).**
"L4.upshockXdistancemed" gives the interaction effect of an upward shock 4 months ago with Distancemed.
Months span from 10/2016-03/2019

Table 9: Missing Value Removal in Outcome Variables

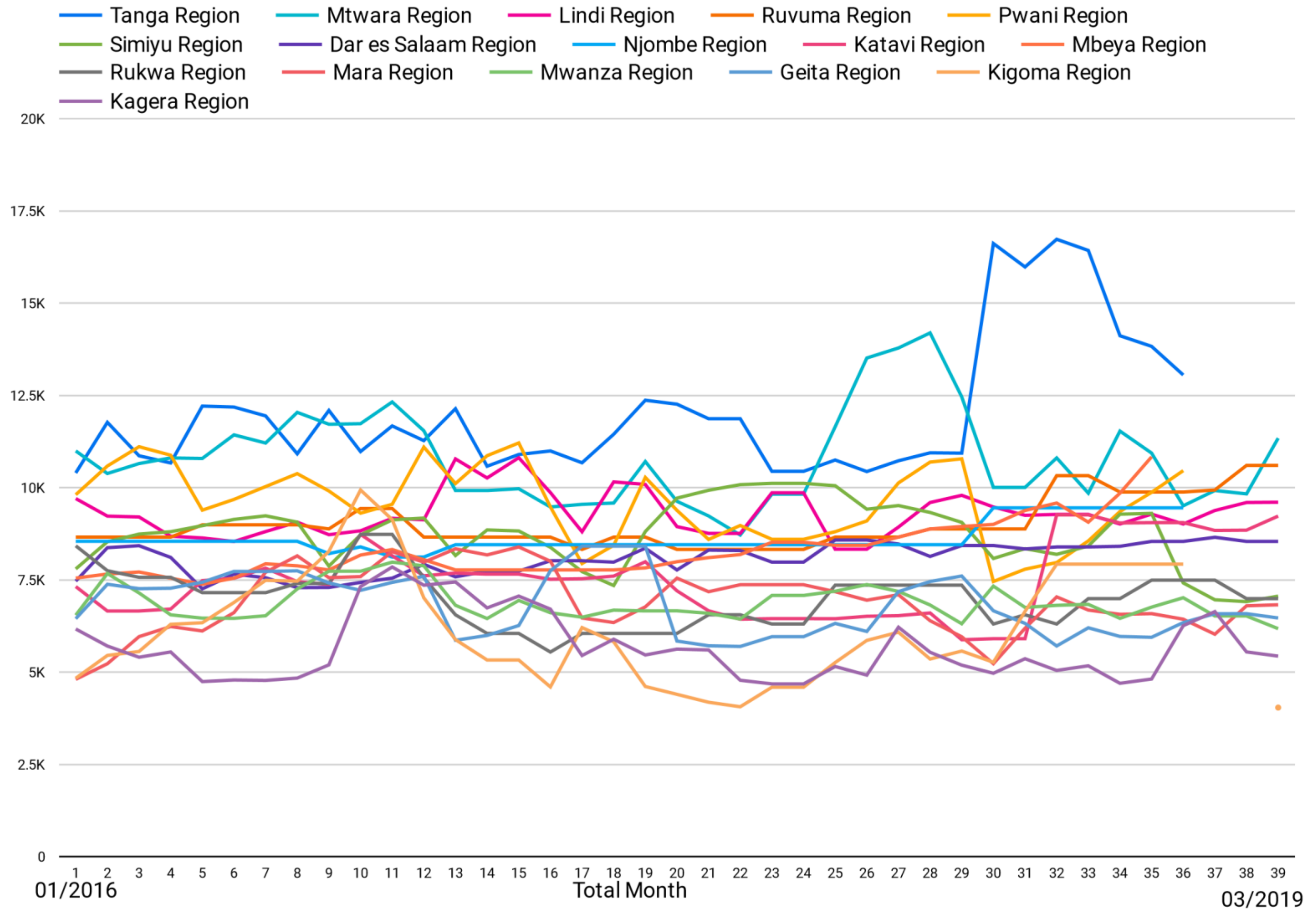
Health Indicator	**MOH UID**	**Stores zero and missing values**	**% of original values removed**
HIV Tests	jT2y2DAIQOr	NO	20.3%
HIV Tests (Male)		NO	20.3%
New HIV +	wuQuMExhCXa,	NO	23.1%
New HIV + (Male)		NO	20.0%
ANC New HIV +	uA7nNtZE8bv		19.7%
ANC Syphilis Tests	PmSZNZHac3t	NO	19.9%
Total Treated for Syphilis	nYUBZNhU74M	NO	22.6%
ANC First Visits	WAdaCligbNP	NO	25.1%
ANC Visits >12 weeks gestational age	ykDWUlQzexW	NO	20.0%
Total Attendance in Outpatients	Yut5amdi7iw	YES	-
Number of Births at Facility	U1KbGaZmjgY	YES	-
Malaria Cases Diagnosed by Rapid Diagnostic Test (mRDT)	NSYWPEpZBuY	YES	-

Criteria for removal of missing values from outcome variables where 'Stores zero and missing values' =NO:

1) **Number of Births at Facility and Total Attendance in Outpatients is missing in that month for that facility**
2) **All other Health indicators are recorded as 0/missing OR have never been recorded for that facility**

Fresh Fish Prices by Region, Tanzania (TZS per KG)

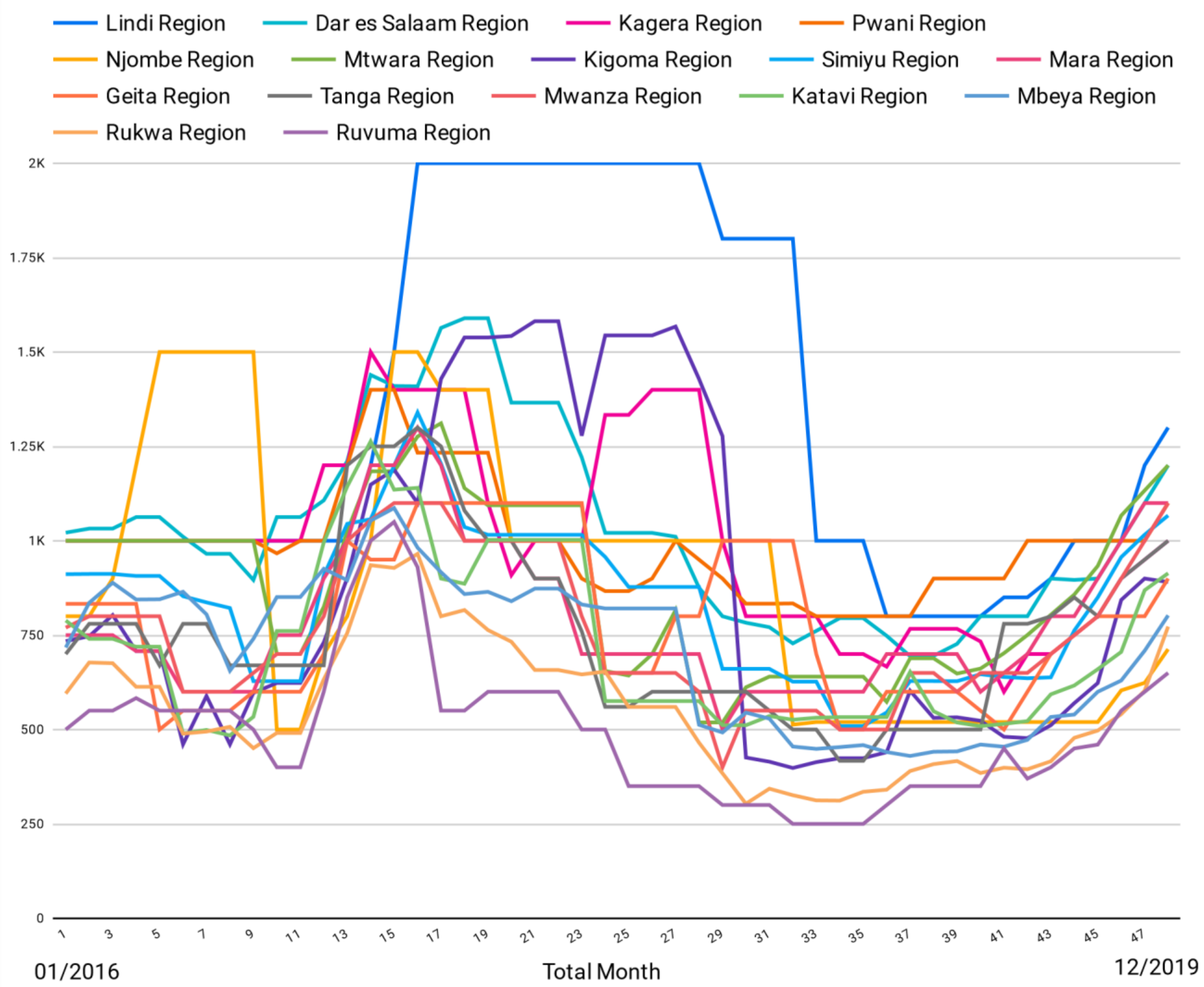
Includes all lake and seashore regions in my sample



	Market	#Upward Shocks ▾	#Downward Shocks
1.	Lindi Region	2	2
2.	Pwani Region	2	2
3.	Rukwa Region	2	2
4.	Tanga Region	2	1
5.	Katavi Region	2	2
6.	Kigoma Region	2	1
7.	Mtwara Region	2	2
8.	Mwanza Region	2	2
9.	Njombe Region	2	1
10.	Ruvuma Region	2	1
11.	Simiyu Region	2	2
12.	Kagera Region	2	1
13.	Mbeya Region	2	1
14.	Geita Region	2	1
15.	Mara Region	2	2
16.	Dar es Salaam Region	1	2

Retail Maize Prices by Region, Tanzania (TZS per KG)

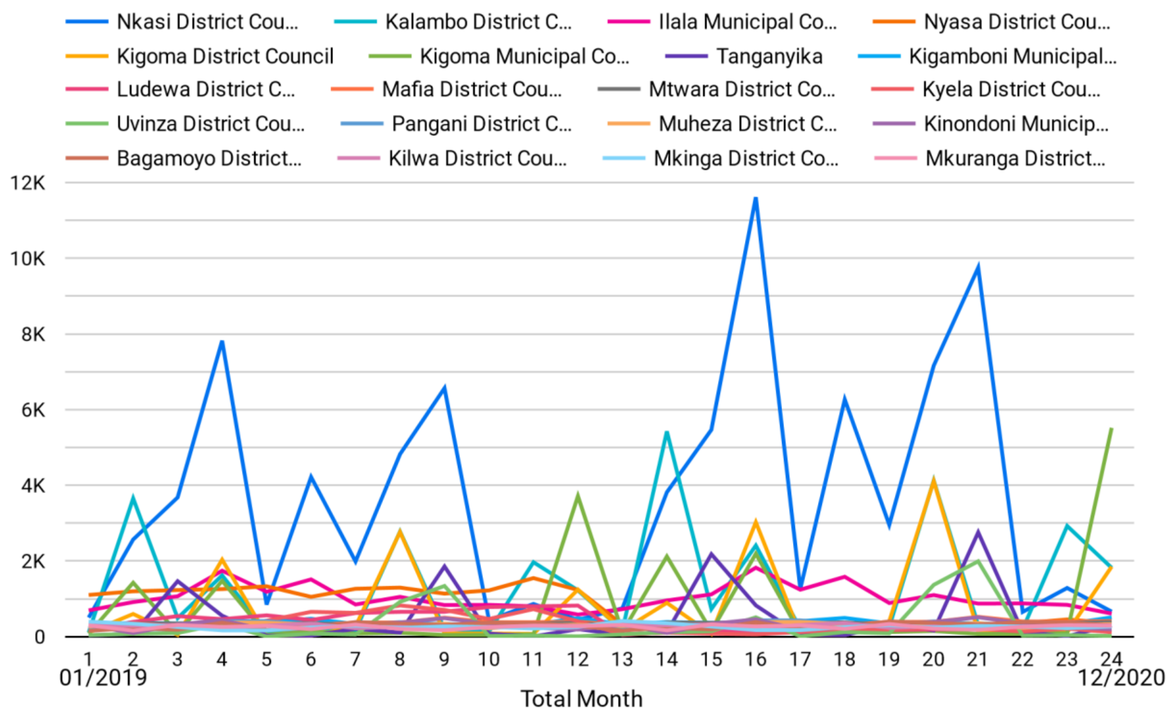
Includes all lake and seashore regions in my sample



	Market	# Upward Shocks ▾	# Downward Shocks
1.	Mara Region	2	1
2.	Pwani Region	2	1
3.	Rukwa Region	2	1
4.	Tanga Region	2	1
5.	Katavi Region	2	1
6.	Kigoma Region	2	1
7.	Mtwara Region	2	2
8.	Mwanza Region	2	2
9.	Njombe Region	2	1
10.	Ruvuma Region	2	1
11.	Simiyu Region	2	2
12.	Dar es Salaam Region	2	1
13.	Kagera Region	2	2
14.	Mbeya Region	2	1
15.	Geita Region	2	1
16.	Lindi Region	1	1

Weight of Fish Captured by District, Tanzania (MT)

Includes all lake and seashore districts in sample



	District	# Upward Shocks ▲	# Downward Shocks
1.	Bagamoyo District Council	1	2
2.	Lindi Municipal Council	1	2
3.	Mkuranga District Council	1	2
4.	Mtwara District Council	1	2
5.	Mkinga District Council	2	1
6.	Mafia District Council	2	2
7.	Mtwara Municipal Council	2	2
8.	Tanga City Council	2	1
9.	Kinondoni Municipal Council	2	2
10.	Lindi District Council	2	2
11.	Ilala Municipal Council	2	1
12.	Kigoma District Council	2	1
13.	Tanganyika	2	1
14.	Pangani District Council	2	2
15.	Ludewa District Council	2	1
16.	Kyela District Council	2	1
17.	Kalambo District Council	2	1
18.	Kigoma Municipal Council	2	1
19.	Nkasi District Council	2	1
20.	Uvinza District Council	2	1
21.	Nyasa District Council	2	1
22.	Kigamboni Municipal Council	2	1
23.	Kilwa District Council	2	2
24.	Rufiji (Kibiti)	2	1
25.	Muheza District Council	2	2

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