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ESSAYS IN POLITICAL ECONOMY

Berlanda Andrea

UNIL | Université de Lausanne

FACULTÉ DES HAUTES ÉTUDES COMMERCIALES

DÉPARTEMENT D'ÉCONOMIE

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THÈSE DE DOCTORAT

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pour l'obtention du grade de
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par

Andrea BERLANDA

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I M P R I M A T U R

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Essays in Political Economy

By
Andrea Berlanda

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Contents

Introduction

The promotion of sustainable development is one of the most relevant challenges that humankind has to face. Providing access to health and promoting gender equality are key components of sustainable development. In addition to being a fundamental right, gender equality is a fundamental element of the sustainable development agenda promoted by the United Nations. In order to promote human capital investments and save lives, ensuring access to health is crucial. The COVID-19 pandemic has demonstrated how pandemics can still negatively impact our economies and how women are the most vulnerable to health shocks.

Cultural and religious norms are among the main drivers of gender inequality through their effects on society and institutions. In the first chapter of this thesis, coauthored with Paolo Buonanno and Marcello Puca, we study how religious beliefs can actually lead to more gender equality and a lower gender gap. More specifically, we focus our analysis on the presence of Waldensian communities in the Italian region of Piedmont. Formed in Lyon (France) in the 12th century, the Waldensian Church is considered a proto-protestant Church and, despite centuries of persecution, it's present in Piedmont since the 13th century. Using data on Inquisition trials held between the 13th and 16th centuries, we identify Waldensian municipalities in the region (i.e., municipalities influenced by Waldensian culture). In our analysis, we explore the effect of religion on gender inequality using historical outcomes, showing that Waldensian presence during the Middle-Age is associated with higher literacy rates, in particular among women, and a reduction in the education gender gap in 1911. To offer a possible channel for those results, we look at public investment in education at the municipality level in 1862-63, and again we find a positive relationship. Lastly, we examine whether the effects persist today. We focus our analysis on outcomes focusing on education, labor market outcomes, and political representation. We find that the Waldensian presence is still associated with higher female education, higher labor market participation, and greater female political representation today.

Adverse health shocks can harm sustainable development in several ways, among others they can generate social instability and violence when governments are not able to respond to them. However, it is still unclear whether health policy interventions can help to reduce conflict. In the second chapter of the thesis, coauthored with Matteo Cervellati, Elena Esposito, Dominic Rohner, and Uwe Sunde, we aim to fill this gap. We focus on the HIV/AIDS epidemic in Africa and the massive worldwide roll-out of antiretroviral therapy (ART) for HIV-positive individuals. A dramatic fall in price in 2001 led to ART becoming available worldwide, resulting in a reduction in mortality and an increase in labor productivity. We ask if, by combatting the HIV/AIDS pandemic in Africa, the ART expansion led also to a reduction in conflicts and social violence. As part of our identification strategy, we use different measures of variation in exposure to ART in a country or subregion. We find robust evidence that the expansion of ART coverage among HIV-positive people led to a reduction in violent events in African countries and sub-national regions. The majority of the reduction is attributed to riots and protests, especially those related to economic issues, but not to large-scale wars. Since our robustness analysis rules out economic well-being as the main driver of social violence, we cannot simply attribute the reduction to a relaxation of economic grievances. An analysis of potential channels shows that ART expansion is strongly associated with an increase in trust in institutions. Our results suggest that adverse health shocks can be an important driver of social unrest, but also that health interventions, besides improving health and economic conditions, can also lead to social peace and stability.

The Covid-19 pandemic has shown us that adverse health shock has a detrimental impact on women empowerment and gender equality. All over the world, we have assisted in a rise in domestic violence reports. This pandemic has shown that women are more affected by adverse health shocks in terms of personal well-being, occupation, and household workload than men. The literature and evidence point to a strong relationship between health shocks and women, but very little is known about how health interventions can affect women empowerment. In my third chapter, I study the effect of ART expansion in Malawi on women empowerment, using Demographic Health Surveys collected at the cluster level in rural areas of the country. As an identification method, I use the health campaign launched by the Malawian government in 2004 to provide free ART in the country's clinics. Based on the scope and accessibility of treatment, I calculate an index to measure the benefit of ART to a community. In communities that have benefited the most from the program, both in terms of the number of beneficiaries and access, women reported increased decision-making and a decrease in physical violence. This positive effect of health policy on empowerment is due to improvement in women education and labor market outcomes.

Lux Lucet in Tenebris: the Role of Waldensian Culture in Reducing the Gender Gap

Andrea Berlanda* Paolo Buonanno† Marcello Puca‡

Abstract

Do religiously driven cultural norms contribute to the gender gap? Focusing on Italian municipalities in the Piedmont region, we study the long-run cultural effect of medieval Waldensian Christian communities on early 19th century female literacy rates. All outcomes of the education gender gap are, on average, statistically and economically lower in municipalities that are home to Waldensian communities. This effect persists until present days, in that women living in these municipalities have, on average, higher education levels. The effect also extends to labor market participation and women's political representation. Our results confirm the importance of cultural and social norms for women's empowerment and the reduction of the gender gap.

Keywords: Gender gap, Religion, Women Empowerment, Waldensians
JEL Codes: J16, N3, Z1

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1 Introduction

In recent years, the study of the long-run determinants of the gender gap has attracted the attention of many economic scholars (Giuliano, 2020). Among other factors, religion seems to be a key factor in the understanding of the phenomenon. The main monotheistic religions have been accused of hindering the development of women's rights throughout the world, contributing to an increase in the gender gap. In 2019, Pope Francis acknowledged that the Catholic Church, throughout its history, has been responsible for male authoritarianism and sexist violence, calling for a church that is more inclusive towards women.[1] In 2021, Amnesty International launched an appeal to stop violence against women perpetrated by the radical Islamic group Boko Haram in Nigeria.[2] The education of women belonging to many Orthodox Jewish communities is gendered since their early years.[3] A recent study by Bentzen and Sperling (2020) shows how, in the U.S., faith-based initiatives are associated with more conservative social views and skepticism when it comes to women who work, or other social issues such as abortion. Becker and Woessmann (2008), using county- and town-level data for Prussia, show that a larger share of Protestants decreased the gender gap in basic education. Previous research also emphasizes the role of culture as a determinant of gender gap in the long term. For instance, Alesina et al. (2013) provide evidence on the long-term effect of technology (i.e. the traditional use of plough) on women force participation through its effect on gender division of labour, while Galor et al. (2020) shows how language structure fostered the transmission of gender roles. Other scholars focus, instead, on the role of societal characteristics on gender gap. For example, Jayachandran (2015) shows how patrilocal societies are associated with higher gender inequality, while Gneezy et al. (2009) how competitive behaviour between men and women is affected by matrilinear and patrilinear society.

In this paper we show that religious beliefs can shape culture and institutions in a way that, actually, *reduces* the gender gap. More specifically, we focus on the case of the Waldensians in Italy. The Waldensian Church, which was formed in France in the 12th

[1] https://www.washingtonpost.com/world/europe/pope-francis-says-church-should-support-womens-rights/2019/04/02/fa7af648-551f-11e9-814f-e2f46684196e_story.html

[2] https://www.amnesty.org/en/latest/news/2021/03/nigeria-boko-haram-brutality-against-women-and-girls-needs-urgent-response-new-research/

[3] https://jewishweek.timesofisrael.com/lets-end-discrimination-against-orthodox-jewish-girls-and-women-in-france/, https://www.csmonitor.com/World/Middle-East/2020/0102/In-Israel-Orthodox-women-are-fighting-to-be-heard-and-seen

century, preached poverty as the only way to heaven, and promoted universal priesthood by allowing women to take on leadership positions in Waldensian communities. The 12th century is also the century in which, by law, women were forced to silence in the religious community.[4] Despite the general environment, we have many authors of the time reporting how among Waldensians was common to have female preachers. Historians consider the Waldensians a "proto-Protestant" faith. Like the Lollards and the Hussites, and well before the Protestant Reformation in 1517, the Waldensians preached ideas that were similar to the Protestant movement. Persecuted for their ideas by the Catholic Church, many Waldensians moved to Italy during the 13th century, settling mainly in Piedmont. Despite centuries of persecution, the Waldensian Church survived in Italy and joined the Reformation in 1532. Today, it remains an active Reformed church (Jahier, 1923, 1924; Tourn, 1977).

Following (Merlo, 1974), our identification strategy relies on the historical persecution of Waldensian communities in Piedmont (Italy) (for a similar approach, see also Drelichman et al., 2021; Miho et al., 2019). Using data on Inquisition trials held between the 13th and 16th centuries, we identify Waldensian municipalities in Piedmont (i.e., municipalities influenced by Waldensian culture), and find that a Waldensian presence contributed to a persistent reduction of the gender gap (both historically and to date). More specifically, our historical analysis focuses on education outcomes, using literacy rates in 1911 and public investment in education in 1862-63. In a similar vein as the analysis of Protestantism by Becker and Woessmann (2008, 2010) and Boppart et al. (2014), we find that the Waldensian presence in Piedmont municipalities is associated with higher literacy rates, an effect that is more pronounced for women, as in Becker and Woessmann (2009). To offer a possible channel of causation through which the Waldensian culture may have affected literacy in 1911, we look at public investment in education at the municipality level in 1862-63. Again, we find a positive association between the Waldensian presence and literacy rates, in line with Boppart et al. (2013). Finally, we study whether the effect of the Waldensian presence persists until the current day, focusing on education, labor market outcomes, and political representation. We find that the Waldensian presence is associated with higher female education, higher labor market participation, and greater female political representation.

Since Max Weber, many authors have studied long term effects of the Reformation on

[4]see *Decretum Gratiani*, XII century

historical social outcomes in Europe, particularly relative to human capital (e.g. Becker and Woessmann, 2008, 2009, 2010; Boppart et al., 2013, 2014; Dittmar and Meisenzahl, 2016), and economic development (e.g. Cantoni, 2015; Cantoni et al., 2018; Nunziata and Rocco, 2018; Arruñada, 2010; Dittmar and Meisenzahl, 2016). Joining this vast literature and the one relative to the relationship between culture and gender gap, our paper makes a threefold contribution. First, we show that religion can have a *positive* effect on the gender gap. Second, we show that the long-term positive effects of the Reformation on education also hold true outside the area of the former Holy Roman Empire. Third, we show that these positive effects persist over centuries, providing new evidences of long term effects of culture and religion on contemporary economic outcomes. These results confirm the importance of social and cultural norms in fostering better social and economic outcomes. In this respect, empowering women in faith communities, taking steps to protect women against sexual harassment, or simply calling for more inclusive religious communities can have a long-lasting positive effect on reducing the gender gap.

The remainder of the paper is organized as follows. Section 2 provides a historical and cultural background on the Waldensian Church and its persecution. Section 3 introduces the data used in the analysis. Section 4 presents our baseline analysis, and Section 5 illustrates the robustness of our results to different specifications. Section 6 concludes.

2 Historical Background

2.1 The History of Waldensians Persecutions

Waldensians are named after Peter Waldo, a wealthy French merchant from Lyon. In 1170, after reading the Gospel account of Jesus and the rich young man (Matthew 19:16-30, Mark 10:17-31, Luke 18:18-30), Waldo decided to sell all his goods and start preaching poverty.[5] He attracted a growing number of disciples, originally known as "the Poor Men of Lyon," who lived in communities that prioritized frugal life and preaching.[6] One of the main characteristics of Waldo's doctrine was universal priesthood: everyone was permitted and actively invited to read the holy scriptures. In pursuit of this goal, Waldensians translated the Bible from Latin to vernacular languages, thus expanding the potential number of readers, as well as allowing both men and women to engage

[5] According to different sources this event likely occurred in 1173 or 1174.
[6] Acts, 2:42-47.

in preaching activities. Involving women in this activity represented a revolution in the context of the XII century. In those years the canon law receipted the *Decretum Gratiani*, a law stating that "a woman, even if she is learned and holy, may not presume to teach men in meeting". This revolutionary attitude toward women is testified also by the chronicles of the times. In the last years of the XII century many inquisitors wrote about Waldensian Women.[7] From these works it appears clear how in the first centuries of the existence of the community women were traveling around villages and cities, preaching in the squares, in the houses, and sometimes even in churches ((Benedetti, 2022)). Sadly, no names of female preachers in the XII century have survived because of those authors' negative views of Waldensian community and their low regard for women.

Waldo's ideas spread rapidly reaching the French region of Provence and Northern Italian regions of Piedmont and Lombardy. After an initial acceptance of Waldensians, motivated by their contribution in the fight against the Cathar heresy, Catholic authorities soon changed their minds, instead considering Waldensians' principles to be erethic. In 1184, following the translation of the Bible into Arpitan (a Franco-Provençal dialect), Pope Lucius III excommunicated the Waldensians from the Roman Catholic Church. Thereafter, the French Catholic authorities began persecuting Waldensians, who were forced to leave the diocese of Lyon. Waldo's followers fled for safer harbors and many of them found refuge in Italy, specifically in the Alpine areas of Piedmont and Lombardy. Still today, there remain several valleys in Piedmont, including Val Pellice, Val Chisone, and Valle Germanasca, which are known as "Waldensian Valleys". Persecutions and inquisitions against the Waldensian heresy started during the 13th century, forcing these communities to hide or escape.[8] Waldensian presence became so relevant in Provence and Piedmont that inquisitors developed specific questionnaires for people suspected of this form of heresy. As we know from the inquisitory registers, there were female preachers among Waldensians during the whole XIII century. ((Biller, 2022)).

This first wave of persecution against the Waldensians reached a peak in 1487, when Pope Innocent VIII issued a bill for the extermination of the Waldensian heresy. The bill resulted in multiple crusades that managed to eradicate all the Waldensian communities

[7] In particular, reference to Waldensian women appears in the memories of the Cistercian monks Geoffry of Auxerre and Alain of Lille, and the Premonstratensian Bernard of Fontcaude

[8] Pope Boniface VIII sent the first inquisitor into the Waldensian Valleys in 1297 and, in 1312, a woman was burnt at the stakes in Pinerolo, in the province of Turin (Tourn, 1977).

in Southern France and Lombardy, though were unsuccessful in Piedmont.[9]

After this initial persecution, the Waldensians joined the Protestant Reformation in 1532. Despite both religious movements promoted universal priesthood, their views on the role of women in society differed. As a result of joining the Reformation, Waldensian women were excluded from public life, and their role shrank to participation in children's education and the family.[10] After the unsuccessful effort to convert the Waldensians, the Duke of Savoy signed a treaty in 1581 that allowed religious freedom for Waldensians in the valleys of Piedmont.

Following a period of tolerance, Waldensians experienced a new wave of repression during the 17th century, though they managed to survive thanks to political support on the part of Protestant countries like England and the Netherlands. The 18th and 19th centuries were, in contrast, a time of relative calm, although Waldensians were only allowed to live in a few villages, known as the *Alpine ghetto*. Finally, Waldensians acquired freedom of worship and full civil rights under Napoleon first, and then later in 1848 with the *Lettere Patenti* signed by the Kingdom of Sardinia (Bosio, 1924; Cameron, 1984, 2000).

2.2 The Role of Women

Initially, women were central figures in the Waldensian movement. Waldo and his disciples lived in communities and monasteries where everyone, even women, was urged to teach and preach the Gospels as well as read the Bible and celebrate Communion.[11] However, women's role became more marginal over the course of the 14th century, and they gradually lost their important place in public life after the Waldensians joined the Protestant Reformation in 1532. Nevertheless, women continued to play a crucial role in recruiting and teaching new believers, even if they were no longer able to preach after persecutions and inquisitions against the Waldensian heresy.

It was only during the 19th century that women reacquired a significant role in Waldensian communities. While primary education became mandatory in Italy with the

[9] According to Tourn (1977), while the crusades in the French region of Dauphiné resulted in the extermination of the Waldensian communities, that in the Waldensian Valleys of Piedmont failed due to the resistance of local communities.

[10] Hugon (1980), page 6.

[11] This evidence is explicitly reported in the writings by Stephen of Bourboun (1180-1261), a Dominican inquisitor and by Alain of Lille (1128-1203) a French theologian. Evidence coming from the records of inquisitorial trials shows that women continued to preach even during the 13th century

"Legge Casati" (Casati Act) of 1859, less attention was paid to the education of young girls compared to that of boys, and many municipalities left school funding to private initiative. In this context, members of the Waldensian Church founded the first female-only school in San Germano Chisone (Turin) in 1826, followed by the establishment of several other female-only schools by the end of the century, in the attempt to improve the education of women (Hugon, 1980). These schools remained active until 1911, when the "Daneo-Credaro reform" introduced a centralized primary education system in Italy.[12] However, because women lacked further education opportunities after primary school, Waldensian communities also opened schools that provided higher education. These included (i) the *Female High School*, which focused on educating women from richer families to become members of the new élite; and (ii) the *Scuola delle ragazze cenciose* (literally the "*School for Ragged Girls*"), which aimed at providing job opportunities to women of lower social status.

During the 20th century, Waldensian women regained their full centrality when they became part of the electorate in the Church Assembly and, later, the right to be elected. Discussion over women's roles had already begun in 1887 during the Waldensian Synod. In 1901, the Synod created a specific commission to discuss women's electoral rights, ultimately allowing women to vote in 1903. A few years later, in 1909, the Synod also started to debate the possibility of permitting women to be elected in the congregation, culminating in 1930 when women obtained this right. It was only in 1949, however, that the first woman gained a chair in the Waldensian Synod. Finally, women were granted full rights after 1962, when the Synod approved the female pastorate, with the first female pastor ordained in 1979. Women's standing continued to rise over time, with female representation among Waldensian deacons and pastors increasing to 10% during the 1980s and to 40% by 2017.[13] After more than seven centuries, women have finally recovered the substantial equality to men they had enjoyed in the first Waldensian communities.

[12] Law no. 487/1911.

[13] See `https://riforma.it/it/articolo/2016/05/16/il-papa-le-donne-e-il-pastorato-femminile-nella-chiesa-valdese` and `https://www.chiesavaldese.org/aria_press.php?ref=72`

3 Data

To study the effect of the Waldensian presence on gender differences, we exploit variation across Piedmont municipalities using both historical and contemporary variables related to educational and labor outcomes, which are measured at the municipality level. Our final baseline sample is composed of 1,188 municipalities. Summary statistics are reported in Table 1. In this section, we discuss in detail how we built the variables used in our analysis.

Table 1: SUMMARY STATISTICS

PANEL A	Waldensian and Output Variables				
Variable	N	Mean	SD	Min	Max
Waldensian	1188	0.088	0.283	0.000	1.000
Literacy	1188	0.882	0.060	0.560	1.000
Literacy women	1188	0.860	0.071	0.515	1.000
Literacy Gap	1188	0.046	0.040	-0.098	0.284
Municipality Schooling Exp (per stud)	1179	8.657	4.942	0.000	92.200
High School or more (Women)	1188	0.353	0.063	0.115	0.642
Women in Labor Force	1188	0.430	0.057	0.118	0.602
Political Representation (Women)	1180	0.304	0.126	0.000	0.715
Employment Rate (Women)	1188	0.395	0.054	0.118	0.587
PANEL B	Historical controls				
Population (1100)	1188	384.577	1706.412	0.000	5.3e+04
Population (1100), excl. Turin	1187	340.080	748.367	0.000	9648.545
Caloric Suitability	1188	2294.637	627.006	1.000	2790.845
Occitan Language	1188	0.077	0.267	0.000	1.000
Franco-Provençal Language	1188	0.040	0.197	0.000	1.000
PANEL C	Geographic controls				
Ruggedness (avg)	1188	222.943	241.674	2.262	986.034
Mountain share	1188	42.520	49.014	0.000	100.000
Altitude	1188	421.619	275.548	76.000	2035.000

Notes: Table 1 reports basic summary statistics for municipalities used in the Baseline Analysis. Panel A reports statistics on our Waldensian presence measure and the outcome variables (literacy rates, gender gap, female representation in labor and politics). Panels B and C report, respectively, summary statistics of the demographic and geographic characteristics of the municipalities in our sample. For each variable we report the number of observation (N), the average value (Mean), Standard Deviation (SD), Minimum Value (Min) and Maximum Value (Max).

3.1 Measures of the Gender Gap

We employ various historical and contemporary measures of the gender gap in this study.

Historical outcomes Our analysis begins with several measures of education, digitized from the 1911 Italian Population Census.[14] For each municipality, the census provides information on the number of literate and illiterate individuals over the age of 6, divided by gender. We used this data to construct the *Literacy Rate* (resp. *Female Literacy Rate*), defined as the share of literate individuals (resp. women) over the total (resp. female) population over age 6. The *Literacy Gender Gap*, then, is calculated as the difference in literacy rates between women and men. While the *Literacy Rate* does not directly measures the gender gap in education, we use it to test whether we can generalize previous results showing a positive effect of the Reformation on education in the Holy Roman Empire.[15]

To understand the channels through which Waldensians may have affected the education gender gap, we also collected information on the *Municipality Expenditure per Student* in primary education. This variable is defined as the ratio between total municipal expenditures on primary education divided by the total number of students enrolled in primary school. Until 1911, education was provided in decentralized manner at the municipal level. It was only after the Daneo-Credaro Law, approved by the Italian parliament in 1911, that most municipal schools became publicly funded. This reform, according to the parliamentary debate, was meant to reduce illiteracy and increase local investments.[16] We digitized the data on education expenditures reported in the school census of 1862-1863.[17]

Contemporary outcomes Access to education and to labor markets can reflect critical differences in the opportunities available to men and women. This is particularly true in countries like Italy, where female participation in the labor market remains among the lowest in the EU.[18] To measure the persistence of gender differences, we collected contemporary data on education, labor market participation, and political representation. Our aim being to analyze to extent to which the Waldensian presence has influenced the role of women in the labor market and in public life. We start with education, defining *Female Education* as the share of women with at least a high school diploma. We then

[14] *Censimento generale della popolazione italiana al 10 giugno 1911*, Tavola V, Ministero di Agricultura, Insutria e Commericio, Direzione Generale della Statistica e del Lavoro, 1914.

[15] See Becker and Woessmann (2009).

[16] See *La scuola italiana dal 1870 ai giorni nostri*, Dina Bertini Jovine, Editori Riuniti, 1958.

[17] *Istruzione Elementare Pubblica per Comuni, Anno Scolastico 1862-1863*, Statistica del Regno d'Italia, 1865.

[18] *European semester thematic factsheet women in the labour market*, 2016.

use two labor market outcomes, namely the *Female Participation Rate*, i.e., the total number of women who are currently employed or in search of a job, and the *Female Employment Rate*, i.e., the ratio of employed women to female working age population. These measures were constructed using data from the 15th Italian Population and Housing Census carried out in 2011 by the Italian Statistical Office (ISTAT).[19] Finally, we also measure the gender gap in terms of political representation. Women are largely under-represented at all levels of political decision-making in Italy, and achieving gender parity in politics remains a distant goal (e.g. Baltrunaite et al., 2014, 2019). In order to study whether the Waldensian presence has also contributed to reducing the gender gap in politics, we define *Women Political Representation* as the average share of elected women in municipal councils over the period of 2014-2018. This data is made available by ISTAT.[20]

3.2 Waldensian Presence

Our main explanatory variable is the presence of Waldensian communities at the municipal level. To this end, we rely on data on inquisition trials against Waldensian communities in Piedmont, which we digitized from Tourn (1977). Despite the potential limitations in data quality and reporting, inquisition trials are considered the best historical source to identify heretical communities in Middle-Age by historians ((Merlo, 1974)). Specifically, we consider Inquisition trials that took place between the 13th and the 16th centuries, a period known as the *Papal Inquisition*.[21] During the *Papal Inquisition*, different monastic orders were appointed by the Papacy as inquisitors – that is, independently from the local authorities – and presided over trials.[22] Usually, inquisitors were traveling through the different parishes announcing their presence and a period of grace for those who appear within a certain period. For this reason, many people appeared in front of the inquisitor of their own free will, even if in the case of an explicit

[19] Censimento della Popolazione e delle Abitazioni 2011, ISTAT.

[20] See *Donne e rappresentanza politica a livello locale - Consigli comunali* at `https://dait.interno.gov.it/contenuti?search_api_views_fulltext=amministratori&f%5B0%5D=node%253Afield_argomento%3A180`.

[21] Three main periods of medieval inquisitions are generally recognised, namely the Episcopal Inquisition (1184–1230s), the Papal Inquisition (1230s-1542), and the Roman Inquisition (1542- 1908).

[22] During the Episcopal Inquisition, instead, inquisitors were appointed by local bishops. During the Episcopal Inquisition, inquisitors were appointed by local bishops. In 1254, with the papal bull *Cum super inquisitione*, Pope Innocenzo IV established 8 inquisitorial districts in Italy, assigned to Dominicans and Franciscans. Districts were in charge to lead investigations and trials against heretics and they were acting independently from local secular and religious authorities Del Col (2007)

suspect they could have been cited. The monk in charge of the process proceeded then with a questionnaire meant to identify if a person was a heretic or not and, through specific questions, if they was a Waldensian or not. A sentence was read in public and, in case of guiltiness, the suspect was assigned to an inquisition court or a civil one. The former issued *spiritual* punishments (e.g., pilgrimages), while the latter issued *secular* (e.g., physical) punishments. The Inquisition investigations and trials considered in our analysis were carried out by the Dominican and Franciscan orders. In our analysis we consider the trials ending with the identification of Waldensian people in a community. We use inquisition trial as a proxy for the presence of Waldensians in a municipality since data regarding the Waldensian population are not available. Reassuringly, narratives show us that it did not exist a systematic under or over-reporting of trials in certain areas. Indeed, inquisitors had a stable presence in the region and they acted independently from secular and religious local authorities (Del Col (2007)). Although our proxy does not measure the number of Waldensian communities, it still convincingly allows us to establish whether a municipality was hosting a community or not.

The variable *Waldensian* is a municipal-level dummy variable that takes a value of 1 if a Waldensian community is present in a municipality, and 0 otherwise. More specifically, we set *Waldensian* equal to 1 in municipalities where a Papal inquisitor carried out an investigation against Waldensians and where trials were held. Figure 1 shows the spatial distribution of Piedmont municipalities identified with our *Waldensian* variable. Table A1 reports summary statistics splitting the sample by Waldensian and non-Waldensian municipalities. Waldensian and not Waldensian communities are not different in terms of the estimated population in 1100. This fact suggests that they did not look for richer or more developed areas once they move from France to Piedmont. However, we find systematic differences in terms of the quality of geography. Waldensian communities are more likely to be found in more rugged and mountainous areas, and in areas less suitable for agriculture.

3.3 Other Control Variables

To ensure that our measure of Waldensian presence does not affect the outcome variables through correlation with omitted municipal climatic, geographical, or historical variables, we include in our estimates a set of control variables that are likely to be correlated with our gender gap measure and the distribution of Waldensians.

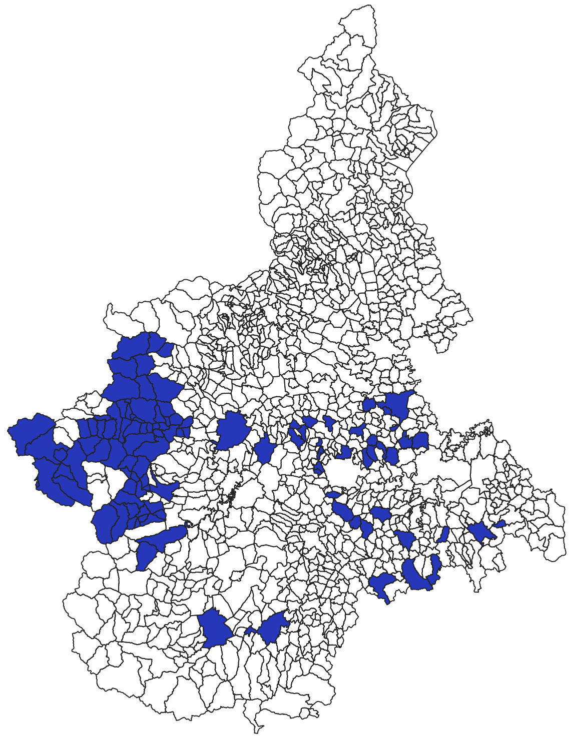

Figure 1: Inquisition trials. Blue indicates municipalities that hosted at least one Inquisition trial against Waldensians.

First, since Waldensian communities came to Italy from France, we take into account any difference across municipalities explained by their French cultural heritage rather than their Waldensian one. We thus record the presence of communities where French regional languages such as Occitan or Franco-Provençal are spoken. To identify these municipalities, we use the list of linguistic minorities in Italy, compiled according to the Italian law no. 482 of 1999.

Second, we focus on geographical factors, which can impact economic development. Indeed, these can sometimes lead to slower growth, in others to positive spillovers, as shown by Nunn and Puga (2012). To account for differences in geography and topography, we control for municipal terrain ruggedness (*Ruggedness*), municipal elevation (*Altitude*), and share of mountainous terrain (*Mountain share*). All geomorphological controls except ruggeddness were obtained from ISTAT.[23]

Finally, to control for potential factors related to human mobility and settlement

[23]The municipal measure of terrain ruggedness was constructed using information from the Global Land One-km Base Elevation Project (GLOBE), a global gridded digital elevation data set covering the Earth's surface at a 10-minute spatial resolution (approximately 1 km).

decisions, our set of control variables also includes: (i) the *Caloric Suitability Index* constructed by Galor and Özak (2016), as a measure of agriculture potential before 1500; and (ii) the estimated total population in 1100 (*Population1100*), taken from Klein Goldewijk, Kees and Beusen, Arthur and Janssen, Peter (2010).

Panel (B) and Panel (C) of Table 1 report summary statistics for the historical and geographical controls.

4 Baseline Evidence

Before discussing the results of our estimates, we first illustrate the baseline model used in our empirical exercise.

4.1 The Model

Our baseline analysis consists in estimating an ordinary least-squared model of the following form:

$$GenderGap_i = \beta \cdot Waldensians_i + \gamma X_i + \zeta_p + \varepsilon_i \tag{1}$$

where: (i) $GenderGap_i$ is a measure of gender-related differences in municipality i; (ii) $Waldensians_i$ is our measure of Waldensian presence; (iii) ζ_p is a year 1911 province fixed effect; and (iv) X_i includes a set of geographical, historical, and demographic control variables.

Our identification strategy relies on the assumption that our measure of Waldensian presence is exogenous to the gender gap measure used in the analysis once we include our set of control variables. In particular, one concern would be that Waldensian communities were located in wealthier and more developed areas in middle age. Summary statistics for Waldensian and not-Waldensian municipalities, reported in Table A1, reassure about this concern. Waldensian communities were located in more remote and less productive areas. According to our data, there is no difference in development, measured as the population in 1100, between Waldensian and non-Waldensian municipalities. Another possible threat to our identification, since it relies on historical data, is measurement error. A first concern could be the fact that more remote areas were more difficult to access, and then we observe fewer inquisition trials in those places. Data allows us to relax this concern, since Waldensian municipalities are characterized by more inhospitable geography, measured using ruggedness, and are more likely to be located in mountainous areas. A second potential source of measurement error could come from the fact that some local authorities could have protected Waldensian communities, resulting in a systematic under-reporting of trials in certain areas. Narratives show us it was not the case. Inquisitors had a stable presence in the region and they acted independently from secular and religious local authorities (Del Col (2007)). Considering this fact, we can safely assume that our data do not suffer from reporting bias.

Table 2 shares the results of our OLS estimation for historical outcomes. To account for possible heterogeneous dynamics of the error term, we report robust standard errors in columns (1), (3), (5), and (7). In columns (2), (4), (6), and (8), meanwhile, we account for potential spatial correlation of the error term using standard errors computed according to Conley (1999), setting the threshold distance at 50 km.[24] All regressions include province fixed effects.

Table 2: Historical Outcomes, Baseline

	Historical Outcomes: Baseline Analysis							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Variable	Literacy		Literacy Women		Literacy Gap		Mun Exp p.s.	
Waldensian	0.016***	0.016***	0.025***	0.025***	-0.020***	-0.020***	1.139***	1.139**
	(0.005)	(0.004)	(0.006)	(0.005)	(0.004)	(0.006)	(0.415)	(0.482)
Observations	1,188	1,188	1,188	1,188	1,188	1,188	1,179	1,179
R2	0.23	0.23	0.23	0.23	0.10	0.10	0.15	0.15
Distance cut-off	NA	50 km	NA	50 km	NA	50 km	NA	50 km
Province f.e.	√	√	√	√	√	√	√	√
Historical controls	√	√	√	√	√	√	√	√
Geographic controls	√	√	√	√	√	√	√	√

Notes: Table 2 reports the results of different estimates for the effect of the presence of Waldensian communities, identified through inquisition trials against Waldensians, on different cross-sections of observations for all Piedmont municipalities in the sample. Odd columns report OLS estimates on a cross-section of observations for all Piedmont municipalities in the sample, using robust standard errors. Even columns report OLS estimates using clustered standard errors, where each municipality is assumed to be correlated to all others in a 50 km radius. The dependent variables are: Cols. (1) and (2) literacy rate in 1911; Cols. (3) and (4) literacy rate among women in 1911; Cols. (5) and (6) the gap in literacy between men and women in 1911; Cols. (7) and (8) the municipal expenditures for primary education per student in 1862-63. Historical controls include the population in the year 1100, the presence of Occitan-speaking communities, the presence of Franco-Provençal communities, and an index of caloric suitability. Geographic controls include: altitude, ruggedness, and the share of mountainous territory. Standard errors in parentheses. *, ** and *** refer to 10%, 5% and 1% significance, respectively.

Column (1) reports the effect of Waldensian communities on the literacy rate in 1911, conditional on our full set of controls. On average, municipalities with a Waldensian presence are characterised by a higher literacy rate in 1911. Column (3) restricts the

[24] Our results are robust to the selection of alternative distance thresholds. See Section 5.

analysis to the female population, revealing a 2.5 percentage point increase in the female literacy rate associated with this presence. Meanwhile, in column (5), we observe a 2 percentage point reduction of the literacy gap between females and males. These results are consistent with the findings of other studies on the effect of the Reformation on human capital (Becker and Woessmann, 2008, 2009), as well as the anecdotal evidence presented in Section 2. To provide a possible channel through which Waldensian communities may have affected literacy, we test whether investment in education is higher in Waldensian municipalities using *Municipality Expenditure per Student* on primary education as the outcome variable. The coefficients reported in column (7) support this supposition, indicating that Waldensian municipalities, on average, invest more in primary education. The baseline results are unaffected once we allow the error terms to be spatially correlated *à la* Conley (1999) (in columns (2), (4), (6), and (8)).

We then present our findings relative to the persistence of the effect of Waldensian communities in Table 3. Column (1) displays the results of our estimates on the share of women who obtained at least a high school diploma by 2011, which increases about 1.6% in association with a Waldensian presence. This suggests that the effect of Waldensian communities on women's literacy is indeed persistent and significant.

Table 3: Contemporary Outcomes, baseline

	Contemporary Outcomes: Baseline Analysis							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Variable	Education (2011)		Women in Labor Force		Women Empl. Rate		Women Political Representation	
Waldensian	0.016**	0.016***	0.011**	0.011*	0.010*	0.010*	0.023*	0.023*
	(0.007)	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.014)	(0.012)
Observations	1,188	1,188	1,188	1,188	1,188	1,188	1,180	1,180
R2	0.12	0.12	0.26	0.26	0.24	0.24	0.03	0.03
Distance cut-off	NA	50 km	NA	50 km	NA	50 km	NA	50 km
Province f.e.	√	√	√	√	√	√	√	√
Historical controls	√	√	√	√	√	√	√	√
Geographic controls	√	√	√	√	√	√	√	√

Notes: Table 3 reports the results of different estimates for the effect of the presence of Waldensian communities, identified through inquisition trials against Waldensians, on different cross-sections of observations for all Piedmont municipalities in the sample. Odd columns report OLS estimates on a cross-section of observations for all Piedmont municipalities in the sample, using robust standard errors. Even columns reports OLS estimates using clustered standard errors, where each municipality is assumed to be correlated to all others in a 50 km radius. The dependent variables are: Cols. (1) and (2) share of female population with at least high school in 2011; Cols. (3) and (4) Female Labor Participation in 2011; Cols. (5) and (6) Women Employment Rate; Cols. (7) and (8) Female Political Representation, measured as the average share of women in a "Consiglio Comunale" over the period of 2014-2018. Historical controls include the population in the year 1100, the presence of Occitan-speaking communities, the presence of Franco-Provençal communities, and an index of caloric suitability. Geographic controls include: altitude, ruggedness, and the share of mountainous territory. Robust standard errors in parentheses. *, ** and *** refer to 10%, 5% and 1% significance, respectively.

Columns (3) and (5), meanwhile, focus on the gender gap in the labor market, showing the effect of Waldensian presence on the female participation rate and employment rate, respectively. We find a positive and significant effect on both in Waldensian municipalities. These results confirm the anecdotal evidence presented in Section 2: since the 19^{th} century, Waldensian communities have supported female workers by providing professional education and contributing to the creation of market conditions more friendly to women.

Finally, in column (7), we consider the gender gap in political empowerment by measuring women's participation and representation in politics. The estimates show a positive and marginally statistically significant effect of Waldensian communities on female political empowerment. This supports the narrative that Waldensian communities created a social environment where women actively participate in decision-making processes. As in Table 2, we see in columns (2), (4), (6), and (8) of Table 3 that our estimates are robust to allowing the error terms to be spatially correlated.

In the Appendix we replicate our analysis controlling for population in 1911 instead of population in 1100 AD. Results, presented in Table A4, are unaffected.

5 The Effect of Waldensians on the Gender Gap

The baseline evidence reveals a positive and statistically significant association between the presence of Waldensians and our measures of female literacy and gender gap reduction. However, since we cannot rule out the possibility that there may be unobserved variables that correlate both with the presence of Waldensians and the outcome variables, we provide an alternative estimate designed to establish a causal link between the two observed phenomena using, more specifically, a neighbor-pair fixed effects. To test the validity of our findings, we also use an instrumental variable (IV) approach and test that our results are robust to different sample restrictions.

5.1 Neighbor Pair Fixed Effects Analysis

In order to verify that systematic differences at the municipality level are not significant drivers of gender differences, we exploit variations in Waldensian presence across directly neighboring municipalities. Specifically, we restrict our sample focusing on the group of 80 Waldensian municipalities with at least one non-Waldensian neighboring municipality, and consider the 231 adjacent non-Waldensian municipalities as the comparison group. Figure A2 graphically illustrates the reduced sample of municipalities used for this empirical strategy. Municipalities in white are excluded from the analysis because they are neither home to a Waldensian community, nor do they border a municipality that is. Similarly, municipalities in black are also excluded because, although they are characterized by Waldensian presence, so too are all their neighboring municipalities. Municipalities with a Waldensian community bordering at least one community without a Waldensian community are indicated in dark grey, while the adjacent non-Waldensian communities are indicated in light grey. Table A2 reports the summary statistics for the municipalities used in this empirical strategy. Compare to the full sample, Waldensian and not-Waldensian municipalities show less differences in terms of outcome.

In this approach we follow Acemoglu et al. (2012) and Buonanno et al. (2015), where we make use of the neighbor-pair fixed effects estimator, very similar to a matching methodology and to a regression discontinuity design. This methodology entails the estimation the following set of equations:

$$Y_i = \beta \cdot Waldensian_i + \gamma X_i + \eta_{in} + \varepsilon_i \quad i \in W \qquad \text{(Waldensian Mun)}$$

$$Y_n = \beta \cdot Waldensian_n + \gamma X_n + \eta_{ni} + \varepsilon_n \quad n \in N(i) \qquad \text{(Neighbor Mun)}$$

where $i \in W$ represents the set of Waldensian municipalities and $n \in N(i)$ the set of non-Waldensian municipalities neighboring municipality i. In estimating this model, we include the same set of control variables used in previous estimations but, instead of province fixed effects, we now include a fixed effect for each of the 685 pairs of municipalities.

Panel (B) of Table 4 reports the findings of the neighbor-pair fixed effect analysis. Overall, the coefficients are qualitatively and quantitatively consistent with the OLS estimates. Even with inclusion of fixed effects at the paired neighboring municipalities level, we identify the effect of Waldensian cultural influence across paired municipalities. This approach is very demanding, and rules out spillover effects on neighboring municipalities, which are excluded by construction. Therefore, the resulting estimates can be considered the lower bound of the true effect of the Waldensian cultural influence on Piedmont municipalities.

Columns (1) to (4) display the estimated coefficients for historical outcomes, which are in line with the OLS estimates in terms of sign and significance and, as expected, are smaller in magnitude. Columns (4) to (8) report, meanwhile, show the estimated coefficients for contemporary outcomes. Those for education and political representation are comparable in terms of their sign and magnitude to the OLS estimates. However, we do not find significant effects on the labor market outcomes. This is arguably explained by the relevance of the significant spillover effects in local labor markets, which make it difficult to observe any statistically significant difference between neighboring municipalities.

5.2 IV Strategy

To test the robustness of our estimates, we provide an alternative estimation approach that takes into account the exact location of Waldensian communities relative to their place of origin, Lyon. As discussed in Section 3, Waldensians settled in more isolated municipalities and hostile areas, partially suggesting that our results are not driven by self selection or reverse causality related to peculiar demographic or geographic characteristics. To take this into account, we adopt an instrumental variable approach that uses the walking distance from Lyon, Peter Waldo's city of birth.[25] We choose walking distance as moving on foot was the most common and cheapest way of travelling in pre-industrial societies.

We compute the walking distance from Lyon to each Piedmont municipality in kilometers using Google API, and then we use the inverse of this distance as the instrument. Figure A1 graphically illustrates the variability of our instrument. Table 4 reports the results of the IV estimation. The first stage regression, reported in column (F.S.) of Table 4, confirms the goodness of our instrument. The distance from Lyon is strongly significant and has the expected sign. The Kleibergeen-Paap statistics for the excluded instrument is approximately 50, suggesting that our estimates do not suffer from a weak instrument problem. The exclusion restriction implies that the distance from Lyon does not affect our outcomes through a channel different than Waldensians presence in a municipality. This may seem implausible at first glance since the distance from Lyon may have affected socioeconomic development through several channels other than Waldensians presence. However, it is worth recall that our set of controls includes municipal level characteristics that net out the effect of several potential channels violation of the exclusion restriction.

[25] The distance should be seen as a proxy of "cultural distance" from the place where the Waldensian Church was founded. Becker and Woessmann (2009) employ a similar approach, using the distance from Wittenberg as an instrument for Protestantism.

Panel (A) of Table 4 reports estimates of the IV analysis. Overall, the estimated coefficients are qualitatively and quantitatively consistent with the OLS results. Columns (2) to (5) report the results for historical outcomes. although the IV coefficients are larger than the OLS ones. This can be explained by local spillover effects: on the one hand, higher levels of education can generate an increase in the supply of literate individuals and teachers in neighboring municipalities as well (*supply spillovers*). On the other hand, higher shares of educated individuals can induce individuals from neighboring municipalities to increase their demand for education (*demand spillovers*). An in increase in supply and demand for education may lead then to a greater benefit of Waldensian communities on education. Similar arguments also hold for outcomes related to labor market conditions and political representation.

Table 4: Historical Outcomes, Robustness

Panel A	Robustness: IV/2SLS								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	F.S.		Historical Outcomes					Contemporary Outcomes	
Dep Variable	Waldensian	Literacy	Literacy Wom	Literacy Gap	Mun Exp p.s.	Education (2011)	Wom in Labor Force	Wom Employement Rate	Wom Political Representation
Distance Lyon	0.132***								
	(0.019)								
Waldensian		0.050**	0.079***	-0.068***	2.306*	0.015	0.113***	0.078***	0.022
		(0.022)	(0.027)	(0.018)	(1.362)	(0.024)	(0.025)	(0.022)	(0.049)
Observations	1,170	1,170	1,170	1,170	1,161	1,170	1,170	1,170	1,162
R2		0.21	0.19	0.01	0.15	0.12	0.06	0.15	0.03
Kleibergen-Paap		50.00	50.00	50.00	49.01	50.00	50.00	50.00	50.06
Province f.e.	√	√	√	√	√	√	√	√	√
Historical controls	√	√	√	√	√	√	√	√	√
Geographic controls	√	√	√	√	√	√	√	√	√

Panel B	Robustness: Neighbor Pair Fixed Effects							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Historical Outcomes					Contemporary Outcomes	
Dep Variable	Literacy	Literacy Wom	Literacy Gap	Mun Exp p.s.	Education (2011)	Wom in Labor Force	Wom Employement Rate	Wom Political Representation
Waldensian	0.007***	0.009***	-0.004**	1.396***	0.014***	-0.002	-0.000	0.018**
	(0.002)	(0.003)	(0.002)	(0.217)	(0.003)	(0.002)	(0.002)	(0.007)
Observations	1,370	1,370	1,370	1,364	1,370	1,370	1,370	1,370
R2	0.06	0.05	0.05	0.33	0.19	0.07	0.07	0.09
Couples f.e.	√	√	√	√	√	√	√	√
Historical controls	√	√	√	√	√	√	√	√
Geographic controls	√	√	√	√	√	√	√	√

Notes: Table 4 reports the results of different estimates for the effect of the presence of Waldensian communities, identified through inquisition trials against Waldensians, on different cross-sections of observations for all Piedmont municipalities in the sample. Odd columns report the second stage of 2SLS regressions using robust standard errors and the walking distance from Lyon as instrument. Even columns report the results of OLS estimates for the effect of the presence of Waldensian communities on a sample containing all the pairs of neighboring municipalities, that include one municipality with a Waldensian community and one without, with standard error clustered at the municipality-pair level. In Panel A the dependent variables are as follows: Cols. (1) and (2) literacy rate in 1911; Cols. (3) and (4) literacy rate among women in 1911; Cols. (5) and (6) the gap in literacy between men and women in 1911; Cols. (7) and (8) municipal expenditures on primary education per student in 1862-63. In Panel B the dependent variables are: Cols. (1) and (2) share of the female population with at least a high school diploma in 2011; Cols. (3) and (4) share of women in the labor force in 2011; Cols. (5) and (6) employment rate among women; Cols. (7) and (8) Women political representation, measured as the average share of women in "Consiglio Comunale" over the period 2014-2018.
Historical controls include the population in year 1100, the presence of Occitan-speaking communities, the presence of Franco-Provençal communities, and an index of caloric suitability. Geographic controls include: altitude, ruggedness, and the share of mountainous territory. Robust standard errors in parentheses. *, ** and *** refer to 10%, 5% and 1% significance, respectively.

The estimates for contemporary outcomes, reported in columns (5) to (9), help us understand why spillover effects are important. Once again, the estimated coefficients are consistent with the OLS estimation, although less statistically significant for education and political representation, and extremely significant for labor market outcomes. This is suggestive of the spatial spillovers captured by the IV approach. Since education was a public good provided by the central government, the cultural influence of Waldensian municipalities on their neighbors vanishes. Conversely, women-friendly labor market conditions may create spillover effects from Waldensian municipalities to neighboring ones, inducing female workers to apply for jobs outside their municipality of residence. The cultural influence of Waldensian communities, in this case, may explain the explosion of the labor market outcome coefficients.

To address these concerns and ensure that our estimates are unbiased, we now perform a further robustness test that takes into account the possible spatial spillovers generated by Waldensian culture.

5.3 Other Robustness Checks

Another potential concern about our results may be the non-random settlement choice of Waldensians, which is not explained by the geographical or demographic control variables. Table A5 addresses this, providing the results of the same set of baseline regressions in Table 2, but where we restrict our sample according to the population size in the year 1100. In columns (1), (3), (5), and (7) we report coefficients for municipalities with fewer than 1,000 inhabitants while, in columns (2), (4), (6), and (8) the coefficients refer to municipalities with fewer than 500 inhabitants. The estimated coefficients remain stable in sign, magnitude, and statistical significance, suggesting that city size does not drive our results.

Another possible issue pertains to the distance threshold selected to compute standard errors according to Conley (1999). We see that this is not, in fact, a problem in Table A6, where we report our baseline estimates with different distance cutoffs (i.e. at 25km and 75km). In this case as well, the estimated coefficients remain stable in sign, magnitude, and statistical significance.

6 Conclusion

While there is no shortage of empirical work on the long-run effects of cultural and institutional changes on economic and social outcomes, few studies also explore the medium and long-run impact of religion-driven cultural norms. We contribute to this growing literature by analyzing the influence of Waldensian communities living in the Italian municipalities of Piedmont in creating an environment that was friendly to women. This has, in turn, led to a reduced gender gap in education, labor participation, and political representation. We identify, in the Waldensian norm that allows every individual to read sacred scriptures independent of sex, the reason for higher levels of education among women.

Our observation of a positive and significant impact of Waldensian culture on women's education in 1911 suggests that religious motives are important cultural factors in explaining the gender gap. Importantly, we find that this effect persists over time, as women in Waldensian municipalities are more likely to have at least a high school diploma, to participate in the labor market, and in politics.

These effects are not the result of other socio-economic, historical, or even geographic factors at play in Waldensian municipalities. Our findings are robust to the inclusion of several control variables, and to various alternative empirical specifications.

Our findings shed greater light on the factors underlying the gender gap, showing that religion does not create an environment that is hostile to women *per se*. The Waldensian emphasis on women's education, combined with their religious norms, appear to be important determinants of women's empowerment.

References

Acemoglu, D., García-Jimeno, C., and Robinson, J. A. (2012). Finding Eldorado: Slavery and long-run development in Colombia. *Journal of Comparative Economics*, 40(4):534–564.

Alesina, A., Giuliano, P., and Nunn, N. (2013). On the origins of gender roles: Women and the plough. *The Quarterly Journal of Economics*, 128(2):469–530.

Arruñada, B. (2010). Protestants and Catholics: Similar work ethic, different social ethic. *The Economic Journal*, 120(547):890–918.

Baltrunaite, A., Bello, P., Casarico, A., and Profeta, P. (2014). Gender quotas and the quality of politicians. *Journal of Public Economics*, 118:62–74.

Baltrunaite, A., Casarico, A., Profeta, P., and Savio, G. (2019). Let the voters choose women. *Journal of Public Economics*, 180:104085.

Becker, S. O. and Woessmann, L. (2008). Luther and the girls: Religious denomination and the female education gap in nineteenth-century Prussia. *Scandinavian Journal of Economics*, 110(4):777–805.

Becker, S. O. and Woessmann, L. (2009). Was Weber wrong? A human capital theory of Protestant economic history. *The Quarterly Journal of Economics*, 124(2):531–596.

Becker, S. O. and Woessmann, L. (2010). The effect of Protestantism on education before the industrialization: Evidence from 1816 Prussia. *Economics Letters*, 107(2):224–228.

Benedetti, M. (2022). Women: A silent presence? In *A Companion to the Waldenses in the Middle Ages*, pages 332–353. Brill.

Bentzen, J. and Sperling, L. (2020). God Politics: Religion, Attitude, and Outcomes. *CEPR Discussion Paper No. DP14380*.

Biller, P. (2022). Inquisitors' interrogations of waldenses. In *A Companion to the Waldenses in the Middle Ages*, pages 354–393. Brill.

Boppart, T., Falkinger, J., and Grossmann, V. (2014). Protestantism and education: Reading (the bible) and other skills. *Economic Inquiry*, 52(2):874–895.

Boppart, T., Falkinger, J., Grossmann, V., Woitek, U., and Wüthrich, G. (2013). Under which conditions does religion affect educational outcomes? *Explorations in Economic History*, 50(2):242–266.

Bosio, D. (1924). *L'emancipazione dei valdesi (17 febbraio 1848) nel centenario della fausta ricorrenza*. Società di studi valdesi, Torre Pelice.

Buonanno, P., Durante, R., Prarolo, G., and Vanin, P. (2015). Poor institutions, rich mines: Resource curse in the origins of the sicilian mafia. *The Economic Journal*, 125(586):F175–F202.

Cameron, E. (1984). *The Reformation of the Heretics: The Waldenses of the Alps 1480-1580*. Oxford University Press: New York NY.

Cameron, E. (2000). *Waldenses: Rejections of Holy Church in Medieval Europe*. Blackwell Publishers: Oxford UK.

Cantoni, D. (2015). The economic effects of the Protestant Reformation: testing the Weber hypothesis in the German lands. *Journal of the European Economic Association*, 13(4):561–598.

Cantoni, D., Dittmar, J., and Yuchtman, N. (2018). Religious Competition and Reallocation: The Political Economy of Secularization in the Protestant Reformation. *Quarterly Journal of Economics*, 133(4):2037–2096.

Conley, T. G. (1999). GMM estimation with cross sectional dependence. *Journal of Econometrics*, 92(1):1–45.

Del Col, A. (2007). I rapporti tra i giudici di fede in italia dal medioevo all'età moderna. In *I tribunali della fede continuità e discontinuità dal medioevo all'età moderna*, pages 83–110. Società di studi valdesi, Torre Pelice.

Dittmar, J. E. and Meisenzahl, R. (2016). Origins of growth: Health shocks, institutions, and human capital in the protestant reformation. *Unpublished*.

Drelichman, M., Vidal-Robert, J., and Voth, H.-J. (2021). The long-run effects of religious persecution: Evidence from the Spanish Inquisition. *Proceedings of the National Academy of Sciences*, 118(33).

Galor, O. and Özak, Ö. (2016). The agricultural origins of time preference. *American Economic Review*, 106(10):3064–3103.

Galor, O., Özak, Ö., and Sarid, A. (2020). Linguistic traits and human capital formation. In *AEA Papers and Proceedings*, volume 110, pages 309–313.

Giuliano, P. (2020). Gender and culture. *Oxford Review of Economic Policy*, 36(4):944–961.

Gneezy, U., Leonard, K. L., and List, J. A. (2009). Gender differences in competition: Evidence from a matrilineal and a patriarchal society. *Econometrica*, 77(5):1637–1664.

Hugon, A. A. (1980). *La donna nella storia valdese*. Società di studi valdesi - Torrepellice.

Jahier, D. (1923). *Pietro Valdo e il movimento valdese italiano nel Medio Evo*. Tipografia Alpina, Torre Pelice.

Jahier, D. (1924). *I Valdesi Italiani prima della riforma del secolo XVI*. Tipografia Alpina, Torre Pelice.

Jayachandran, S. (2015). The roots of gender inequality in developing countries. *Annual Review of Economics*, 7(1):63–88.

Klein Goldewijk, Kees and Beusen, Arthur and Janssen, Peter (2010). Long-term dynamic modeling of global population and built-up area in a spatially explicit way: HYDE 3.1. *The Holocene*, 20(4):565–573.

Merlo, G. C. (1974). Distribuzione topografica e coposizione sociale delle comunità valdesi in piemonte nel basso medioevo. *Bollettino della Società di Studi Valdesi*, (174).

Miho, A., Jarotschkin, A., and Zhuravskaya, E. (2019). Diffusion of gender norms: Evidence from stalin's ethnic deportations. *Available at SSRN 3417682*.

Nunn, N. and Puga, D. (2012). Ruggedness: The blessing of bad geography in Africa. *Review of Economics and Statistics*, 94(1):20–36.

Nunziata, L. and Rocco, L. (2018). The protestant ethic and entrepreneurship: Evidence from religious minorities in the former holy roman empire. *European Journal of Political Economy*, 51:27–43.

Tourn, G. (1977). *I Valdesi: la singolare vicenda di un popolo-chiesa,(1170-1976)*. Claudiana editrice.

A Appendix

A.1 Figures

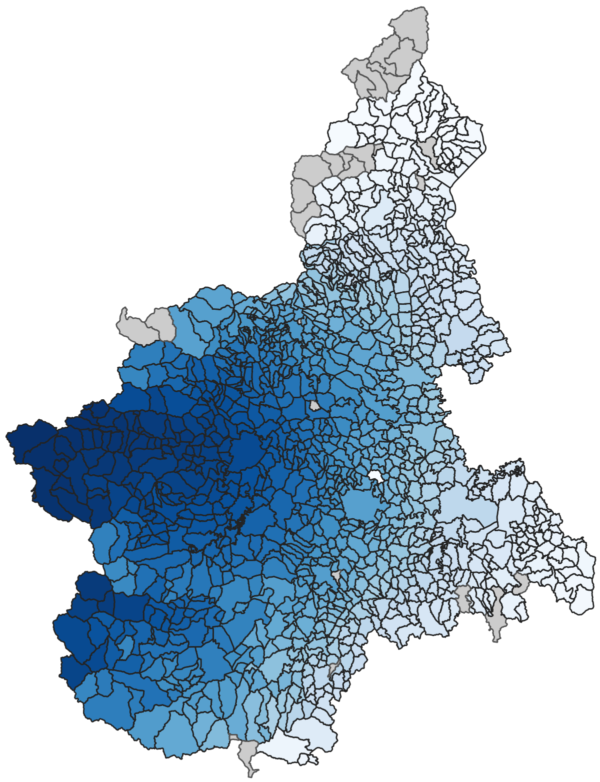

Figure A1: Distance from Lyon. Darker levels of blue indicate a shorter distance from Lyon.

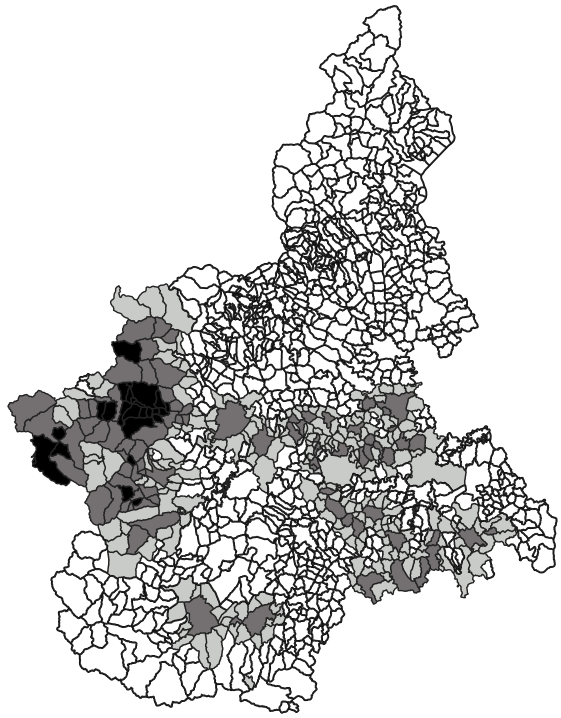

Figure A2: Neighbor fixed-effects municipalities. Dark grey municipalities are those with a Waldensian community that borders at least one municipality without such a community, while light grey municipalities are non-Waldensian municipalities that border a Waldensian municipality. Municipalities with only like neighbors are excluded from the analysis, and are represented in black (Waldensian municipalities surrounded by other Waldensian municipalities) or white (non-Waldensian municipalities with only non-Waldensian neighbors).

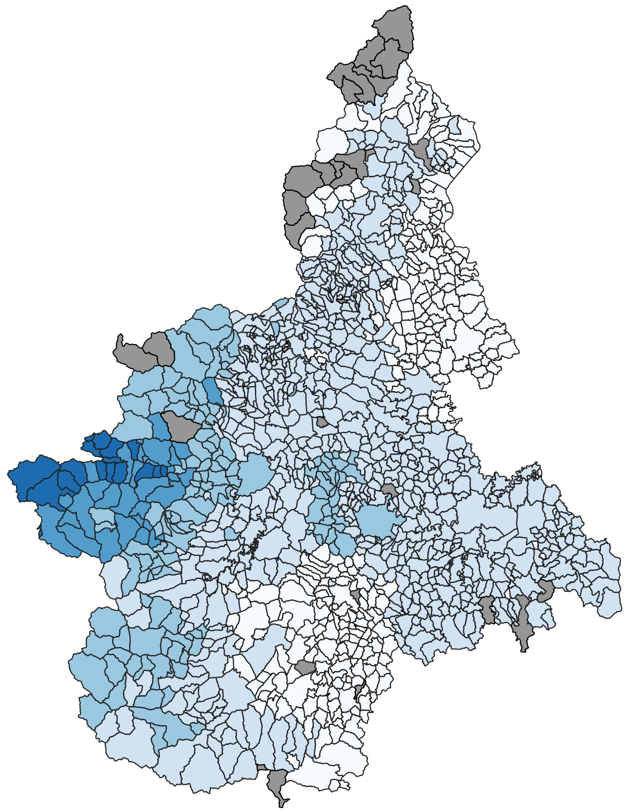

Figure A3: Coefficients of the first-stage IV regression between the indicator of a Waldensian municipality and the distance from Lyon. Darker blue shading indicates a larger coefficient. Grey municipalities are excluded from the sample because of missing observations in the set of control variables.

A.2 Tables

Table A1: Summary statistics, by Waldensian municipalities

PANEL A												
	Output Variables											
	Waldensians >0					Waldensians $=0$						
Variable	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	Diff.	p (2-tailed)
Literacy	104	0.895	0.049	0.699	0.988	1084	0.881	0.060	0.560	1.000	.015	.005
Literacy women	104	0.878	0.057	0.668	0.990	1084	0.858	0.072	0.515	1.000	.02	.001
Literacy Gap	104	0.034	0.035	-0.098	0.145	1084	0.047	0.041	-0.066	0.284	-.013	.001
Municipality Schooling Exp (per stud)	104	8.192	4.303	1.549	21.538	1075	8.702	4.999	0.000	92.200	-.51	.257
High School or more (Women)	104	0.373	0.069	0.204	0.642	1084	0.351	0.062	0.115	0.603	.023	.001
Women in Labor Force	104	0.428	0.050	0.273	0.598	1084	0.431	0.057	0.118	0.602	-.003	.5710000000000001
Political Representation (Women)	104	0.328	0.125	0.020	0.625	1076	0.302	0.126	0.000	0.715	.025	.05
Employment Rate (Women)	104	0.390	0.047	0.261	0.566	1084	0.395	0.055	0.118	0.587	-.005	.302
PANEL B	Historical controls											
Population (1100)	104	835.817	5221.899	9.016	5.3e+04	1084	341.285	759.380	0.000	9648.545	494.532	.337
Population (1100), excl. Turin	103	327.398	623.755	9.016	3770.844	1084	341.285	759.380	0.000	9648.545	-13.887	.833
Caloric Suitability	104	1882.529	904.105	1.000	2562.194	1084	2334.175	579.030	1.000	2790.845	-451.646	0
Occitan Language	104	0.231	0.423	0.000	1.000	1084	0.063	0.243	0.000	1.000	.168	0
Franco-Provençal Language	104	0.202	0.403	0.000	1.000	1084	0.025	0.156	0.000	1.000	.177	0
PANEL C	Geographic controls											
Ruggedness (avg)	104	381.308	277.459	27.719	899.827	1084	207.750	232.495	2.262	986.034	173.558	0
Mountain share	104	63.139	48.058	0.000	100.000	1084	40.542	48.669	0.000	100.000	22.597	0
Altitude	104	571.817	394.687	116.000	2035.000	1084	407.208	256.960	76.000	1684.000	164.609	0

Notes: Table A1 reports basic summary statistics for municipalities in the sample distinguishing between Waldensian and not Waldensian municipalities. Standard errors are in parentheses.

Table A2: Summary statistics, Paired municipalities

	MEAN		
	Waldensians (1)	No Waldensians (2)	DIFFERENCE (3)
Literacy	0.886	0.878	-0.008
	(0.002)	(0.002)	(0.003)
Literacy women	0.868	0.856	-0.011
	(0.003)	(0.002)	(0.004)
Literacy gap	0.036	0.043	0.006
	(0.001)	(0.001)	(0.002)
Municipality Schooling Exp (per stud)	11.04	8.57	-2.47
	(0.187)	(0.145)	(0.236)
High School or more (Women)	0.375	0.356	-0.018
	(0.002)	(0.002)	(0.003)
Women in Labor Force	0.421	0.424	0.003
	(0.002)	(0.002)	(0.002)
Political Representation (Women)	0.304	0.297	-0.006
	(0.004)	(0.004)	(0.006)
Employment Rate (Women)	0.384	0.388	0.003
	(0.001)	(0.002)	(0.002)
Population (1100)	394.36	535.67	141.3
	(78.52)	(80.69)	(145.26)
Caloric Suitability	2260.76	2258.48	-2.28
	(25.79)	(24.84)	(35.79)
Occitan Language	0.058	0.068	0.011
	(0.009)	(0.009)	(0.013)
Franco-Provençal Language	0.058	0.049	-0.012
	(0.009)	(0.008)	(0.012)
Ruggedness (avg)	193.72	191.59	- 2.12
	(8.51)	(8.74)	(12.20)
Mountain share	29.86	33.07	3.21
	(1.71)	(1.74)	(2.44)
Altitude	623.99	598.23	-25.76
	(21.90)	(22.49)	(31.40)

Notes: Table A2 reports basic summary and statistics for municipalities used in the Neighbor Pair Fixed Effects Analysis distinguishing between Waldensian not Waldensian municipalities. Standard errors are in parentheses. Column 3 reports the difference of the variable between the Waldensian municipalities and the not Waldensian one.

Table A3: Baseline Estimates without controls

	Panel A: Historical Outcomes			
	(1)	(2)	(3)	(4)
	Literacy	Literacy Wom	Literacy Gap	Mun Exp p.s.
Waldensian	0.015***	0.020***	-0.013***	-0.510
	(0.005)	(0.006)	(0.004)	(0.447)
Observations	1,188	1,188	1,188	1,179
	Panel B: Contemporary Outcomes			
	(1)	(2)	(3)	(4)
	Education (2011)	Wom in Labor Force	Wom Employement Rate	Wom Political Representation
Waldensian	0.023***	-0.003	-0.005	0.025**
	(0.007)	(0.005)	(0.005)	(0.013)
Observations	1,188	1,188	1,188	1,180

Notes: Table A3 reports the results of different estimates for the effect of the presence of Waldensian communities, identified through inquisition trials against Waldensians, on different cross-sections of observations for all Piedmont municipalities in the sample. Columns report OLS estimates on a cross-section of observations for all Piedmont municipalities in the sample without using any control variable. Panel A dependent variables are: Col. (1) literacy rate in 1911; Col. (2) literacy rate among women in 1911; Cos. (3) the gap in literacy between men and women in 1911; Col. (4) the municipal expenditures for primary education per student in 1862-63. Panel B dependent variables are: Col. (1) share of female population with at least a high school diploma in 2011; Col. (2) share of women in labor force in 2011; Col. (2) employment rate among women; Col (4) women's political representation, measured as the average share of women in "Consiglio Comunale" over the period 2014-2018., using robust standard errors.

Table A4: Historical Outcomes, controlling for population 1911

	Panel A: Historical Outcomes - Baseline Analysis							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep Variable	Literacy		Literacy Wom		Literacy Gap		Mun Exp p.s.	
Waldensian	0.018***	0.018***	0.026***	0.026***	-0.020***	-0.020***	1.403***	1.403**
	(0.005)	(0.006)	(0.006)	(0.006)	(0.004)	(0.006)	(0.417)	(0.562)
Observations	1,190	1,190	1,190	1,190	1,190	1,190	1,181	1,181
R2	0.23	0.23	0.23	0.23	0.10	0.10	0.15	0.15
	Panel B: Contemporary Outcomes - Baseline Analysis							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep Variable	Education (2011)		Wom in Labor Force		Wom Employement Rate		Wom Political Representation	
Waldensian	0.016**	0.016***	0.015***	0.015***	0.014***	0.014**	0.026*	0.026**
	(0.007)	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.014)	(0.012)
Observations	1,190	1,190	1,190	1,190	1,190	1,190	1,180	1,180
R2	0.12	0.12	0.26	0.26	0.24	0.24	0.03	0.03
Distance cut-off	NA	50 km	NA	50 km	NA	50 km	NA	50 km
Province f.e.	√	√	√	√	√	√	√	√
Historical controls	√	√	√	√	√	√	√	√
Geographic controls	√	√	√	√	√	√	√	√

Notes: Table A4 reports the results of different estimates for the effect of the presence of Waldensian communities, identified through inquisition trials against Waldensians, on different cross-sections of observations for all Piedmont municipalities in the sample. Odd columns report OLS estimates on a cross-section of observations for all Piedmont municipalities in the sample, using robust standard errors. It differentiantes from Tables 2 and 3 since here we control for municipality population in 1911 and not the estimates for 1100 population. Even columns report OLS estimates using clustered standard errors, where each municipality is assumed to be correlated to all others in a 50 km radius. Panel A dependent variables are: Cols. (1) and (2) literacy rate in 1911; Cols. (3) and (4) literacy rate among women in 1911; Cols. (5) and (6) the gap in literacy between men and women in 1911; Cols. (7) and (8) the municipal expenditures for primary education per student in 1862-63. Panel B dependent variables are: Cols. (1) and (2) literacy rate in 1911; Cols. (3) and (4) literacy rate among women in 1911; Cols. (5) and (6) the gap in literacy between men and women in 1911; Cols. (7) and (8) the municipal expenditures for primary education per student in 1862-63. Panel B dependent variables are: Cols. (1) and (2) share of female population with at least a high school diploma in 2011; Cols. (3) and (4) share of women in labor force in 2011; Cols. (5) and (6) employment rate among women; Col (7) and (8) women's political representation, measured as the average share of women in "Consiglio Comunale" over the period 2014-2018. Historical controls include the population in the year 1100, the presence of Occitan-speaking communities, the presence of Franco-Provençal communities, and an index of caloric suitability. Geographic controls include: altitude, ruggedness, and the share of mountainous territory. Standard errors in parentheses. *, ** and *** refer to 10%, 5% and 1% significance, respectively.

Table A5: Baseline Analysis, population threshold

	Historical Outcomes: Robustness (Pop. 1100 Threshold)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep Variable	Literacy		Literacy Wom		Literacy Gap		Mun Exp p.s.	
Waldensian	0.017***	0.018***	0.027***	0.028***	-0.022***	-0.023***	0.980**	0.967**
	(0.006)	(0.006)	(0.007)	(0.007)	(0.004)	(0.005)	(0.423)	(0.433)
Observations	1,107	1,031	1,107	1,031	1,107	1,031	1,100	1,024
R2	0.22	0.23	0.22	0.23	0.09	0.09	0.15	0.14
	Contemporary Outcomes: Robustness (Pop. 1100 Threshold)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep Variable	Education (2011)		Wom in Labor Force		Wom Employement Rate		Wom Political Representation	
Waldensian	0.015**	0.016**	0.014**	0.015**	0.013**	0.013**	0.027*	0.029*
	(0.007)	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)	(0.015)	(0.015)
Observations	1,107	1,031	1,107	1,031	1,107	1,031	1,099	1,023
R2	0.11	0.11	0.25	0.24	0.24	0.23	0.03	0.03
Population threshold	≤ 1000	≤ 500	≤ 1000	≤ 500	≤ 1000	≤ 500	≤ 1000	≤ 500
Province f.e.	√	√	√	√	√	√	√	√
Historical controls	√	√	√	√	√	√	√	√
Geographic controls	√	√	√	√	√	√	√	√

Notes: Table A5 reports the results of different estimates for the effect of the presence of Waldensian communities, identified through inquisition trials against Waldensians, on different cross-sections of observations for subsamples of Piedmont municipalities in the baseline sample. Odd columns restrict the sample to municipalities with a population of under 1000 people in the year 1000, while even columns restrict the sample to municipalities with a population lower than 500 people in the year 1000. In the top panel, the dependent variables are: Cols. (1) and (2) literacy rate in 1911; Cols. (3) and (4) literacy rate among women in 1911; Cols. (5) and (6) the gap in literacy between men and women in 1911; Cols. (7) and (8) the municipal expenditures on primary education per student in 1862-63. In the bottom panel, the dependent variables are: Cols. (1) and (2) share of female population with at least a high school diploma in 2011; Cols. (3) and (4) share of women in labor force in 2011; Cols. (5) and (6) employment rate among women; Col (7) and (8) women's political representation, measured as the average share of women in "Consiglio Comunale" over the period 2014-2018. Historical controls include the population in the year 1100, the presence of Occitan-speaking communities, the presence of Franco-Provençal communities, and an index of caloric suitability. Geographic controls include: altitude, ruggedness, and the share of mountainous territory. Robust standard errors in parentheses. *, ** and *** refer to 10%, 5% and 1% significance, respectively.

Table A6: Arbitrary Clustering, different threshold

	Historical Outcomes: Robustness (Alternative clustering)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep Variable	Literacy		Literacy Wom		Literacy Gap		Mun Exp p.s.	
Waldensian	0.016***	0.016***	0.025***	0.025***	-0.020***	-0.020***	1.139***	1.139***
	(0.002)	(0.004)	(0.002)	(0.005)	(0.005)	(0.003)	(0.344)	(0.352)
Observations	1,188	1,188	1,188	1,188	1,188	1,188	1,179	1,179
R2	0.23	0.23	0.23	0.23	0.10	0.10	0.15	0.15
	Contemporary Outcomes: Robustness (Alternative clustering)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep Variable	Education (2011)		Wom in Labor Force		Wom Employement Rate		Wom Political Representation	
Waldensian	0.016	0.016***	0.011*	0.011**	0.010*	0.010**	0.023**	0.023*
	(0.011)	(0.001)	(0.007)	(0.005)	(0.006)	(0.004)	(0.009)	(0.012)
Observations	1,188	1,188	1,188	1,188	1,188	1,188	1,180	1,180
R2	0.12	0.12	0.26	0.26	0.24	0.24	0.03	0.03
Distance cut-off	25 km	75 km	25 km	75 km	25 km	75 km	25 km	75 km
Province f.e.	√	√	√	√	√	√	√	√
Historical controls	√	√	√	√	√	√	√	√
Geographic controls	√	√	√	√	√	√	√	√

Notes: Table A6 reports the results of different estimates for the effect of the presence of Waldensian communities, identified through inquisition trials against Waldensians, on different cross-sections of observations for all Piedmont municipalities in the sample. Odd columns reports OLS estimates using clustered standard errors, where each municipality is assumed to be correlated to all others within a 25km radius. Even columns reports OLS estimates using clustered standard errors, where each municipality is assumed to be correlated to all others within a 75 km radius. In the top panel, the dependent variables are: Cols. (1) and (2) literacy rate in 1911; Cols. (3) and (4) literacy rate among women in 1911; Cols. (5) and (6) the gap in literacy between men and women in 1911; Cols. (7) and (8) the municipal expenditures on primary education per student in 1862-63. In the bottom panel, the dependent variables are: Cols. (1) and (2) share of female population with at least a high school diploma in 2011; Cols. (3) and (4) share of women in labor force in 2011; Cols. (5) and (6) employment rate among women; Col (7) and (8) women's political representation, measured as the average share of women in "Consiglio Comunale" over the period 2014-2018. Historical controls include the population in the year 1100, the presence of Occitan-speaking communities, the presence of Franco-Provençal communities, and an index of caloric suitability. Geographic controls include: altitude, ruggedness, and the share of mountainous territory. Robust standard errors in parentheses. *, ** and *** refer to 10%, 5% and 1% significance, respectively.

Medication Against Conflict*

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Abstract

The consequences of successful public health interventions for social violence and conflict are largely unknown. This paper closes this gap by evaluating the effect of a major health intervention – the successful expansion of anti-retroviral therapy (ART) to combat the HIV/AIDS pandemic – in Africa. To identify the effect, we combine exogenous variation in the scope for treatment and global variation in drug prices. We find that the ART expansion significantly reduced the number of violent events in African countries and sub-national regions. The effect pertains to social violence and unrest, not civil war. The evidence also shows that the effect is not explained by general improvements in economic prosperity, but related to health improvements, greater approval of government policy, and increased trust in political institutions. Results of a counterfactual simulation reveal the largest potential gains in countries with intermediate HIV prevalence where disease control has been given relatively low priority.

JEL-classification: $D74$, $I15$, $O10$
Keywords: HIV, Conflict, Social Violence, ART expansion, Trust, Africa, Health Intervention, Domestic Violence.

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1 Introduction

Adverse health conditions and social violence constitute major problems for developing countries. This is particularly the case in Africa, which is plagued by widespread social violence, insecurity, and unrest. At the same time, Africa is particularly affected the spread of communicable diseases as reflected by, e.g., the HIV/AIDS pandemic. Around 24 million people in Africa still live with HIV, with an annual death toll of half a million and a prevalence of a fourth of the population in some countries. Besides the serious health consequences, the HIV pandemic led to lower labor productivity, increased expenditures for medication and assistance, and increased poverty. Around the turn of the millennium, following the massive increase in HIV prevalence and in view of projections of global infections and mortality, scientists and international organizations raised serious concerns regarding the grim outlook for the socio-economic consequences of the pandemic. This included warnings of the risk of widespread anger, social unrest and violence in the face of inadequate health policies (Birmingham, 2000; Kumar, 2000; Fourie and Schönteich, 2001; Feldbaum et al., 2006; de Waal, 2010). International organizations emphasized repeatedly that the dissatisfaction with government policies and the erosion of trust in institutions associated with this dissatisfaction potentially plays an important role for the failure of many countries in building peaceful and inclusive societies (see, e.g., OECD, 2017; United Nations, 2021). However, whether major health interventions can help to reduce conflict and social violence remains largely unknown.

The HIV epidemic provides a unique laboratory to investigate this question. Soon after the turn of the millennium, a massive worldwide roll-out of antiretroviral therapy (ART) for HIV-positive individuals followed as consequence of a substantial decline in the costs of drug production. This health intervention yielded substantial health improvements, reductions in mortality, and a recovery of labor productivity. Yet, surprisingly little is known about the consequences of major health interventions, such as the ART roll-out, for social violence. As discussed in more detail below, existing empirical studies have focused on population dynamics, weak institutions, ethnic tensions, natural resource competition, income and commodity price shocks, short-term weather driven shocks, and climate as root causes of conflict and social violence. The findings of these studies often have no clear implications for policy, or policy implications that are difficult to implement. Only recently, some empirical work has pointed at the potential role of health shocks for outbreaks of civil conflict, but without analyzing the effect of public health interventions. At the same time, public health interventions, such as the roll-out of ART, were very successful in improving public health. To the extent that labor productivity and opportunity costs play important roles for explaining incentives to engage in protests, riots and other forms of social violence, the success of such public health interventions may reduce social grievances. Hence, besides restoring labor productivity and fostering individual medical and economic well-being, public health interventions might remove important factors behind protests and social violence and help restoring confidence and trust in institutions and the government. However, evidence for the hypothesis that major health interventions like the ART expansion reduce conflict is still missing.

This paper closes this gap in the literature by investigating whether health interventions play a potentially relevant role in reducing conflict and social violence. To address this question, we perform a first systematic empirical investigation of the effects of a large-scale health policy, the ART roll-out to combat HIV/AIDS, on violent events in Africa. We ask whether, by successfully combating the HIV/AIDS pandemic in Africa, the ART expansion also led to a reduction in conflict and social violence, and, if so, through which channels. The identification strategy is based on variation in the exposure to the ART expansion in a country or sub-national region. We filter out time-invariant confounders and global shocks, and draw on an identification strategy that combines cross-sectional variation in the potential for ART treatment (based on HIV prevalence before the availability of ART) with time variation in the access to ART at the global level (based on the global variation in prices and production costs of ART that was driving the dynamics of ART coverage worldwide). The identification strategy is implemented using different measures to construct this interaction, and the analysis is conducted with a variety of estimation methods and robustness checks.

We find robust evidence that the expansion of ART coverage led to a significant reduction in the number of violent events in African countries and sub-national regions. This reduction pertains, in particular, to riots and demonstrations related to economic and human rights motives, but not to large scale armed conflict. The effect works partly through a reduction in economic grievances, but does not merely reflect an improvement in overall economic well-being. In particular, we find evidence for an independent effect of health interventions that does not work through economic well-being per se. A large set of potential confounds can be ruled out as driving the result. An analysis of potential channels reveals that the expansion of ART was associated with increase in individual trust in institutions like the parliament and the local government, and with an increase in individual approval of government policies related to the management of HIV, of basic health provision, and economics in general, but not with policies related to education. Taken together, these findings imply that ill health may be a potent driver of social unrest and violence, and that besides improving health and economic conditions, public health interventions can also help curbing social violence. Results of a counterfactual simulation analysis suggest that efforts to increase the ART coverage would have had the largest quantitative potential gains in African countries with intermediate HIV prevalence and in which HIV treatment has been given relatively low priority.

Our analysis contributes to the recent literature in several ways. It has become increasingly clear that social violence, in the form of protests and riots, rather than civil war, constitutes the vast majority of conflict events in Africa and thereby poses a major impediment for development (see, e.g., Straus, 2012). A growing body of research has provided evidence that variation in productivity and opportunity costs is relevant for explaining the incentives to engage in protests, riots and other forms of social violence. Existing empirical studies on the root causes of social violence have focused on income and commodity price shocks (Dube and Vargas, 2013; Bazzi and Blattman, 2014; McGuirk and Burke, 2020; Berman et al., 2021), short-term weather driven shocks (Miguel et al., 2004; Dell et al., 2014; König et al., 2017; Harari and La Ferrara, 2018), and climate (Theisen et al., 2013; Burke et al., 2015; Breckner and Sunde, 2019). Related work has pointed at the role of weak institutions (Besley and Persson, 2011), ethnic tensions (Esteban et al., 2012), natural resource competition (Caselli et al., 2015; Berman et al., 2017; Rohner, 2018) and population (Acemoglu et al., 2020). Few recent studies have found evidence for weather-related health shocks as a previously largely overlooked cause of social violence (Cervellati et al., 2017, 2022). Evidence for the impact of public health interventions, and an evaluation of whether and through which channels public health interventions affect social violence, however, is largely missing. Our paper fills this gap.

Addressing the role of major health interventions is of foremost importance from a policy perspective. To our knowledge, there exists no systematic evaluation of the effects of major health interventions on social conflict. This way, our work complements research on the effects of policy for social violence, which has considered foreign aid (de Ree and Nillesen, 2009; Savun and Tirone, 2012; Nunn and Qian, 2014), cash transfers (Crost et al., 2014), infrastructure investments (Berman et al., 2011), reconciliation (Ciliers et al., 2016), and employment policies (Blattman and Annan, 2016; Fetzer, 2020), but which has neglected the role of health interventions. In fact, the results of the existing literature suggest that the effects of policy interventions to prevent or reduce social violence were generally mixed, and policies that resulted in the disbursement of appropriable cash were generally much less successful than policies that led to a higher opportunity cost of fighting (see, e.g., Rohner and Thoenig, 2020, for a survey). This is exactly what health interventions accomplish, so our evidence contributes an important missing piece of evidence regarding the scope of policy interventions against conflict. Our findings also provide evidence that support arguments that health interventions help fostering trust in states and policies (see, e.g., Khemani, 2020). On a more general level, the result that health interventions also help reducing social violence implies that taking into account additional societal and economic benefits beyond pure individual health effects is key for appraising the impact of public health policy. The findings therefore complement findings of purely economic effects of major health interventions such as the ART expansion (see, e.g., Tompsett, 2020) and suggest the usefulness of a broad assessment of the overall benefits of other health policies, such as, for example, extending the global availability of COVID-19 vaccination.

From the perspective of political economy, the findings indicate that public health interventions are a key source of political legitimacy for institutions and incumbent governments, with potential implications for other public investments in health. In particular, our findings complement recent evidence on the role of economic hardship and public support for democracies as well as the rise of populism (e.g., Algan et al., 2017; Claassen, 2020). Evidence for public health interventions helping to restore trust in government contributes a new aspect to the literature on the role of state performance for political trust (see, e.g., Citrin and Stoker, 2018, for a survey) and is consistent with recent evidence for the effect of life expectancy on democratic attitudes (Lechler and Sunde, 2019). In light of recent calls by international organizations for the need of fostering trust in institutions in order to maintain economic and political security (OECD, 2017; United Nations, 2021), our results are informative about policies that are effective in this dimension.

The remainder of the paper is organized as follows. Section 2 describes the data and the empirical methodology. Section 3 presents the empirical results, robustness checks, and evidence for the underlying mechanisms. Section 4 concludes with a discussion of the policy implications.

2 Data and Empirical Strategy

2.1 Background: HIV and ART in Africa

The human immunodeficiency virus (HIV) impairs the function of white blood cells in the immune system (CD4 cells) and replicates itself inside these cells. As consequence, infected individuals experience a weakening of the immune system, making the body vulnerable to infections and some types of cancer. In advanced stages, the infection turns into the acquired immunodeficiency syndrome (AIDS), which ultimately leads to death. Recent evidence suggests that the most infective strain of HIV crossed from chimpanzees to humans probably before 1920 in Cameroon, while the beginning of the spread of HIV across Africa has been traced back to Kinshasa, located in today's Democratic Republic of Congo, around 1920 (Gao et al., 1999; Faria et al., 2014). From the late 1970s onwards, the spread of HIV turned into an epidemic that swept across Africa and the entire world. By 1980, about half of human infections in the Democratic Republic of Congo were observed outside of Kinshasa. In Africa, the virus subsequently diffused out of the Democratic Republic of Congo, first towards the great lakes area and then along the East of Africa, eventually reaching the Mediterranean basin and South Africa as well as the North-West towards Nigeria during the 1990's (Kalipeni and Zulu, 2012). By 2000, an estimated 26 million adults and children lived with HIV/AIDS in Africa, constituting more than 70 percent of the global infections.[1]

During the early 1980s, the then still unknown disease rapidly spread across the world, leading to the first clinical and epidemiological observations of AIDS in 1981. The severity led to intense microbiological research. During the early 1980s, the retrovirus responsible for AIDS (the HIV-1 virus) was isolated successfully, and subsequent discoveries concerned the transmission and life cycle of HIV. The identification of the main receptors of the HIV led to the development of combination antiretroviral therapy (ART) in the late 1990s (see, e.g., Barré-Sinoussi et al., 2013, for a survey of the history of HIV research). Parallel to the scientific advances, campaigns to inhibit a further spread of HIV and the development and widespread distribution of drugs to treat HIV/AIDS also became important issues on the political agendas of national governments and international organizations. This led to mounting pressure by international non-government organizations (NGOs) on pharmaceutical companies to no longer prevent the distribution of generics, which culminated in the introduction of generic drugs for antiretroviral therapy in 2001. The subsequent expansion of the availability of ART, which was heavily supported by the Global Fund and the WHO through its "3-by-5" initiative, led to a significant reduction in morbidity and mortality and a restoration of immunity in infected persons. Ultimately, the availability of ART transformed HIV infections from fatal to a manageable chronic disease with moderate implications for life expectancy if treated appropriately, and international organizations and NGOs continue to exert great effort on expanding ART coverage, particularly in Africa.

2.2 Data

The analysis is based on observational data at the country level for 50 African countries and at sub-national administrative level 1 for 170 regions over 18 African countries over the period 1990–2017.

[1]See, e.g., the December 2000 AIDS epidemic update by UNAIDS/WHO.

We use geo-localized data for events of social violence from multiple sources. The baseline analysis uses the Social Conflict Analysis Database (SCAD), which is a compilation of violent events that is based on global press coverage. The SCAD data represents a complete and extensive measure of social violence of different forms (protests, demonstrations, riots, strikes, and other forms of social disturbances) and comprises a classification of different event types, including organized events, spontaneous events, and events related to elections, economic grievances, or human rights. In addition, the data contain information on event sizes, in terms of casualties and participants. Based on the narratives contained in the data set, it is also possible to isolate different event types related to targets or actors involved in events (such as NGOs, health workers, or civil servants), which allows a detailed investigation of the mechanisms underlying outbreaks of social violence. The main advantage of the SCAD data in comparison to other frequently used sources of civil conflict is that it focuses on social violence defined as social and political unrest, as opposed to large-scale organized armed conflicts. Moreover, the SCAD data are available for long time periods and exhibit high data quality.

In further analysis, we also use data on riots and protests from alternative sources such as the Armed Conflict Location and Event Data (ACLED) and data on organized violence involving the state collected by the Uppsala Conflict Data Program (UCDP) to gain a more complete picture. Detailed descriptions of the various data sources, the definitions of violent events, and the different aspects covered by the different data sets are contained in the Supplementary Appendix.

Data for HIV prevalence and Antiretroviral Therapy (ART) coverage at the country level are provided by UNAIDS for 50 African countries. HIV prevalence information is based on model estimates by UNAIDS, which collects all country estimates and reviews them in order to guarantee that estimates are comparable across regions and countries over time. Information on ART coverage is based on national registers of antiretroviral therapy, and is compiled by UNAIDS. Regional HIV prevalence (at administrative level 1) is constructed by us using survey data from the Demographic and Health Survey Program (DHS), which represents a comprehensive source of sub-national information to map HIV prevalence. We assembled sub-national level measures of HIV prevalence for 170 regions over 18 African countries (see Figures 1 and A1 in the Supplementary Appendix).

The identification strategy makes use of data on the global price of the first line of combined ART treatment as well as of information about the costs of the active pharmaceutical ingredients used in the production of these treatment lines. The respective data have been collected by the WHO Global Price Reporting Mechanism and by the Global Fund Pooled Procurement Mechanism Reference Pricing and cover approximately 70-80 percent of the global transactions of the respective drugs.

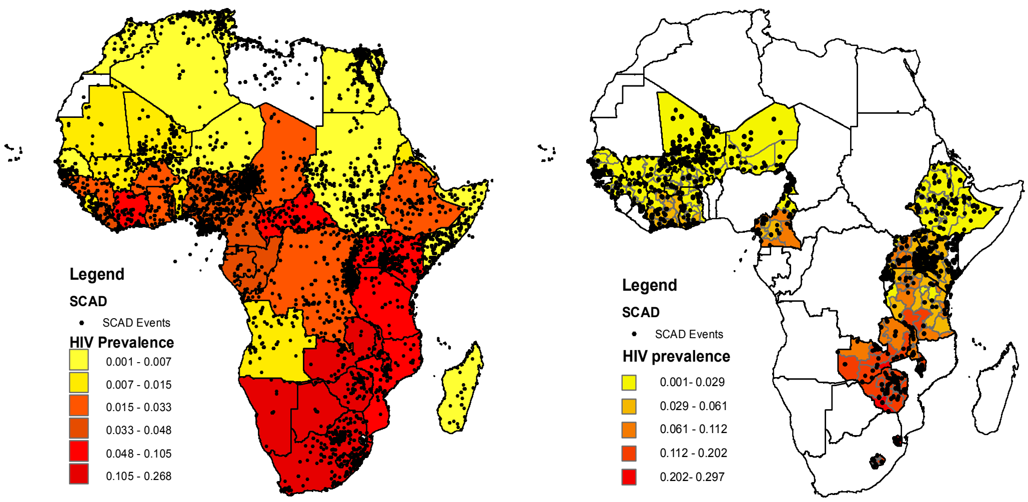
Additional data on population and life expectancy at birth is provided by the UN Population Division and various Census reports. Information on GDP (in constant 2010 US$) is from the World Bank. Information on trust in institutions is extracted from individual survey responses from the Afrobarometer.

Detailed information about data sources, variable definitions and the construction of the variables used for estimation as well as of the construction of the samples at the country-level and at sub-national level is contained in the Supplementary Appendix (Section A.1).

2.3 Empirical Approach: Graphical Illustration

Figure 1 shows a map of HIV prevalence in 2001 and the distribution violent events (SCAD) aggregated over the entire observation period for the country sample and for the sample of sub-national regions. The figure illustrates a geographical distribution of HIV prevalence that exhibits higher levels in sub-Saharan Africa and in the South-East of the continent. The visual inspection suggests a correlation between HIV prevalence and violent events.

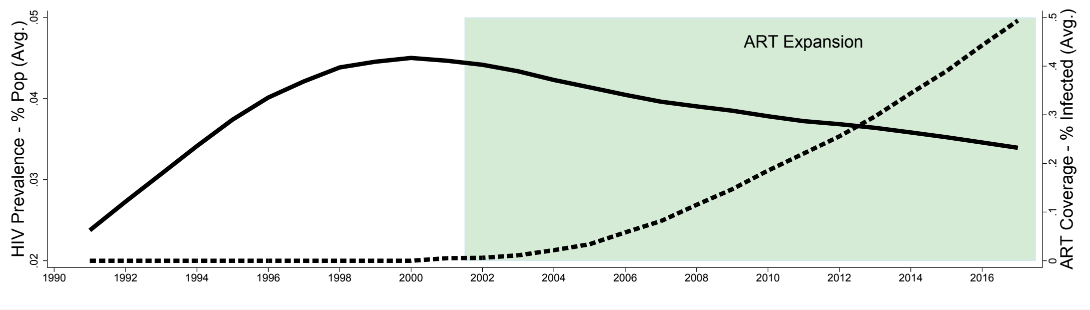
Figure 1: HIV Prevalence and Social Violence in Africa: SCAD



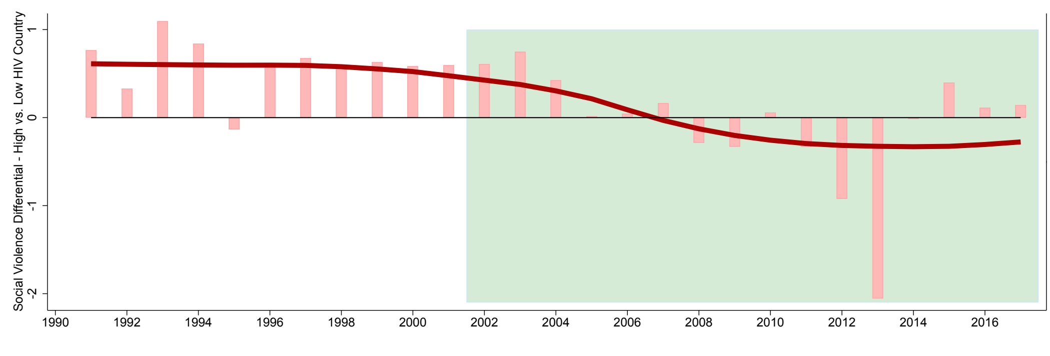
(a) Country Sample (b) Sub-National Regions Sample

Note: Panel (a): HIV prevalence in 2001 and location of violent events (SCAD) aggregated at the country level. Panel (b): HIV prevalence and location of violent events (SCAD) at the level of sub-national regions as contained in the sample. See Appendix A.3.1 for summary statistics.

Figure 2(a) plots the increase of HIV prevalence in Africa during the 1990s as depicted by the solid line, as well as the expansion of ART during the early 2000s (dashed line), which led to a reversal in the dynamics of HIV infections. This reversal prevented an estimated 9.5 million deaths and brought considerable economic benefits (Forsythe et al., 2019), mainly by contributing to a substantial reduction in mortality (Bor et al., 2013; Tompsett, 2020) and leading to a recovery of labor productivity (Habyarimana et al., 2010; Bor et al., 2012; Baranov et al., 2015). Figure 2(b) illustrates that the increase in HIV prevalence during the 1990s was associated with a relative increase in social violence in countries with high HIV prevalence in comparison to countries with low HIV prevalence. This relative increase in violent events in high HIV countries peaked during the early 2000s and was followed by a reversal that coincided with the ART expansion. The empirical analysis below investigates the hypothesis that the expansion in ART was causally responsible for the relative decline in social violence.



(a) HIV prevalence and ART coverage



(b) Difference in social violence in high *vs.* low HIV countries

Figure 2: HIV Prevalence, ART Coverage, and Social Violence in Africa

Note: Panel (a): Evolution of average HIV prevalence as percentage of the population in Africa (solid line), and of average ART coverage as percentage of infected population (dashed line); data from UNAIDS, averages weighted by country population. Panel (b): Difference in social violence in countries with HIV prevalence above and below the median in 2001 (bars, based on SCAD database) and non-linear time trend in terms of log polynomial smooth (line). Average social violence is weighted by country population; differences in high and low HIV countries are normalized by average population-weighted social violence for Africa in each year.

2.4 Estimation and Identification

Estimation. The empirical analysis is based on the model

$$Violence_{c,t} = \beta \cdot ARTcoverage_{c,t} + \gamma X_{c,t} + \delta_c + \zeta_t + \rho_R \cdot t + \varepsilon_{c,t} \quad \text{(OLS/2SLS–Stage 2)}$$

which is a regression of social violence in country c and year t on ART coverage, control variables $X_{c,t}$, country fixed effects δ_c, year fixed effects ζ_t, African-subregion-specific linear time trends $\rho_R \cdot t$, and an error term ε.

The identification of the effect of ART coverage on social violence, β, relies on the assumption that ART coverage is uncorrelated with unobserved or omitted confounding factors contained in the error term ε. Violation of this assumption leads to biased estimates and may materialize in a spurious effect. In particular, this would be the case if ART coverage and the level of social violence are both correlated with unobserved variables that create problems of omitted variables or reverse causality. Examples for omitted confounders include institutions: if countries with better institutions and public governance, or just a better economic performance, are more effective in providing health services and ART coverage and, at the same time, more effective in reducing social tensions and violence, this would imply simultaneity bias. Examples for reverse causality include political pressure: if social violence in terms of strikes and demonstrations in a country leads to an intensified effort to treat HIV by governments, international organizations or international aid donors, this would reflect reverse causality from violence to ART coverage. The inclusion of an extensive set of control variables accounts for a variety of potential confounds. The inclusion of country fixed effects and country-level controls accounts for concerns related to systematic variation across countries and at the country level. Likewise, the inclusion of time fixed effects accounts for factors that affect social violence in a given year and that are common to all countries, which include the possible role of events that affect several countries at the same time and whose influence might vary over time (such as the Arab spring movements, or health initiatives by international donors or organizations). The inclusion of time trends for macro regions within Africa, and of country-specific trends related to HIV prevalence accounts for time-varying effects related to variation or interventions in specific macro areas (e.g., the increase in Islamic militant violence in Northern Africa during the early 2000s) and trends related to country-specific initial conditions in terms of HIV prevalence at the onset of the ART expansion. Population controls account for mechanical effects of population density.

Identification Strategy. To further address identification concerns related to omitted variables or reverse causality and to identify the effects of ART coverage on social violence, the analysis employs an identification strategy that is based on instrumental variables and 2SLS estimation. The instrument for ART coverage combines cross-sectional variation in the local scope for ART, $Z_{c,2001}$, and the global time-series variation in the access to ART, $ART_{IV,t}$. The resulting first stage regression model with instrument $Z_{c,2001} \cdot ART_{IV,t}$ is

$$\text{ART}_{c,t} = \alpha \cdot Z_{c,2001} \cdot ART_{IV,t} + \gamma X_{c,t} + \delta_c + \zeta_t + \rho_R \cdot t + u_{c,t} \,. \qquad \text{(2SLS–Stage 1)}$$

We use different measures in both dimensions to construct the instrumental variable as discussed in detail below.

In the intention-to-treat (ITT, or reduced form) analysis, social violence is regressed directly on the instrument. This analysis does not require a reliable geo-referenced and time-varying measure of ART coverage as instrumented variable and can thus also be conducted at the subnational region level, where such data are unavailable. For comparability, we conduct intention-to-treat estimations at the national and sub-national levels. The estimation framework is given by

$$Violence_{r,t} = \phi \cdot Z_{r,2001} \cdot ART_{IV,t} + \gamma X_{r,t} + \delta_r + \zeta_t + \rho_c \cdot t + \epsilon_{r,t} \,, \qquad \text{(ITT)}$$

for data at the level of countries or sub-national, administrative regions r; the specification includes country-specific linear time trends $\rho_c \cdot t$. Throughout, the main effect (linear term) of the cross-sectional term of scope for ART, $Z_{c,2001}$ or $Z_{r,2001}$, is absorbed by the (country or region) fixed effects, δ_r, and the time-varying instrument for ART coverage $ART_{IV,t}$ is absorbed by the year fixed effects ζ_t.

Identification Assumptions. The major concerns for identification are related to unobserved third factors that correlate with both social violence and ART coverage (e.g., quality of institutions and governance), or to reverse causality, with the incidence of events of social violence influencing the access to ART in a given year and country or region (e.g., by political pressure on governments or international donors). The instrumentation addresses these concerns and allows identifying the effect of interest, β (or ϕ, respectively).

Technically, we construct the instrument using a measure for the cross-sectional differences in potential for ART $Z_{c,2001}$ – capturing *where* ART coverage had a greater scope to increase upon availability. This is combined with a measure of the global expansion of ART treatment intensity $ART_{IV,t}$ – capturing *when* ART coverage increased. The validity of the instrument requires relevance (i.e., the instrument should be a relevant predictor of ART coverage) and the exclusion restriction: the instrument should affect social violence only through its effect on ART coverage. Concretely, this requires that the *interaction* between cross-sectional variation in potential for treatment in terms of HIV prevalence prior to the ART expansion (as of 2001), and global dynamics in the access to ART treatments, is exogenous to the incidence of social violence in a given year in a country or region, and hence that $Z_{c,2001} \cdot ART_{IV,t}$ (or $Z_{r,2001} \cdot ART_{IV,t}$, respectively) is uncorrelated with ε.

The rationale for the instrumentation approach is based on a differences-in-differences logic. First, an increase in ART coverage is expected to have had more pronounced effects in countries or regions that exhibited a higher level of HIV prevalence at the time when ART became widely available. In the baseline implementation of the instrumentation strategy, the scope for ART coverage at the onset of roll out in HIV treatment, $Z_{c,2001}$ is measured by the HIV prevalence in a country in 2001, i.e., prior to the world-wide ART expansion, $HIV_{c,2001}$. Contrary to country-level data, HIV prevalence is not available for the same year (2001) in all regions; instead, HIV_r measures the HIV prevalence in the respective region in the year closest to 2001 for which data are available. The details of the variable construction can be found in the Supplementary Appendix (Appendix Sections A.1.3). Before 2001, ART treatments were effectively not available in Africa, and hence the cross-country variation in potential for ART (HIV prevalence) is unrelated to potential confounds for the analysis that affect subsequent ART coverage, such as institutions, economic development, or political pressure, and that are absorbed by an extensive set of control variables. The direct effect of this local (country-specific or sub-national region-specific) variation in potential for ART expansion on violence is accounted for by (country or region) fixed effects, and time-varying effects of HIV prevalence before 2001 on violence are accounted for by the inclusion of control variables and flexible specifications of country-specific trends related to HIV prevalence.

Second, the worldwide expansion of ART availability, captured by $ART_{IV,t}$, largely occurred for reasons unrelated to what happened within each African country. In particular, the time variation in global ART expansion is related to global factors like the decline in the price for medication and the resulting increase in availability of ART that were the result of international political agreements and innovation in the pharmaceutical industry and that were unrelated to region-specific or country-specific time trends in HIV prevalence or social violence. To implement a measure of global dynamics in ART availability and construct the instrument, we collected time series data of the prices for the most common first line of ART treatment regimens for adults and construct the instrument by interacting $Z_{c,2001}$ with the median world price of ART treatment regimens as measure for ART treatment intensity $ART_{IV,t}$

(ART Price). This measure only provides indirect information about the availability of ART treatments in a country, but it has the advantage that the instrument does not respond, by construction, to the country-specific level of social violence or any policy intervention that is specifically targeted to a given country in a given year. Moreover, conceptually, this measure is directly related to actual ART treatment in a country since the reduction in prices constitutes the ultimate driver of the increase in ART coverage. The global dynamics were unrelated to the dynamics of social violence in particular African countries and the direct effects of global dynamics in ART availability are accounted for by time fixed effects and region-specific time trends.

The instrument combines these two dimensions, the potential for ART, $Z_{c,2001}$, and global variation over time in the access to ART treatment responsible for the ART expansion, $ART_{IV,t}$, to predict the country-specific expansion of ART coverage, and hence captures variation that is exogenous to the evolution of social violence in specific African countries. Controlling for country/region fixed effects and time-varying covariates accounts for systematic variation that might violate the exclusion restriction for the measures of cross-sectional heterogeneity in scope for ART. Moreover, the inclusion of year fixed effects, time-trends for African regions, or country-specific time trends accounts for trends in social violence that might violate the exogeneity of the global dynamics in ART expansion. Below, we present additional results for alternative constructions of the instrument. While conceptually capturing the same underlying phenomenon, the interactions of different cross-sectional measures of potential for ART treatment with different measures of the global expansion of ART treatment intensity differ in terms of data quality and potential concerns regarding the validity of the identifying assumptions of the corresponding interaction term that is used as instrument.

Our baseline instrumentation approach complements recent work by Acemoglu et al. (2020) that combines cross-sectional variation in mortality from several diseases prior to treatment and assumes that the respective mortality declined to zero in the context of the global epidemiological transition to investigate the effects of population dynamics on civil conflict (adapting a similar strategy from earlier work by Acemoglu and Johnson, 2007). In contrast, rather than using a proxy for the latent mortality decline based on the cross-sectional pre-treatment variation in mortality, our approach makes use of several alternative proxies for cross-sectional treatment scope in combination with several measures of time variation in treatment intensity that are based on global dynamics of the price or cost of treatment, or of the actual treatment intensity outside Africa. Our approach also differs from recent work on the economic effects of ART expansion by Tompsett (2020) who made use of time variation in ART coverage in low and middle income countries. In addition to our baseline instrumentation based on time variation in prices and cost of drugs, in the robustness checks below we also conduct the analysis using global variation in ART coverage in low and middle income countries outside Africa, thereby accounting for concerns of endogeneity due to cross-country spill-overs across African countries.

3 Results

3.1 Baseline Instrumentation

Table 1 presents the main results. All coefficients reported in this and other tables correspond to standardized regressors to ensure direct comparability. OLS regressions deliver a significantly negative association between ART coverage and the incidence of social violence at the country level (Table 1 Column 1). The 2SLS estimates reveal that the association remains significant and is quantitatively even larger. These results suggest an upward bias in the OLS estimates towards zero. This is consistent with possible problems of measurement error related to ART coverage, problems of simultaneity due to omitted factors that correlate positively with social violence and ART coverage, or with reverse causality due to social violence directly influencing HIV prevalence (McInnes, 2009; Iqbal and Zorn, 2010). One example of a confound are more foreign military or humanitarian interventions in countries or regions with a high incidence of social violence that are associated with better access to health provisions and, in particular, greater ART coverage. In fact, the evidence is consistent with such a confound. In particular, the data show a positive correlation between foreign interventions (measured in terms of the cumulative annual Global Fund disbursement) and social violence (events) of 0.23. At the same time, the correlation between foreign interventions and ART coverage is 0.49. Hence, failing to account for such foreign interventions might induce an upward bias in the OLS estimates. The use of an instrument that combines cross-sectional variation in the potential for ART treatment determined *before* the availability of ART, with time variation in the global expansion of the availability of ART *outside* Africa, provides exogenous variation that allows for a consistent estimation of the causal effect of ART treatment on social violence. By making use of the interaction between country-specific potential for ART treatment and the global increase in treatment intensity as instrumental variable, the instrumental variables approach therefore accounts for these identification concerns.

Similar results are also found with an intention-to-treat approach at the country level or at the sub-national level (Table 1 Columns 3 and 4). Next, we present results for alternative constructions of the instrument that address various potential concerns.

Table 1: Effect of ART Expansion on Social Violence

	Events of Social Violence			
	OLS	2SLS	ITT	
	(1)	(2)	(3)	(4)
ART	-0.316**	-0.966**		
	(0.157)	(0.362)		
$Z_{i,2001} \times ART_{IV,t}$			-0.163***	-0.166***
			(0.060)	(0.034)
Instrument				
$Z_{i,2001}$		$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{r,2001}$
$ART_{IV,t}$		ART Price	ART Price	ART Price
Observations	1,394	1,394	1,394	4,760
Clusters	50	50	50	170
Adj-R2	0.23	0.17	0.23	0.09
Kleibergen-Paap		33.77		
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	×	×	×	√

Note: Dependent variable: natural logarithm of the number of social conflict events in a year (measured as ln(#events+1)) at country level (Columns 1 to 3) and at sub-national level (administrative regions) (Column 4); data source: SCAD database. All coefficients refer to standardized explanatory variables. ART: ART coverage based on data from UNAIDS, measure standardized. Column 1: OLS estimates. Column 2: 2SLS estimates of the effect on violent events of instrumented ART coverage; results of first stage regressions are reported in Appendix Table A3. Columns 3–4: coefficients from intent-to-treat regressions of the effect of instrument for ART coverage on violent events. Instruments are interactions between cross-sectional variation in the potential for ART treatment, $Z_{i,2001}$ ($i = c$ at country level and $i = r$ at region level), and a time-varying measure of ART expansion, $ART_{IV,t}$; the interaction term has been standardized; see text for details. Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; sub-national region-level specification includes controls for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level (Columns 1-3) or sub-national region level (Column 4). Summary statistics are contained in Appendix A.3.1.

3.2 Alternative Constructions of the Instrument

Alternative Measures of Global ART Expansion $ART_{IV,t}$. Conceptually, the instrumentation approach combines cross-sectional variation in the scope for ART expansion, $Z_{c,2001}$, with time variation in the dynamics of the expansion of ART treatment intensity $ART_{IV,t}$ as reflected by the global decline in the price of the most important treatment regimens. This variation in prices provides relevant information that is plausibly exogenous from the perspective of single countries in Africa. Nevertheless, this measure is subject to some potential limitations. One limitation for the quantitative interpretation of this instrument is that a reduction in the prices paid by a government might release budget resources that can be used for alternative policies and, accordingly, might lead to a reduction of, e.g., protests or strikes. Moreover, to the extent that prices for ART treatments might be determined by monopolistic pricing of pharmaceutical multinational corporations, international organizations might exert an indirect effect through their influence on price negotiations. This would show up in terms of a decline in prices due to lower mark-ups over costs, raising concerns about simultaneity.

To address these concerns, we constructed an alternative measure for $ART_{IV,t}$ that is based on the evolution of the cost of the active pharmaceutical ingredients of the main first line ART treatments for adults (ART Cost). The conceptual advantage of this measure is that it captures the dynamics of global production costs and thereby directly reflects the decline in costs that was related to the increase in the amount of treatments produced worldwide. The reduction in costs of production also maps into the reduction in prices, but the time variation of the two series differs because of variation in the markups charged by pharmaceutical companies, particularly due to increasing competition associated with the introduction of active principles produced as generics. Thus, the validity of the instrument based on ART Cost is based on similar arguments as that based on ART Price, but this measure has the appealing feature of not relying on changes of markups of pharmaceutical companies, which might be influenced by political pressure. This makes the information about cost even less susceptible to pressures by international organizations since this variation is related to an increase in research competition and patent expiration. Hence, the use of ART Cost is conceptually preferable for instrument construction. However, this instrument is subject to more severe data limitations in terms of availability and coverage, which requires interpolation of data for years with missing information. This reduces the variability of the measure and leads to lower predictive power on the first stage.

As a second alternative measure for $ART_{IV,t}$, we constructed the evolution of a synthetic price index of the main first line ART treatments for adults (Synth. Price). This measure is exclusively based on information about the initial price of first line treatment regimens of the first line of ART treatment in 2001, prior to the expansion of ART demand (and thus prior to potential influence of donors on the price development), and on price data after the major expansion (2015-2017). For the intermediate time period, the price index is constructed based on the assumption of a constant proportional decline of the price-over-cost mark-up each year. This decline approximates the global dynamics of treatment costs and prices in line with the sharp initial decline that is followed by more moderate reductions as market prices converge to the limit price. The appealing feature of this price index is that only two data points are involved in its construction, alleviating potential concerns about a demand-driven price decline that violates the exclusion restriction due to systematic variation in prices in response to an ART expansion in particular countries. The synthetic price (Synth. Price) index is therefore, by construction, unrelated to political interventions and to any other sort of demand-driven price decline while resembling the typical evolution of drug prices after the end of patent exclusivity, and after the introduction of generic drugs.

As a third alternative measure for $ART_{IV,t}$, we make use of data on expansion of ART coverage in low and middle income countries outside Africa (ART Cov). The ART coverage in other low and middle income countries outside Africa captures effective variation in access, and thus comes closest conceptually to the variation captured by the instrumented variable (ART coverage in African countries), while offering high data quality and longer and more coherent time coverage compared to the data on the dynamics of prices and costs of treatment regimens. A similar identification strategy has previously been applied successfully at the country level to explore the economic effects of ART expansion (Tompsett, 2020), who made use of time variation in ART coverage in low and middle income countries. Differently from this application, the approach applied here combines cross-sectional heterogeneity in disease (HIV) prevalence prior to the treatment expansion in combination with time variation in ART coverage in low and middle income countries *outside* Africa. The use of global ART coverage outside Africa is conceptually not affected by the level of ART coverage in a specific country and the inclusion of year fixed effects accounts for global shocks. In particular, this addresses potential endogeneity through cross-country spill-overs across the African continent and ensures that the interaction is exogenous to social violence at the country-year level, conditional on the control variables in the empirical specification. However, the dynamics in global ART coverage might also be problematic for various reasons. In particular, a direct role of international actors or organizations in extending ART coverage worldwide might raise potential concerns about simultaneity. While global ART coverage is a proxy for lower ART prices, this variation might also correlate with the intensity of aid from the Global Fund and other donors, thus picking up dynamics that are linked to social violence, but that do not necessarily reflect the ART expansion due to cheaper drug provision. One might even consider the possibility of reverse causality if social violence reflects protests that led to a stronger response to HIV globally, such that higher ART coverage in low and middle income countries not only correlates with ART coverage in Africa but also with fewer protests by advocates of intensified HIV control.

In sum, while conceptually capturing the same variation, the three alternative dynamic instrument components differ in terms of data quality and potential concerns regarding the validity of the identifying assumptions, and thus provide useful alternatives to assess the sensitivity of the baseline instrumentation. Details of the construction of each of these variables can be found in the Supplementary Appendix (Sections A.1.5, A.1.6, and A.2).

Alternative Measure of Scope For ART Expansion ($Z_{i,2001}$). The baseline instrumentation uses HIV prevalence in the respective country or region in 2001, prior to the ART expansion, as measure of cross-sectional variation in the scope for ART expansion, $Z_{c,2001}$. This instrumentation parallels recent work that has used disease prevalence prior to the epidemiological transition (Acemoglu et al., 2020). To address potential concerns about the exogeneity of the cross-sectional variation in the scope for ART expansion, $Z_{c,2001}$, we conduct extensive robustness checks, including tests of parallel trends, placebos, different base years, or additional controls and interaction terms, which are reported below. The most salient concern about the use of cross-sectional variation in HIV prevalence in 2001 is a potential correlation with institutions and other factors that would otherwise question the exclusion restrictions. The extensive specifications with country fixed effects and additional controls, and recent findings that interaction terms with one potentially endogenous factor require weaker identification assumptions than standard exclusion restrictions (Bun and Harrison, 2019), alleviate this concern.

To further account for the concern that persistent factors such as institutions or culture might affect pre-ART-expansion HIV prevalence as well as post-ART-expansion social violence and ART coverage jointly, thus posing a threat to the exclusion restriction, we constructed an alternative proxy measure of the country-specific scope of ART expansion that exclusively relies on geography, HIV_{geo}. Concretely, we compute the geography-related exposure to HIV as the effective distance from Kinshasa, using exclusively information about first nature geographic characteristics and a minimum criterion for population, based on the fast-marching method (Sethian, 1996, 1999). The resulting proxy variable therefore reflects the effective distance to the origin of the HIV epidemic that measures the potential exposure to HIV. This measure is therefore a valid predictor of the cross-sectional distribution of HIV prevalence in Africa during the late 20th century prior to the ART expansion. By construction, this measure is not related to institutional, cultural or political features that could have affected the evolution of the HIV epidemic in a country prior to 2003 and that might challenge the exclusion restrictions. The details of the variable construction can be found in the Supplementary Appendix (Appendix Section A.1.4).

Results for Alternative Instrument Constructions. Table 2 presents results of 2SLS regressions with instruments constructed from these different measures of $Z_{i,2001}$ and $ART_{IV,t}$ in comparison to the results for the baseline measures that are presented in Column (1). The remaining columns show results for different combinations of measures to construct the instrument $Z_{i,2001} \times ART_{IV,t}$. The first stage results indicate that all instruments are relevant, with somewhat weaker but still acceptable performance of instruments based on the geography-based measure $\text{HIV}_{geo,16K}$.[2] The comparison of second stage estimates from the different specifications of the instrumental variable suggest that the results are not sensitive to the different instrument constructions. This provides strong support for the validity of the main findings and their robustness to potential confounds discussed before.

The results of statistical tests on instrument selection reveal that the joint validity of all instruments is never rejected while none of the instruments is redundant in the sense that asymptotic efficiency of the estimation is improved by each instrument. Since the instruments are highly correlated, the null of orthogonality is rejected for each combination of instruments, suggesting the use of a single instrument at a time, rather than a combination of instruments. More details on identification are contained in the Appendix Section A.2.

3.3 Synthetic Control Approach

Figure 3 provides an illustration of the impact of ART on social violence based on the synthetic control method for causal inference in comparative case studies (Abadie and Gardeazabal, 2003; Abadie et al., 2010, 2015; Abadie, 2021). The synthetic control method is an alternative data driven procedure to construct a time-varying counterfactual unit for each treated unit by creating a weighted combination of different control units. Unlike in a difference-in-difference approach, the synthetic control method thereby allows controlling for time-varying confounders and provides a systematic data-driven way of constructing a synthetic counterfactual for treated units had they not received the treatment. In the figure, treated units correspond to the 25% of countries with the highest levels of ART coverage (relative to HIV infected individuals) after 2001.[3] The donor pool of countries that are used to construct the counterfactual for each treated unit consists of the 25% of countries with lowest ART

[2]The construction of the measure $\text{HIV}_{geo,16K}$ involves a minimum criterion of a population of 16.000 inhabitants per grid cell, which corresponds to the 8^{th} decile of the distribution of population density. In the Appendix, we report results for alternative thresholds.

[3]Figure A4 in the Appendix shows the corresponding results when relating ART coverage to HIV prevalence.

Table 2: Effect of ART Expansion on Social Violence – Alternative Instrumentation

	Social Violence (log events) - SCAD Data					
	2SLS	2SLS - Alternative IV Constructions				
	(1)	(2)	(3)	(4)	(5)	(6)
ART	-0.966**	-0.954**	-0.922**	-0.999**	-1.197**	-1.227**
	(0.362)	(0.361)	(0.356)	(0.388)	(0.578)	(0.575)
Instrument						
$Z_{i,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{geo,16K}$	$HIV_{geo,16K}$
$ART_{IV,t}$	ART Price	ART Cost	ART Synth. Price	ART Cov	ART Price	ART Synth. Price
Observations	1,394	1,394	1,394	1,394	1,366	1,366
Clusters	50	50	50	50	49	49
Adj-R2	0.17	0.18	0.18	0.17	0.08	0.07
Kleibergen-Paap	33.77	31.42	38.12	34.69	11.40	11.14
Country f.e.	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√
Population	√	√	√	√	√	√

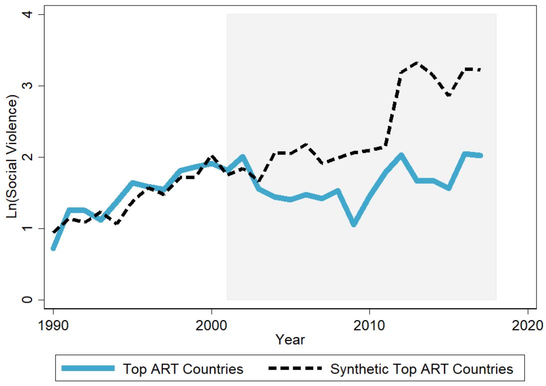
Note: Dependent variable: natural logarithm of the number of social conflict events in a year (measured as ln(#events + 1)) at country level; data source: SCAD database. All coefficients refer to standardized explanatory variables. ART: ART coverage based on data from UNAIDS, measure standardized. 2SLS estimates of the effect on violent events of instrumented ART coverage; results of first stage regressions are reported in Appendix Table A3. Instruments are interactions between cross-sectional variation in the potential for ART treatment, $Z_{i,2001}$ ($i = c$ at country level and $i = r$ at region level), and a time-varying measure of ART expansion, $ART_{IV,t}$; the interaction term has been standardized; see text for details. Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; sub-national region-level specification includes controls for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level. Summary statistics are contained in Appendix A.3.1.

coverage after 2001. Alternatively, the analysis was replicated with the bottom 10% of countries in terms of average ART coverage after 2001 as donor pool. The graph illustrates that the trend in social violence is almost identical in the treatment and synthetic control groups before the onset of the ART expansion. After the onset, the treatment group experienced substantially lower levels of social violence than the control group.

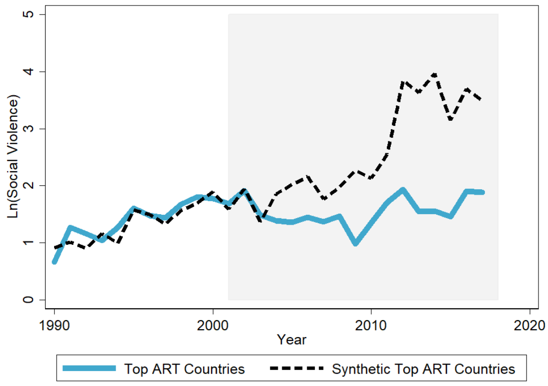
3.4 Robustness

In this subsection, we briefly describe the results of various robustness checks. The detailed results are contained in the Supplementary Appendix.

Parallel Trends Assumption and Alternative Base Years. Regarding the plausibility of the parallel trends assumption, i.e., a similar dynamic evolution of social violence in the absence of differential ART coverage, neither the raw data nor



(a) Top 25% vs. Bottom 25%



(b) Top 25% vs. Bottom 10%

Figure 3: ART Expansion and Social Violence: Synthetic Control Approach

Note: Results based on the synthetic control method. For each treated unit, the incidence of social violence is computed under the average treatment and for the synthetic counterfactual. The graph plots averages across all treated units. With the intervention period beginning in 2001, the synthetic control is computed for each treated unit by minimizing the mean squared prediction error (MSPE) relative to the treated units during the pre-intervention period 1990 to 2000. As predictor variables for the construction of the weighted counterfactual of each treated unit, the procedure uses the average log number of conflict events, population and HIV prevalence (all measured between 1990 to 2000), the fraction of the country area within 100 km from the coast, the fraction of desert and of tropical forest, latitude and longitude.

group-year averages reveal any evidence for systematic trend differences in social violence across countries with different HIV prevalence in 2001 (Appendix Figures A5 and A6). To test the sensitivity of the results with respect to the choice of 2001 as base year for HIV prevalence to measure the scope of ART expansion, the estimation was repeated with alternative base years with similar results (Tables A5 and A6, Figure A7).

As a more formal way to assess the plausibility of the parallel trend assumption, we constructed event-study graphs based on estimators that are robust to heterogeneous treatment effects, across units or over time. In particular, the graphs map the reduced form effect of the instrumental variable on social violence, while the inclusion of lags and leads allows displaying the dynamics of the effect over time. The estimation is performed using the routine devised by Chaisemartin and Haultfoeuille (2020). In terms of controls, each estimation replicates an analogous specification as in Table 1 Column (3). In addition to the instantaneous effect, each estimation is performed including 8 placebo effects to assess the effect dynamics and the plausibility of parallel trends assumption. The specification also allows for 10 dynamic effects to explore the evolution of the effect over time. The results are shown in

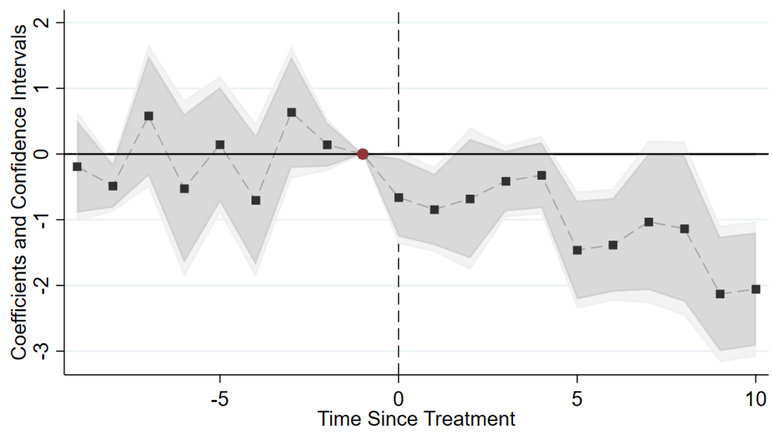


Figure 4: Reduced Form Estimates – Event Study Plots

Note: The figure plots event study graphs for the coefficient of interest from the ITT model. The empirical specification is as in Table 1 Column (3) of the paper, using $HIV_{c,2001}\times$ART Price as instrument. The estimation is conducted using the routine devised by Chaisemartin and Haultfoeuille (2020). Dark shades show the corresponding 90-% confidence interval, light shades the corresponding 95% confidence interval.

Figure 4 with the omitted coefficient (for the year prior to the expansion of ART in 2002) reported as zero, and the time axis normalized by 0 as the first year of the expansion. The results show consistently insignificant effects of the pre-trends, which is reassuring regarding the plausibility of the parallel trends assumption. Concretely, countries that are about to experience a more pronounced increase in ART coverage, as proxied by the instrument, are not experiencing any different decrease/increase in social violence in the years preceding the increase in ART coverage. In terms of timing of the effect, the graph indicates that the effect materializes right on impact and then increases monotonically over time in terms of magnitude. Similar patterns emerge for alternative instrument constructions (see Appendix Figure A8).

Price/Cost Data for Alternative Treatment Regimens. The results are not sensitive to the use of price and cost information for a specific first line treatment regimen. In particular, the results are similar when using the price for an alternative, first line regimen (Table A7). This suggests that the findings are not driven by the specific ART treatment used to construct the instruments. A similar comment applies when alternative time-varying measures of ART expansion are combined with the alternative measures of cross-country variation in the scope for expansion (Table A8).

Falsification: Malaria Prevalence and Malaria Treatment. To investigate the validity of the instrument and the exclusion restriction, a falsification exercise was conducted by exploiting information about the prevalence of malaria and about the time evolution of prices for anti-malaria treatment. Malaria is a disease of major importance in Africa that has been subject to extensive health campaigns promoted by governments and international organizations. Moreover, weather-driven malaria shocks have been documented to lead to outbreaks of social violence (Cervellati et al., 2022). Similar to HIV treatment, the treatment of malaria has attracted funds from international organizations and global efforts have led to substantial reductions in prices for treatments. The validity of the identification strategy implies that alternative instruments that combine scope for HIV treatment with the price of malaria treatment, or variation in global access to ART treatment with scope for malaria treatment should not predict ART coverage. The results of these falsification tests show that a combination of information about malaria prevalence with time variation in the expansion of ART coverage, or of pre-expansion HIV prevalence with variation in world prices of anti-malaria treatments, do not predict ART coverage (Appendix Table A9).

Placebo and Overidentification: Heterogeneity in Institutional Quality. As alternative test of the validity of the instrument and the exclusion restriction, the estimation was conducted when using various measures of institutional quality as cross-sectional component of the instrumentation stage, replacing the scope for treatment, $Z_{c,2001}$, in the instrument $Z_{c,2001} \cdot ART_{IV,t}$ on the first stage of the 2SLS framework (2SLS–Stage 1) by the institutional placebo $X_{c,2001}$ and estimating the model with instrument $X_{c,2001} \cdot ART_{IV,t}$ (Tables A10 and A11). Alternatively, an extended version of model (2SLS–Stage 1) was estimated using $X_{c,2001} \cdot ART_{IV,t}$ as additional control (Tables A12 and A13). Both sets of robustness checks provide no indication of a violation of the identification assumptions and confirm the main results.

Relaxing the Assumption of Strict Exogeneity of the Instrument. To investigate the sensitivity of the results with respect to violations of the exclusion restriction of strict exogeneity, we estimated extended specifications that relax the restriction that the direct effect of the instrument on the outcome is exactly equal to zero (Conley et al., 2012). These estimates reveal that, in order for the effect of interest to be not statistically different from zero, the direct effect, conditional on all controls, would have to be almost of the order of magnitude as the effect of interest, which we consider implausible (Figure A9).

Sub-samples. The results are not sensitive to the inclusion/exclusion of single countries (Figures A10 and A11). Similar findings emerge when accounting for separate, non-linear time trends across African regions (Table A14). Separate estimates for different sub-samples of countries suggest that the instruments are stronger for the sub-samples of sub-Sahara Africa, or the sample of countries with high HIV prevalence within Africa, but the overall results are similar to the baseline (Table A15).

Confounds Related to International Aid, Institutions, and Economic Development. The potential role of specific time-varying country-specific characteristics that could drive both health policies and social violence has been discussed in the context of the differences between OLS and 2SLS results. We explored this aspect in various dimensions. Results from extended specifications with controls for the level of health aid (measured by the extent of Global Fund donations received by a country in a given year), for the level of development (in terms of GDP per capita), or for the quality of public governance (in terms of democracy), confirm the baseline results (Table A16). Moreover, instrument performance is not affected by including these controls, which provides support for the notion that the identifying variation contained in the instruments is exogenous and not driven by these time-varying country-specific features.

Another potential confound is related to the multifaceted efforts to combat the HIV pandemic and to achieve the millennium development goals, which placed substantial emphasis on increasing access to schooling. As consequence, many governments in Africa lowered the cost of schooling around the time of the expansion of ART coverage. The identification strategy accounts for these confounds. In particular, in the sub-national analysis, the inclusion of country-specific linear time trends and linear time trends interacted with average region-level HIV prevalence accounts for the associated variation. Additional analysis reveals no evidence for education enrolment as a potential confound for the main results. For the baseline specification, there is no indication that the ART expansion is related to higher primary or secondary school enrolment, while the results are robust to controlling for school enrolment (Tables A17 and A18).

Scale. Similar results were found when using ART coverage of the population instead of relative to the population living with HIV in a country (Table A19). Likewise, the finding that the expansion of ART coverage led to a reduction in social violence consistently emerges for when considering social violence relative to the population as measured by the log events per population (Table A20).

Confounds Related to International Organizations or Interest Groups. The discussion of the identification assumptions suggests a potential violation of the exclusion restriction as the result of interventions at the international level that led to changes in ART coverage or prices. To explore this possibility, text analysis was applied to the narratives of SCAD events to assess if the results are driven by specific event types or events involving particular groups of participants. This analysis reveals that the results are not driven by events involving NGOs or health workers, public employees or strikes (Tables A21 and A22). This suggests that the main findings are not driven by events that could be connected to political pressure on governments or international organizations or, for instance, the use of budget resources freed by the reduction in prices under the pressure of specific categories of actors or events.

3.5 Mechanisms

The results presented so far provide evidence that is consistent with the hypothesis that health interventions, such as the ART expansion, led to a reduction in social violence. In the following, we present additional results on the potential mechanisms behind these findings.

Health Improvements vs. Generic Improvements in Economic Prosperity. We begin the analysis by investigating whether the negative effect of improved public health on social violence and unrest might merely be related to generic improvements in economic prosperity that have been documented in the context of the ART expansion (see Tompsett, 2020).[4]

In an attempt to investigate whether the effect could be mediated by generic improvements in economic well-being, we conducted an additional analysis in which we replaced ART treatment as instrumented variable by income per capita (or income per capita growth) or life expectancy, and estimated the effect of the ART expansion on social violence that works through income or health. The results reveal that the ART expansion, as instrumented by the interaction of the cross-sectional scope for expansion and the global dynamics of the ART expansion, is only a weak predictor of GDP per capita, with a weak first stage performance (with F-statistics around 1). In the second stage, the estimates provide no evidence that the effect of the

[4]In fact, an additional analysis documents that the expansion of ART coverage in the context of the HIV/AIDS epidemic in Africa did not lead to a significant improvement in aggregate economic prosperity as measured by income per capita, but it did lead to a significant increase in life expectancy (see Appendix Tables A23–A25). This implies that it is unlikely that the main findings are driven to a large extent by overall economic prosperity. A similar conclusion emerges from the earlier results from extended specifications that account for international aid, institutional quality, and economic development (see Table A16).

ART expansion on social violence might work through income (see Appendix Tables A26 – A29). Repeating the same analysis for life expectancy as mediating factor in fact reveals strong and statistically highly significant effects on the first stage. In the second stage, the results show a significant reduction in social violence as life expectancy increased in the context of the ART expansion, but this effect only materializes for social violence as measured in the SCAD data, not for major armed conflicts as measured in the UCDP data (see Appendix Tables A30 and A31). This evidence corroborates the previous findings and suggests that health interventions play an important independent role in reducing social violence that go beyond variation in economic living conditions. In sum, these findings support the hypothesis that health interventions exhibit a "dividend" that is distinct from the direct effects on health and economic well-being by reducing social violence.

Types of Violent Events. In a next step, we conduct an additional analysis on the different types of violent events and replicate the analysis for data on social violence and civil conflict from various different sources.

Figure 5 plots the standardized IV estimates of the coefficient of interest for the baseline specification and for different types of social violence and the different instrument constructions (using ART Price, ART Cost, and ART Cov) at the country level. The significantly negative effect of the ART expansion emerges for the data on social violence from the Social Conflict Analysis Database (SCAD) as well as for data from the Armed Conflict Location and Event Data (ACLED) or data from the Global Database of Events, Language, and Tone (GDELT). Similar to SCAD, both alternative data sources contain information about frequent and recurrent events of social violence, in terms of protests and riots, and deliver comparable estimates (see also for detailed results for ACLED data base, Tables A32–A33; and for GDELT data, Table A34). In contrast, we find no significant effect of ART expansion on civil conflict, as measured by the Uppsala Conflict Data Program (UCDP), consistent with the conjecture that health interventions mainly affect social violence (Table A35). Additional results for different subsets of conflicts without casualties versus with casualties, or for different numbers of participants, confirm this view (see Table A36). To rule out the possibility that social violence and ART coverage could be related to ongoing major civil conflicts, we also estimated an extended specification with social violence based on the SCAD data as dependent variable, while including ongoing major armed conflicts (based on the UCDP data) as additional control. The results are basically unaffected, again highlighting that health interventions mainly affect social conflict (Table A37).

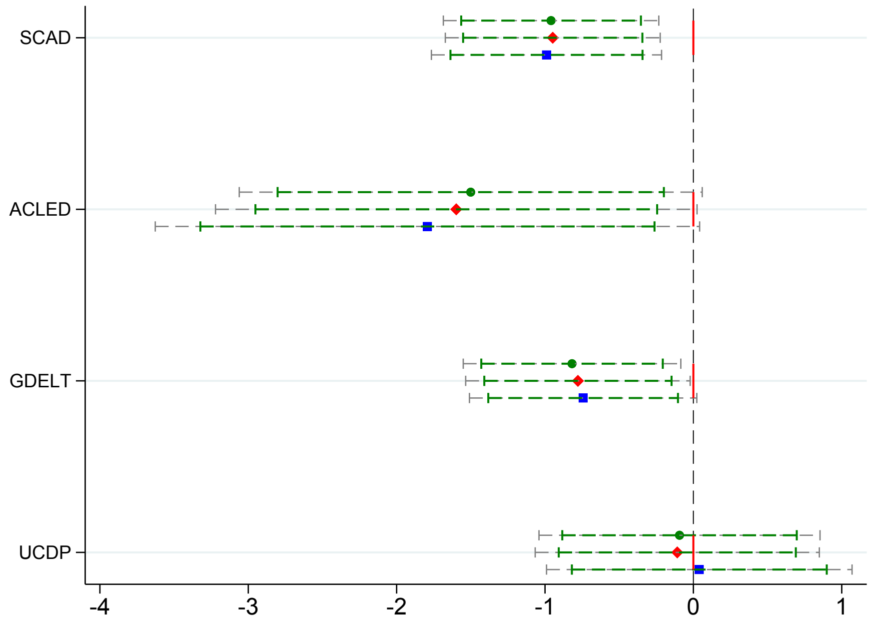


Figure 5: Mechanisms: Types of Social Violence

Note: 2SLS estimates of β, country level (see Section 2.4). Instrument: interaction between cross-sectional variation in the potential for ART treatment, $Z_{i,2001}$ (measured by HIV prevalence at country level, 2001), and a time-varying measure of ART expansion, $ART_{IV,t}$ (measured by the global variation in the median world price of ART treatment regimens, ART Price, or, alternatively, by the cost of ART treatment regimens, ART Cost, or global ART coverage outside Africa, ART Cov); the interaction term has been standardized. Coefficients are based on the same specification as in Table 1 Column (2). Dependent variable is log events of social violence from the different data sets (SCAD, ACLED, GDELT, UCDP, see text for details).

Motives for Social Violence. To investigate the underlying mechanisms in more detail, we replicate the estimation at the sub-national level using events of different types and with different underlying motives, based on categories provided by the SCAD database, as dependent variable. We conduct the analysis for subsets of violent events as dependent variables. Violent events are classified based on the information about types of events (all, spontaneous, organized) or motives (events related to elections, economic factors, human rights) in the SCAD data set. Intention-to-Treat regressions are based on the (log) number of events in a particular category as outcome variable (see Appendix Sections A.1.1 and A.4.8.1 for details).

Figure 6 reports the respective intention-to-treat estimates of the coefficient of interest at the sub-national region level for the different instrument constructions (using ART Price, ART Cost, and ART Cov). The results document that the reduction in violent events is particularly pronounced for organized events of social violence. This is consistent with fewer demonstrations, strikes, or other forms of social discontent as result of better provision with ART. In contrast, no significant effect is found for spontaneous outbreaks of social violence. In terms of motives behind social violence, we find that better treatment coverage reduces social violence related to economic factors and human rights, but we find no significant reduction in violence associated with political or electoral reasons (see also Appendix Table A38).

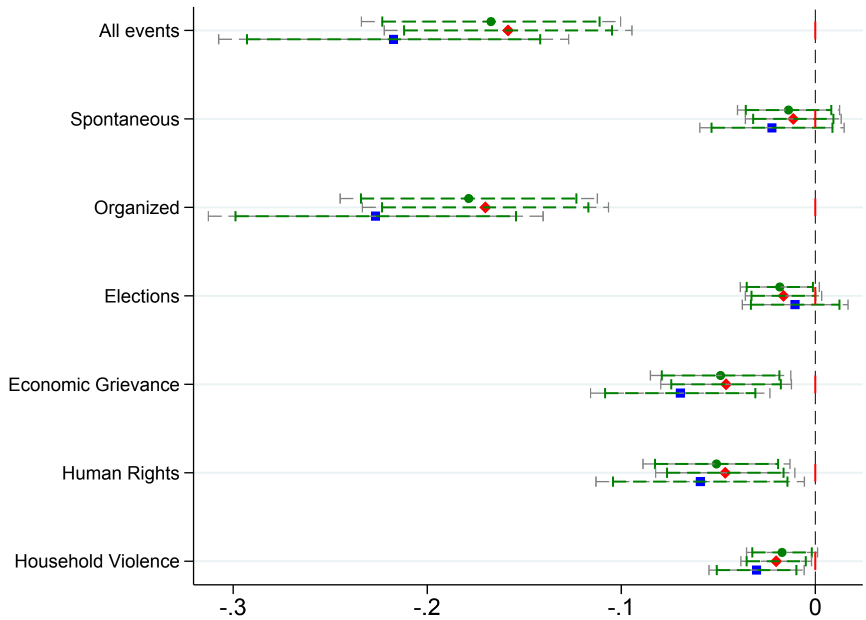


Figure 6: Mechanisms: Motives for Social Violence

Note: Intention-to-treat estimates of ϕ, regional level (see Section 2.4). Instrument: interaction between cross-sectional variation in the potential for ART treatment, $Z_{i,2001}$ (measured by HIV prevalence at region level, 2001), and a time-varying measure of ART expansion, $ART_{IV,t}$ (measured by the global variation in the median world price of ART treatment regimens, ART Price, or, alternatively, by the cost of ART treatment regimens, ART Cost, or global ART coverage outside Africa, ART Cov); the interaction term has been standardized. Coefficients are based on the same specification as in Table 1 Column (4). Dependent variable is log events of social violence, classified by motives; classification of social violent events is based on the codification in the SCAD database. Household Violence: intimate partner violence; Source: Demographics and Health Surveys (DHS), see also text and Appendix A.4.7.6.

To explore the effects on other forms of violence experienced by individuals at the household level, we collected data for intimate partner violence from the Demographics and Health Surveys (DHS) and replicated the analysis for this dependent variable. Despite serious data limitations in terms of spatial and temporal coverage, we find patterns for violence at the household level that are qualitatively comparable to the findings for social violence (bottom row of Figure 6 and Appendix Figure A13). The fact that the results generalize to different coding of violent events is interesting as it provides an indication that the results are not limited to a particular type of social violence. At the same time, the results again indicate that health interventions mainly reduce social violence events, which might reflect a reduction in discontent with the government or the (health-related) living conditions, but not major armed conflict or civil wars. This is also consistent with the findings from the analysis of potential confounds related to international interventions or interest groups, which revealed that the effects mainly emerge for social violence that does not involve organized actors like strikes, NGOs, or public health workers or civil servants (Tables A21 and A22). Moreover, the consistency of the results is reassuring regarding the validity of the instruments because the exclusion restrictions are conceptually different and less likely to be violated in light of the discussion above.

Approval of Government Policy. The results shown so far point towards a greater approval of governmental policies as potential mechanism behind the reduction in social violence. In particular, the successful expansion ART led to improved health and, indirectly, an alleviation of concerns about overall economic and political living conditions, which might have led to a decline in, e.g., organized social unrest like protests and riots. To investigate the empirical validity of this conjecture, we conducted additional analysis based on survey data from the Afrobarometer. In particular, we consider responses to questions that relate to the individual approval of policy, as dependent variables. Survey questions about individual approval of government policies range from individual assessments of how well the government handles HIV/AIDS, to provision with basic health, management of the economy, or combatting crime (see Appendix Section A.1.7.2 and A.4.8.2 for details).

Figure 7 displays the intention-to-treat estimates of the coefficient of interest corresponding to the survey responses to the subjective approval of government policies in various dimensions. A higher ART coverage is associated with a significantly higher approval rate of the government's management of HIV, whereas the approval of the government's management of education is unaffected by the ART expansion. This suggests that the decline in violence is associated with a more positive assessment of the government's actions in the dimension of dealing with HIV. This also has implications for a greater approval of government policies in the domain of basic health provision, the economic domain, and, to a lesser extent, with a reduction of crime (see also Appendix Table A39).

Trust in Institutions. Finally, better perception of government policies dealing with HIV might also contribute to a greater trust of individuals in institutions and policy makers. The critical role of trust in institutions for building peaceful and inclusive societies, and the role of satisfaction with government policies, has been emphasized repeatedly by international organizations (see, e.g., OECD, 2017; United

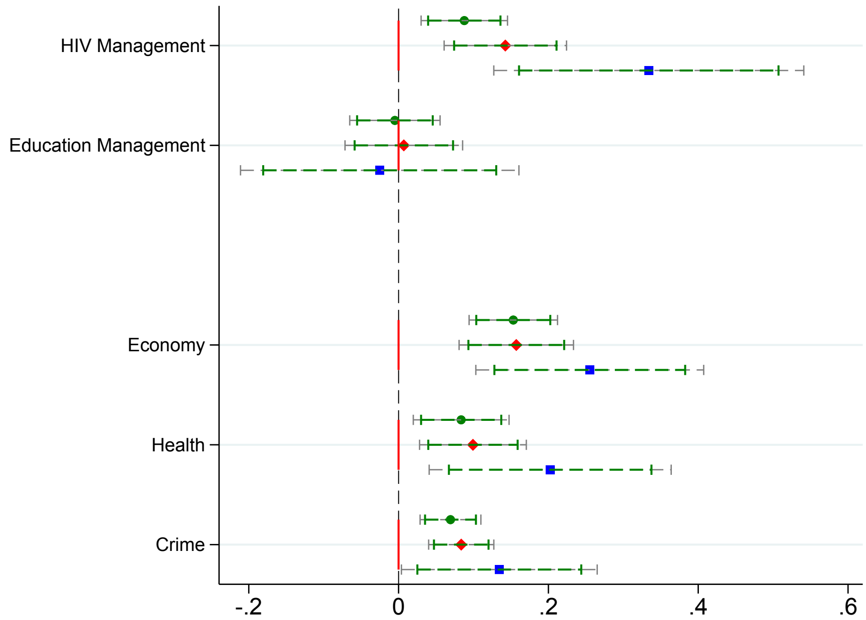


Figure 7: Mechanisms: Approval of Government Policy

Note: Intention-to-treat estimates of ϕ, regional level (see Section 2.4). Instrument: interaction between cross-sectional variation in the potential for ART treatment, $Z_{i,2001}$ (measured by HIV prevalence at region level, 2001), and a time-varying measure of ART expansion, $ART_{IV,t}$ (measured by the global variation in the median world price of ART treatment regimens, ART Price, or, alternatively, by the cost of ART treatment regimens, ART Cost, or global ART coverage outside Africa, ART Cov); the interaction term has been standardized. Coefficients are based on the same specification as in Table 1 Column (4). Dependent variables: survey responses to questions how well the current government handles various policy issues (HIV/AIDS, basic health provision, the economy, and crime). Data are from Afrobarometer. Confidence at 90 % (green) and 95% (grey). Corresponding estimates at sub-national region level are reported in Table A39.

Nations, 2021), but direct evidence for how specific policies, in particular health policies, contribute to strengthening trust in institutions is still lacking.

To shed light on greater trust in institutions as part of the potential underlying channel of transmission we conducted additional analysis based on survey responses to questions that relate to trust in various dimensions as dependent variables. Again, survey questions are from the Afrobarometer and refer to trust in specific institutions (the parliament, the local government, the police) (see Appendix Sections A.1.7.2 and A.4.8.2 for details).

Figure 8 displays the intention-to-treat estimates of the coefficient of interest corresponding to the survey responses about trust in institutions. The findings reveal that the ART expansion, as proxied by the instrument for a greater ART coverage at the sub-national level, is associated with greater trust in the national parliament as well as in the local government. In contrast, no significant effect is found for trust in institutions that are related to implementing law and order (represented by the police), rather than policy making in relation to HIV. This suggests that health interventions do not generically increase the trust in institutions, but trust in specific institutions and actors that individual respondents associate with the successful implementation of these interventions (see also Appendix Table A40).[5]

Together, these results indicate that once the root cause of hardship is alleviated by effective treatment of the disease, here in terms of the management of HIV by increasing ART coverage, approval with governmental policies that lead to improved health and economic conditions is increased. Consistent with the conceptual considerations, this greater approval of the governmental responses and policies is associated with higher trust in institutions that are seen as responsible for the policies, and goes along with a decline in social violence and unrest.

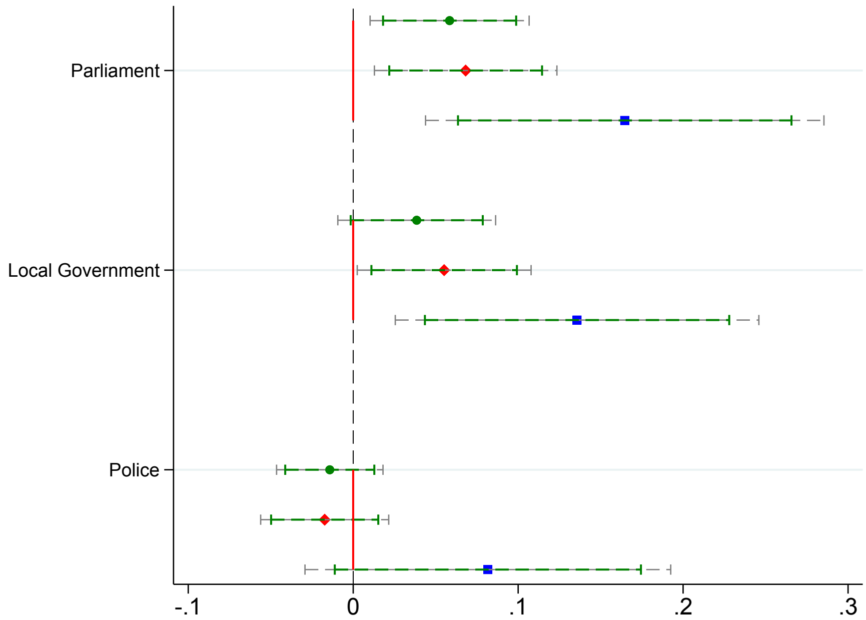


Figure 8: Mechanisms: Trust in Institutions

Note: Intention-to-treat estimates of ϕ, regional level (see Section 2.4). Instrument: interaction between cross-sectional variation in the potential for ART treatment, $Z_{i,2001}$ (measured by HIV prevalence at region level, 2001), and a time-varying measure of ART expansion, $ART_{IV,t}$ (measured by the global variation in the median world price of ART treatment regimens, ART Price, or, alternatively, by the cost of ART treatment regimens, ART Cost, or global ART coverage outside Africa, ART Cov); the interaction term has been standardized. Coefficients are based on the same specification as in Table 1 Column (4). Dependent variables: survey responses to questions about trust in institutions (parliament, local government, police). Data are from Afrobarometer. Confidence at 90 % (green) and 95% (grey). Corresponding estimates at sub-national region level are reported in Table A40.

[5]Unreported estimates for trust in other institutions, like the president, the ruling party, or the electoral commission reveal similar findings.

4 Discussion

By documenting that the expansion of ART coverage in the context of the HIV/AIDS epidemic in Africa led to a significant reduction in social violence, our findings extend earlier evidence regarding the consequences of the ART expansion for increased life expectancy, incomes, and quality of life in various dimensions. From a policy perspective, the findings suggest another channel through which health interventions have the potential to break the vicious cycle of poor living conditions, short-sighted behavior, and lack of development: health interventions can play an important role in reducing social tensions and unrest. Considering the impact of health policies over a time horizon in which population responses can be expected to be minor, we find that public health improvements lead to a significant decline in social violence, but have no effect on large-scale civil conflicts. Quantitatively, the 2SLS results of Table 1 suggest that a 10% increase in ART coverage implies a reduction in events of social violence of about 25% of the unconditional mean. As the potential for treatment depends on HIV prevalence, the interpretation of an average effect of ART coverage is not straightforward.

To provide an illustration of the quantitative relevance of the results, we conducted a simulation exercise that contrasts, for each country, the observed average number of violent events with the number of violent events predicted by the model estimates. The predicted effect of ART treatment is evaluated relative to a simulated counterfactual scenario in which each country is assigned an ART coverage equivalent to the average of the 10% of countries with the highest ART coverage during a given year. With the exception of ART coverage, all other influences are evaluated at the respective means of the explanatory variables, in a given year.

Figure 9 contrasts a country's actual average HIV prevalence in 2001 and average ART coverage with the predicted reduction in social violence that the country would have experienced as a result of the counterfactual treatment.[6] By combining the model estimates with actual ART coverage in the countries with the highest coverage, this provides an indication of the predicted effects of conceptually feasible policy interventions. The results indicate that an extended ART coverage comparable to that of the 10% countries with highest ART coverage would have led to a reduction in violent events of around 5 percent on average. The benefits from intensified treatments in terms of reductions in social tensions would have been larger for some countries with intermediate or below-average HIV prevalence and treatments like South Sudan, Guinea-Bissau or Nigeria, or for countries that implemented the treatment with delay, like South Africa.[7]

[6]The difference between observed and predicted values is plotted as orange bars.

[7]The estimates are based on ART coverage relative to the population, as in Appendix Table A19.

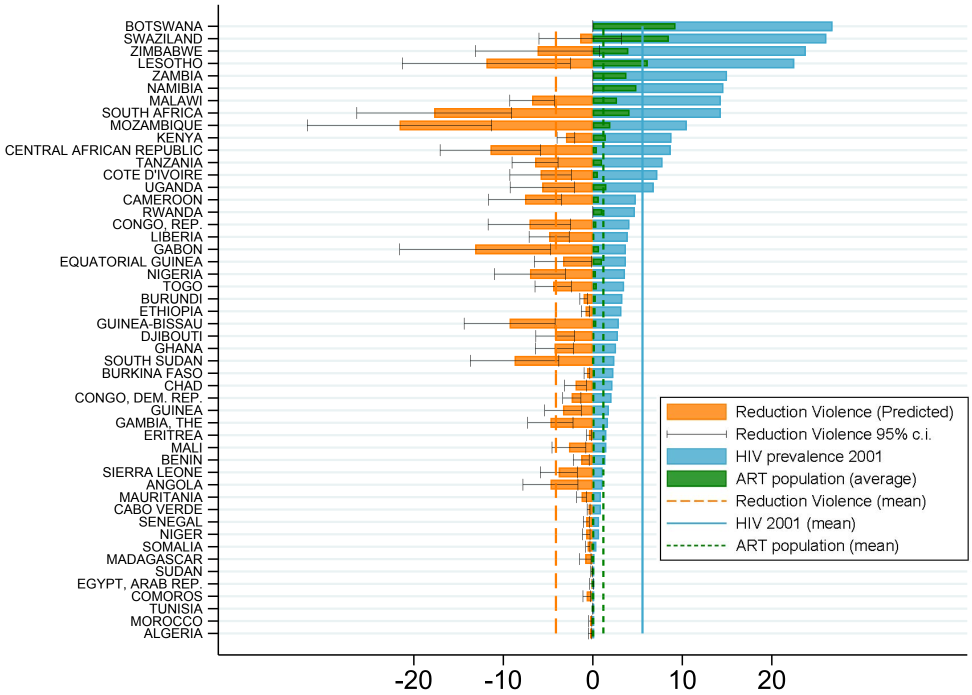


Figure 9: Quantification and Policy Implications: Counterfactual Predictions
Note: Reduction in Social Violence: Counterfactual % reduction in violent events between 2000 and 2017 based on a simulation of country-specific ART coverage set to the level of ART coverage of the 10% countries with the highest ART coverage in a given year. Simulation based on same specification as baseline model estimates (Table 1(2), see Appendix Table A19), changes relative to observed values. Effects for countries with ART coverage in the top 10% are set to 0. HIV prevalence 2001: observed prevalence, used as proxy for ART potential (see text for details). ART Coverage: Observed coverage by country (relative to population, average 2000–2017). Vertical lines indicate the average of each respective variable (orange: predicted reduction in violent events; green: average ART treatments 2000-2017; blue: HIV prevalence in 2001).

Our results call for sustained efforts to fight HIV and other infectious diseases by showing that the predicted benefit from intensified ART provision is relatively larger in countries with below-average or intermediate disease (HIV) prevalence and where disease control has been given relatively lower priority. Evidence that the ART expansion reduced social violence through improved trust in institutions corroborates suggestions that health interventions can foster trust in states and policies and contributes a new perspective on the mixed evidence for the role of policy interventions to curb conflict. In light of the extensive country-specific controls, the similarity of findings at national and subnational levels, and extensive robustness checks, it is unlikely that the results are driven by other specific policies, such as education policies, although accompanying measures and policies might have contributed in selective

Qualitatively similar, but quantitatively larger effects are found when using ART coverage relative to HIV prevalence as in the baseline estimates. Details are available upon request.

cases. Hence the results suggest that by improving individual health, promoting labor productivity, and attenuating social tensions, health interventions have the potential to generate a "triple dividend". In light of these findings, further research extending beyond ART treatment, and tackling other current challenges, such as the unequal global access to COVID-19 vaccination is warranted to explore the external validity of the effects of public health interventions on social violence documented here. Another promising direction for future research is to further explore the role of health policies for building trust in institutions.

References

Abadie, Alberto, "Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects," *Journal of Economic Literature*, 2021, *59* (2), 391–425.

_ **, Alexis Diamond, and Jens Hainmueller**, "Synthetic Control Methods for Comparative Case Studies," *Journal of the American Statistical Association*, 2010, *105* (490), 493–505.

_ **,** _ **, and** _ , "Comparative Politics and the Synthetic Control Method," *American Journal of Political Science*, 2015, *59* (2), 495–510.

_ **and Javier Gardeazabal**, "The Economic Costs of Conflict: A Case Study of the Basque Country," *American Economic Review*, 2003, *93* (1), 113–132.

Acemoglu, Daron and Simon Johnson, "Disease and development: the effect of life expectancy on economic growth," *Journal of Political Economy*, 2007, *115* (6), 925–985.

_ **, Leopoldo Fergusson, and Simon Johnson**, "Population and Conflict," *Review of Economic Studies*, 2020, *87* (4), 1565–1604.

Algan, Yann, Sergei Guriev, Elias Papaioannou, and Evgenia Passari, "The European Trust Crisis and the Rise of Populism," *Brookings Papers on Economic Activity*, 2017, *Fall 2017*, 309–382.

Baranov, Victoria, Daniel Bennett, and Hans-Peter Kohler, "The indirect impact of antiretroviral therapy: Mortality risk, mental health, and HIV-negative labor supply," *Journal of Health Economics*, 2015, *44*, 195–211.

Barré-Sinoussi, Francoise, Anna Laura Ross, and Jean-Francois Delfraissy, "Past, present and future: 30 years of HIV research," *Nature Reviews – Microbiology*, 2013, *11*, 877–894.

Bazzi, Samuel and Christopher Blattman, "Economic Shocks and Conflict: Evidence from Commodity Prices," *American Economic Journal: Macroeconomics*, 2014, *6* (4), 1–38.

Berman, Eli, Jacob N. Shapiro, and Joseph H. Felter, "Can Hearts and Minds Be Bought? The Economics of Counterinsurgency in Iraq," *Journal of Political Economy*, 2011, *119* (4), 766–819.

Berman, Nicolas, Mathieu Couttenier, Dominic Rohner, and Mathias Thoenig, "This mine is mine! How minerals fuel conflicts in Africa," *American Economic Review*, 2017, *107* (6), 1564–1610.

_ , **Matthieu Couttenier, and Raphael Soubeyran**, "Fertile Ground for Conflict," *Journal of the European Economic Association*, 2021, *19* (1), 82–127.

Besley, Timothy and Torsten Persson, "The logic of political violence," *Quarterly Journal of Economics*, 2011, *126* (3), 1411–1445.

Birmingham, Karen, "UN acknowledges HIV/AIDS as a threat to world peace," *Nature Medicine*, 2000, *6* (2), 117.

Blattman, Christopher and Jeannie Annan, "Can Employment Reduce Lawlessness and Rebellion? A Field Experiment with High-Risk Men in a Fragile State," *American Political Science Review*, 2016, *110* (1), 1–17.

Bor, Jacob, Abraham J. Herbst, Marie-Louise Newell, and Till Bärninghausen, "Increases in adult life expectancy in rural South Africa: valuing the scale-up of ART," *Science*, 2013, *339* (6122), 961–965.

_ , **Frank Tanser, Marie-Louise Newell, and Till Bärninghausen**, "Nearly Full Employment Recovery Among South African HIV Patients On Antiretroviral Therapy: Evidence From A Large Population Cohort," *Health Affairs*, 2012, *31* (7), 1–16.

Breckner, Miriam and Uwe Sunde, "Temperature Extremes, Global Warming, and Armed Conflict – New Insights From High Resolution Data," *World Development*, 2019, *123* (104624), 1–14.

Bun, Maurice J.G. and Theresa D. Harrison, "OLS and IV estimation of regression models including endogenous interaction terms," *Econometric Reviews*, 2019, *38* (7), 814–827.

Burke, Marshall, Solomon M Hsiang, and Edward Miguel, "Climate and conflict," *Annu. Rev. Econ.*, 2015, *7* (1), 577–617.

Caselli, Francesco, Massimo Morelli, and Dominic Rohner, "The geography of interstate resource wars," *The Quarterly Journal of Economics*, 2015, *130* (1), 267–315.

Cervellati, Matteo, Elena Esposito, and Uwe Sunde, "Epidemic Shocks and Civil Violence: Evidence from Malaria Outbreaks in Africa," *Review of Economics and Statistics*, 2022, *104* (4), 780–796.

__ **, Uwe Sunde, and Simona Valmori**, "Pathogens, Weather Shocks and Civil Conflicts," *The Economic Journal*, 2017, *127* (607), 2581–2616.

Ciliers, Jacobus, Oeindrila Dube, and Bilal Siddiqi, "Reconciling after civil conflict increases social capital but decreases individual well-being," *Science*, 2016, *352* (6287), 787–794.

Citrin, Jack and Laura Stoker, "Political Trust in a Cynical Age," *Annual Reviews of Political Science*, 2018, *21*, 49–70.

Claassen, Christopher, "Does Public Support Help Democracy Survive?," *American Journal of Political Science*, 2020, *64* (1), 118–134.

Conley, Timothy G., Christian B. Hansen, and Peter E. Rossi, "Plausibly Exogenous," *Review of Economics and Statistics*, 2012, *94* (1), 260–272.

Crost, Benjamin, Joseph Felter, and Patrick Johnston, "Aid under fire: Development projects and civil conflict," *American Economic Review*, 2014, *104* (6), 1833–56.

de Chaisemartin, Clément and Xavier D'Haultfoeuille, "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects," *American Economic Review*, 2020, *110* (9), 2964–2996.

de Ree, Joppe and Eleonora Nillesen, "Aiding violence or peace? The impact of foreign aid on the risk of civil conflict in sub-Saharan Africa," *Journal of Development Economics*, 2009, *88*, 301–313.

de Waal, Alex, "HIV/AIDS and the challenges of security and conflict," *Lancet*, 2010, *375* (9708), 22–23.

Dell, M., B.F. Jones, and B.A. Olken, "What Do We Learn from the Weather? The New Climate–Economy Literature," *Journal of Economic Literature*, 2014, *52* (3), 740–798.

Dube, Oeindrila and Juan F. Vargas, "Commodity Price Shocks and Civil Conflict: Evidence from Colombia," *Review of Economic Studies*, 2013, *80* (4), 1384–1421.

Esteban, Joan, Laura Mayoral, and Debraj Ray, "Ethnicity and conflict: An empirical study," *American Economic Review*, 2012, *102* (4), 1310–42.

Faria, Nuno R., Andrew Rambaut, Marc A. Suchard, Guy Baele, Trevor Bedford, Melissa J. Ward, Andrew J. Tatem, João D. Sousa, Nimalan Arinaminpathy, Jacques Pépin, David Posada, Martine Peeters, Oliver G. Pybus, and Philippe Lemey, "The early spread and epidemic ignition of HIV-1 in human populations," *Science*, 2014, *346* (6205), 56–61.

Feldbaum, Harley, Kelley Lee, and Preeti Patel, "The National Security Implications of HIV/AIDS," *PLoS Medicine*, 2006, *3* (6), e171.

Fetzer, Thiemo, "Can workfare programs moderate conflict? Evidence from India," *Journal of the European Economic Association*, 2020, *18* (6), 3337–3375.

Forsythe, Steven S., William McGreevey, Alan Whiteside, Maunank Shah, Joshua Cohen, Robert Hecht, Lori A. Bollinger, and Anthony Kinghorn, "Twenty Years Of Antiretroviral Therapy For People Living With HIV: Global Costs, Health Achievements, Economic Benefits," *Health Affairs*, 2019, *38* (7), 1163–1172.

Fourie, Peter and Martin Schönteich, "Africa's New Security Threat: HIV/AIDS and human security in Southern Africa," *African Security Review*, 2001, *10* (4), 29–42.

Gao, F., E. Bailes, D.L. Robertson, Y. Chen, C.M. Rodenburg, S.F. Michael, L.B. Cummins, L.O. Arthur, M. Peeters, G.M. Shaw, P.M. Sharp, and B.H. Hahn, "Origin of HIV-1 in the chimpanzee Pan troglodytes troglodytes," *Nature*, 1999, (397), 436–441.

Habyarimana, James, Bekezela Mbakile, and Cristian Pop-Eleches, "The Impact of HIV/AIDS and ARV Treatment on Worker Absenteeism," *Journal of Human Resources*, 2010, *45* (4), 809–839.

Harari, Mariaflavia and Eliana La Ferrara, "Conflict, Climate, and Cells: A Disaggregated Analysis," *Review of Economics and Statistics*, 2018, *100* (4), 594–608.

Iqbal, Zaryab and Christopher Zorn, "Violent Conflict and the Spread of HIV/AIDS in Africa," *Journal of Politics*, 2010, *72* (1), 149–162.

Kalipeni, Ezekiel. and Leo C. Zulu, "HIV and AIDS in Africa: a geographic analysis at multiple spatial scales," *GeoJournal*, 2012, *77*, 505–523.

Khemani, Stuti, "An Opportunity to Build Legitimacy and Trust in Public Institutions in the Time of COVID-19," *World Bank Research & Policy Brief*, 2020, *32.*

König, Michael D., Dominic Rohner, Mathias Thoenig, and Fabrizio Zilibotti, "Networks in conflict: Theory and evidence from the great war of Africa," *Econometrica*, 2017, *85* (4), 1093–1132.

Kumar, Sanjay, "Protests in India after arrest of HIV/AIDS activists," *Lancet*, 2000, *355* (9218), 1896.

Lechler, Marie and Uwe Sunde, "Individual Life Horizon Influences Attitudes Toward Democracy," *American Political Science Review*, 2019, *113* (3), 860–867.

McGuirk, Eoin and Marshall Burke, "The Economic Origins of Conflicts in Africa," *Journal of Political Economy*, 2020, *128* (10), 3940–3997.

McInnes, Colin, "Conflict, HIV and AIDS: a new dynamic in warfare?," *Global Change, Peace & Security*, 2009, *21* (1), 99–114.

Miguel, Edward, Shanker Satyanath, and Ernest Sergenti, "Economic Shocks and Civil Conflict: An Instrumental Variables Approach," *Journal of Political Economy*, 2004, *112* (4), 725–753.

Nunn, Nathan and Nancy Qian, "US food aid and civil conflict," *American Economic Review*, 2014, *104* (6), 1630–66.

OECD, Paris: OECD Public Governance Reviews, Organization of Economic Cooperation and Development, 2017.

Rohner, Dominic, "Natural Resources and Conflict," *The New Palgrave Dictionary of Economics*, 2018, pp. 1–8.

_ **and Mathias Thoenig**, "The Elusive Peace Dividend of Development Policy: From War Traps to Macro Complementarities," *Annual Review of Economics*, 2020, *13.*

Savun, Burcu and Daniel C. Tirone, "Exogenous Shocks, Foreign Aid, and Civil War," *International Organization*, 2012, *66* (3), 363–393.

Sethian, J. A., "A Fast Marching Level Set Method for Monotonically Advancing Fronts," *Proceedings of the National Academy of Sciences*, February 1996, *93* (4), 1591–1595.

_ , "Fast Marching Methods," *SIAM Review*, 1999, *41* (2), 199–235.

Straus, Scott, "Wars do end! Changing Patterns of Political Violence in Sub-Saharan Africa," *African Affairs*, 2012, *111* (443), 179–201.

Theisen, Ole Magnus, Nils Petter Gleditsch, and Halvard Buhaug, "Is climate change a driver of armed conflict?," *Climatic change*, 2013, *117* (3), 613–625.

Tompsett, Anna, "The Lazarus drug: the impact of antiretroviral therapy on economic growth," *Journal of Development Economics*, 2020, *143*, 102409.

United Nations, "Trust in public institutions: Trends and implications for economic security," *United Nations Department of Economic and Social Affairs (DESA), Policy Brief*, 2021, *108.*

SUPPLEMENTARY APPENDIX

Medication Against Conflict *

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January 10, 2023

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A.1 Data

A.1.1 Data: Measuring Social Violence

A.1.1.1 Social Conflict Analysis Database - SCAD

Primary Sources and Data Construction. The main measure of events of social violence is based on information from the Social Conflict Analysis Database –SCAD (Salehyan, Hendrix, Hamner, Case, Linebarger, Stull and Williams 2012). These data contain information on protests, demonstrations, riots, strikes, and other forms of social disturbances in Africa. The data set does not include violent events related to organized armed conflict such as rebellions, civil wars, and international war. The SCAD data and documentation about coding procedures can be accessed at `https://www.strausscenter.org/scad.html` (last accessed 3.8.2020).

The SCAD database covers all countries with a population of more than 1 million in Africa and compiles events reported by Associated Press (AP) and Agence France Presse (AFP), accessed through Lexis-Nexis. The relevant articles have been selected according to a search protocol based upon keyword searches of country names and five terms: "protest," "riot," "strike," "violence," and "attack". Before coding, each retrieved article was then examined by a member of the SCAD team, discarded if not related, and otherwise kept and coded into different types of events. The SCAD team double-coded 10 percent of the country-years to verify the accuracy of the coding procedures. Particular attention was devoted to avoid double or triple counting a single event, whenever an event was documented by multiple articles. Last, the geographic location of the event was added by searches on a wide variety of platforms.

Definition of Event Types. Following the SCAD codebook, events are classified into different categories depending on events being spontaneous/organized and on the underlying motive of the unrest. The analysis here primarily focuses on events defined as follows:

- *Organized Events*: all events for which "clear leadership or organization(s) can be identified".
- *Spontaneous Events*: all events for which "clear leadership or organization(s) cannot be identified".
- *Elections*: events that mention "elections" as the first issue of the social disturbance.
- *Economic Grievance*: events that mention "economy, jobs" and/or "economic resources/assets" as the first issue of the social disturbance.
- *Human Rights*: events that mention "human rights, democracy" as the first issue of the social disturbance.

Additional Information on Event Size. The analysis also uses information about the number of participants and the number of fatalities related to violent events, classified into the following categories:

- *No casualties*: Social disturbance characterized by no casualties.
- *Casualties*: Social disturbance resulting in at least one death.

- *Few Participants*: Social disturbance with at most 100 participants (or missing information regarding the size).
- *Many Participants*: Social disturbance with more than 100 participants.

Construction of Data for Analysis. Over the period 1990-2017, 17,644 events, localized across 50 African countries, are retrieved. The only event category excluded is Intra-Government violence, which represents events reflecting social conflict within the army or the police forces. Events are linked to the respective country/region based on information about latitude and longitude. To generate a measure of social violence at sub-national levels, only geo-localized events are used. The main measure of social violence denotes the total number of violent events in the country/region in a given year.

Country-level data: The data set used in the analysis covers 50 African countries over the period 1990-2017. The number of events ranges between a minimum of 0 to a maximum of 617, with an average of 11.9 events per country/year. More than 77% of all country-year observations exhibit at least one event. For a subset of events (7,750 out of 17,644 events) information on the approximate number of participants of the event is available.

Sub-national level data: The data for the analysis at the level of sub-national regions is restricted to events that are geo-coded. Events that are attributed to the country capital because of lack of information are discarded. The data set used in the analysis covers 170 administrative level-1 units in 18 countries over the period 1990-2017. Administrative level-1 units correspond to the largest sub-national administrative units (comparable to federal states in the United States or Bundesländer in Germany). The number of events in a sub-national unit ranges between 0 and 61, with an average of 0.8 events per sub-national unit/year. The share of subnational region-year observations with at least one event is 25%. For 1,858 out of 4,004 events, information on the number of participants of the event is available.

Definition of Types of Riots/Protests based on SCAD Narratives. Using information about the actors involved in an event provided by the short narratives that describe a given event allows identifying events involving specific categories. Using a "bag-of-words" approach, the analysis focuses on the following categories:

- *Health Workers*: We identify events involving health workers by a keyword search through all event fields of the keywords: "nurse" OR "doctor" OR "paramedic" OR "midwife" OR (("health" OR "health care" OR "hospital" OR "medical") AND ("worker" OR "staff" OR "employee" OR "personnel" OR "professional")).
- *Civil Servants*: We identify events involving civil servants by a keyword search through all event fields of the keywords: "civil servant" OR "public sector worker" OR "government employee" OR "civil service worker" OR "teacher" OR "professor" OR "government official" OR "city official".
- *NGOs*: We identify events involving non-governmental and human rights activists by a keyword search through all events fields of the words: "NGO" OR "activist" OR "non-governmental".

Appraisal of SCAD. The SCAD database has several major advantages for the analysis presented here. First, the data focus on social violence defined as social and political unrest, excluding large-scale organized armed conflicts. Access to ART treatment is expected to be particularly relevant for social violence as opposed to large scale conflict, which is not merely affected by individual-level factors –like access to health treatment– but driven by a variety of macro-level factors related to collective action. Second, the data has long time coverage and high data quality. In particular, the procedures of data construction of the SCAD data avoid duplication of events, which is a particularly serious concern for comparable data sets – especially for data sets that (unlike SCAD) rely exclusively on automated text extraction algorithms. Third, the same sources are used for retrieving episodes of violence for all countries/regions/years in the sample – which is of great importance for the consistency of coding. These features (the very consistent definition of events of interest with exclusive focus on social violence, avoiding double-counting, and the consistency in the sources used) explain the fact that the number of total events is lower in the SCAD data than in comparable data sets, such as the ACLED database (described below).

A.1.1.2 The Armed Conflict Location And Event Data - ACLED

Primary Sources and Data Construction. As alternative data source for social violence, the analysis makes use of the Armed Conflict Location and Event Data – ACLED (Raleigh, Linke, Hegre and Karlsen 2010). These data contain information on all forms of political disorder for nearly 100 countries since 1997. Political violence is defined as "the use of force by a group with a political purpose or motivation". ACLED includes accurate information about the timing of events, the actors and the exact location, with events reflecting violent acts between and across non-state groups, militias, unnamed agents, violent political agents and riots and protests. ACLED data and documentation about coding procedures can be accessed at `https://acleddata.com/curated-data-files/`.

ACLED data are collected by experienced researchers and retrieved from a wide range of local, regional and national sources. These sources include local, regional, national and continental media (including Telegram and Twitter); reports from NGOs or international organisations; and information from local conflict observatories. The data collection procedure can be summarized as follows: each week individual researchers scrutinize information on available reports; this information is then aggregated and coded by a first reviewer; a second reviewer cross-checks the available information; notes and details are inspected by a third final reviewer.

Definitions of Event Types. Following the ACLED codebook, events are classified into different categories. The analysis here primarily focuses on riots and protests, which are classified as follows:

- *Riots* are violent events where demonstrators or mobs engage in disruptive acts, including but not limited to rock throwing, property destruction, etc. They may target other individuals, property, businesses, other rioting groups or armed actors. Rioters may begin as peaceful protesters, or may be intent on engaging in spontaneous and disorganized violence from the beginning of their actions. Contrary to armed groups, rioters do not use sophisticated weapons such as guns, knives or swords. "Crude bombs" (e.g. Molotov cocktails, petrol bombs, firecrackers) may be used in rioting behavior.

- *Protests* are defined as public demonstrations in which the participants do not engage in violence, though violence may be used against them. Events include individuals and groups who peacefully demonstrate against a political entity, government institution, policy, group, tradition, businesses or other private institutions. Events that are not coded as protests are symbolic public acts such as displays of flags or public prayers (unless they are accompanied by a demonstration), protests in legislatures such as parliamentary walkouts or MPs staying silent, strikes (unless they are accompanied by a demonstration), and individual acts such as self-harm actions (e.g. individual immolations or hunger strikes).

Construction of Data for Analysis. Over the period 1997-2017, 41,407 events, localized across 50 African countries, are retrieved. Events are linked to the respective country/region based on information about latitude and longitude.

Country-level data: The data set covers 50 African Countries over the period 1997-2017. The number of events ranges between a minimum of 0 to a maximum of 1,782, with an average of 38.7 events per country/year. More than 81% of the country-year observations exhibit at least one event.

Sub-national level data: The data for the analysis at the level of sub-national regions is restricted to the subset of events that are geo-coded. The data set used in the analysis covers 170 administrative level-1 units in 18 countries over the period 1997-2017. The number of events ranges between 0 and 556, with an average of 2.8 events per sub-national unit/year. The unconditional probability of experiencing a social violence event for a subnational unit is 38 percent. The share of region-year observations with at least one event exceeds 38%.

Appraisal of ACLED. The main advantage of the ACLED database for the purpose of this analysis is its reliance on a rich pool of primary and secondary sources, which allows mapping a relatively high number of events. The main shortcoming is that the pool of sources is not necessarily stable across country/regions and years. These features make it an ideal secondary data source to perform robustness checks for the results obtained with the SCAD data.

A.1.2 Data from the Uppsala Conflict Data Program (UCDP)

Primary Sources and Data Construction. As alternative data source for social violence, we also make use of data on conflict events collected by the Uppsala Conflict Data Program (UCDP GED). The UCDP data contain violent events, defined as "the incidence of the use of armed force by an organized actor against another organized actor, or against civilians, resulting in at least 1 direct death in either the best, low or high estimate categories at a specific location and for a specific temporal duration (Sundberg and Melander 2013). The data contain information about location, timing, and involved actors of events.

UCDP data are based on automated searches of global news companies, media, international organizations, NGOs, historical achives and other sources of information, which are then evaluated by human coders. UCDP data and documentation can be accessed at `https://www.pcr.uu.se/research/ucdp/`.

Definitions of Event Types. UCDP data contain information on armed conflicts, which represents a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state. UCDP data only contain organized events involving at least one fatality; incidents without information on fatalities are not included. Conflict events in the UCDP data that meet these criteria therefore represent organized violence of considerable intensity.

Construction of Data for Analysis. Over the period 1990-2017, 35,264 events, localized across 50 African countries, are retrieved. Events are linked to the respective country.

Country-level data: The data set covers 50 African Countries over the period 1997-2017. The number of events ranges between a minimum of 1 to a maximum of 583, with an average of 55.1 events per country/year. All of the country-year observations in Africa exhibit at least one event.

Appraisal of UCDP Data. For the purpose of the analysis, the UCDP data represent information about social conflict that involves organized violence of substantial intensity. This measure complements the SCAD data used in the baseline analysis, which excludes all events defined as "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in one calendar year". This makes it an ideal source of information to investigate the mechanism and the sensitivity of the results to different types of violent conflict.

A.1.2.1 Intimate Partner Violence from Demographic and Health Surveys (DHS)

Information about intimate partner violence is based on data from the Demographic and Health Surveys (DHS) Program (DHS Program Spatial Data Repository, funded by USAID; `spatialdata.dhsprogram.com` [Last accessed August 3, 2020]). The DHS collects nationally representative data on health and population in developing countries. Data on domestic violence in the DHS are available for some, but not all, countries surveyed, as the information on domestic violence stems from an optional module of questions (for further information, see: `https://dhsprogram.com/data/Guide-to-DHS-Statistics/17_Domestic_Violence.htm#References4`). The set of questions related to domestic violence is further administered to a sub-sample of randomly selected respondents.

Construction of Data for Analysis. Regional-level information on domestic violence is available for the following countries (years): Burkina Faso (2010), Cameroon (2004, 2011), Cote d'Ivoire (2011), Ethiopia: 2016), Ghana (2008), Kenya (2003, 2008, 2014), Malawi (2004, 2010, 2015), Mali (2006, 2012), Rwanda (2005, 2010, 2014), Senegal (2017), Tanzania (2010, 2015), Zambia (2007, 2013), Zimbabwe (2005, 2010, 2015). The analysis is based on data aggregated by the statcompiler (see https://www.statcompiler.com/en/); we retrieved information on the percentage of women aged 15-49 who have experienced physical violence in the past 12 months (often or sometimes). This delivers 219 observations, across 124 Administrative level-1 units within 13 countries, between 2003 and 2017. Around one-fifth of women in the sample (20,2 percent) experienced physical violence (often or sometimes) in the 12 months before the survey. The variable ranges from a minimum of 0.2 (Centre-Nord, DHS region, Burkina Faso, 2010) to a maximum of 0.575 (Mara, DHS region, Tanzania, 2010).

Appraisal of Intimate Partner Violence from DHS. For the purpose of our analysis, this data is of great importance for being able to study the extent of individual violence taking place in the household context. A drawback of this data is coverage and the small number of observations, which restricts the statistical analysis that can be conducted.

A.1.3 Data: HIV Prevalence

Data at Country Level. At the country level, data for HIV prevalence are obtained from UNAIDS (downloaded from the World Bank data platform `https://data.worldbank.org/indicator/SH.DYN.AIDS.ZS`). Since the exact number of individuals living with HIV cannot be determined in many countries, the best possible approximation is obtained through model estimates. For each country, UNAIDS composes teams of experts (epidemiologists, demographers, monitoring and evaluation specialists and technical partners) who collect and process data to produce estimates for HIV prevalence. UNAIDS collects all country estimates and reviews them through the work of the Strategic Information and Monitoring Division, in order to guarantee that estimates are comparable across countries over time. The construction of estimates differs across countries with high and low levels of HIV prevalence:

- For *high-level HIV epidemic countries* the estimates are based on data from surveillance among pregnant women and from nationally representative population-based surveys.
- For *low-level HIV epidemic countries* the estimates are based on data from sub-populations at high risk of HIV infections that are combined with nationally representative surveys to produce the estimates.

Construction of Data for Analysis – Country level. The analysis is based on HIV prevalence among the population group with age 15-49 years. Formally, this variable is defined as HIV Prevalence = number HIV infected (15-49 years) / total population (15-49 years). The data set covers 50 African countries over the period 1990-2017. The average HIV Prevalence (15-49) is 0.047, ranging from a minimum of 0.001 to a maximum of 0.285 (Swaziland in 2013 and 2014).

Data at Sub-national Level. HIV prevalence at the sub-national level (administrative level-1 units) is constructed using DHS survey data (DHS Program Spatial Data Repository, funded by USAID; `spatialdata.dhsprogram.com` [Last accessed August 3, 2020]). DHS data are, to the best of our knowledge, the most comprehensive source of sub-national information to map HIV prevalence. The data has been retrieved from `https://www.statcompiler.com/en/`. Since no information from DHS waves was available for some countries before 2001, the analysis makes use of information about HIV prevalence from waves up to 2006 for a subset of countries. Specifications of the empirical framework with country-year fixed effects address possible bias arising from this specific data limitation.

Construction of Data for Analysis – Sub-national level. The analysis is based on HIV prevalence among the population group with age 15-49 years. Formally, this variable is defined as HIV Prevalence = number HIV infected (15-49 years) / total population (15-49 years). The data set contains HIV prevalence for a total of 170 regions in 18 African countries. The average HIV Prevalence (15-49) is 0.068, ranging from a minimum of 0.001 to a maximum of 0.297 (Leribe region in Lesotho).

A.1.4 Data: Latent HIV Exposure based on Geography

An alternative measure of cross-country exposure to HIV and scope for treatment is constructed based on historical geographic origin of the HIV epidemic and its subsequent spread. According to current knowledge the most infective strain of the HIV virus crossed from chimpanzees to humans probably before 1920 in Cameroon, while the beginning of the spread of HIV across Africa has been traced back to Kinshasa around 1920 (Gao, Bailes, Robertson, Chen, Rodenburg, Michael, Cummins, Arthur, Peeters, Shaw, Sharp and Hahn 1999, Faria, Rambaut, Suchard, Baele, Bedford, Ward, Tatem, Sousa, Arinaminpathy, Pépin, Posada, Peeters, Pybus and Lemey 2014). By 1980, about half of human infections in the Democratic Republic of Congo were observed outside of

Kinshasa. The virus subsequently diffused out of DRC, first towards the great lakes area and then along the East of Africa, eventually reaching the Mediterranean basin and South Africa as well as the North-West towards Nigeria during the 1990's (Kalipeni and Zulu 2012). In general, the spread and prevalence of HIV in a population depends on multiple factors, including population density, economic activities, and public health policies. The spread of HIV within Africa, however, was affected strongly by geographical features. While equatorial forests and deserts or semidesert areas constituted obstacles, rivers such as the Congo River played an important role by facilitating the spread of the virus out of Kinshasa. These geographic features are considered as prime determinants of the comparatively intense initial but uneven and non-concentric diffusion of HIV to the South-East of Africa (Faria et al. 2014).

Construction of Latent Exposure Index (HIV_{geo}). An index of latent exposure to HIV is constructed based on the effective (non-geodesic) distance from the origin of the spread of the virus in Kinshasa. The measure exclusively uses information on first nature geography. A generalized version of the Dijkstra algorithm known as Fast Marching Method (Sethian 1996, Sethian 1999) is used to compute the shortest path to Kinshasa from any location, defined as centroids of grid-cells. These grid-cells span the entire African continent and are transformed that span the entire African continent and that are transformed to an equal area projection using the Africa Albers Equal Area Conic projection (ESRI:102022). The algorithm assigns a measure of effective distance that accounts for propagation costs for HIV transmission. These costs depend exclusively on first nature geographic features of the shortest travel path from each location to Kinshasa. This accounts for the iso-cost contour expanding more slowly through deep forests, very rugged terrains, or deserts and thereby reflects the fact that paths along such geographies involve higher effective distance, paralleling applications of similar procedures (Allen and Arkolakis 2014). Importantly, the measure reflects the relative propagation speed, or distance, from Kinshasa to a location relative to other locations.

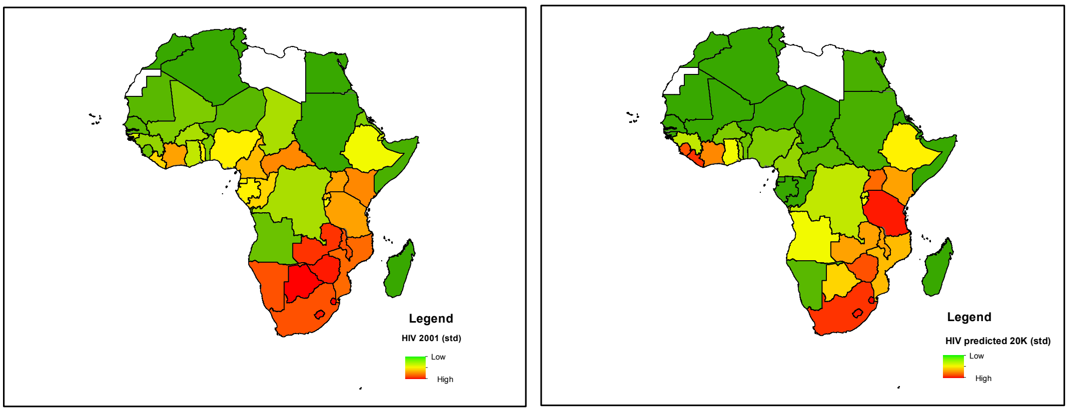
Denoting by c_i the instantaneous cost associated with passing any given cell i, a parameter $x_i \geq 0$ constitutes the inverse of costs, with $c_i = 1/x_i$. Accounting for the role of geography for the spreading of HIV, maximum instantaneous costs are associated with grid-cells i that exhibit inhospitable conditions as reflected by deserts or deep forests, or with monthly average maximum temperatures above 38°C, such that $x_i = 0$, rendering these cells virtually impenetrable and ignored by the fast marching method in the identification of the closest path from each location (grid-cell) to Kinshasa. For all other cells, the instantaneous costs are associated with a level $x_i > 0$. The minimum instantaneous cost is associated with cells that are penetrated by major rivers and water reservoirs. For all other cells, the instantaneous costs increase with the intensity of forest coverage and the roughness of the terrain. For any origin-destination pair, the algorithm delivers a (normalized) distance, which when summed up delivers a measure of latent HIV exposure of a location in terms of its spreading distance to Kinshasa.

Since the distribution of human populations in Africa is uneven with the vast majority of locations hosting no sizable human settlements and only a minority of locations (less than 20 percent) hosting comparatively large communities, only locations (grid-cells of 5×5km) that exhibit sufficiently large population density are associated with positive HIV potential and considered for the analysis. Population density data are as of year 2000 (Center for International Earth Science Information Network - CIESIN 2018, Tatem 2017). As baseline, the distances are computed for a population threshold for locations (grid-cells) of at least 16903 inhabitants, which corresponds to the 80th percentile (8th decile) of the distribution of population density. As alternative specifications, we computed the distances based on a population threshold of 20,000 inhabitants per cell (which is equivalent to around 1,000 inhabitants per square km), which corresponds to the 17.5%

most densely populated cells (or the 82.5th percentile), as well as based on a population threshold of 10,000 (corresponding to the top 28.6 percent of the population density distribution). In a last step, cell-level data are aggregated to the country level.

The resulting measure of latent HIV exposure and scope for treatment in the year 2000 is a function of effective, purely geography-based distance from Kinshasa. Figure A1 displays the actual HIV prevalence in 2001 at the country level (left panel) and the corresponding measure of purely geography-based HIV exposure (right panel, both standardized).

Figure A1: Actual HIV Prevalence and Latent HIV Exposure (Country Level)



(a) HIV Prevalence 2001 ($\text{HIV}_{c,2001}$) (b) Geography-based HIV exposure (HIV_{geo})

Note: Panel (a): HIV prevalence in 2001; data source: UNAIDS. Panel (b): Latent HIV exposure based on effective distance to Kinshasa, based on fast marching method algorithm; country-level averages. For greater comparability, measures in both panels have been standardized.

A.1.5 Data: Antiretroviral Therapy (ART) Coverage

Data for Antiretroviral Therapy (ART) coverage at the country level is obtained from UNAIDS (downloaded from the World Bank data platform `https://data.worldbank.org/indicator/SH.HIV.ARTC.ZS`). ART coverage indicates the percentage of all individuals living with HIV who receive antiretroviral therapy. In each country, local facilities administering antiretroviral therapy hold registers that are compiled and sent to national authorities on a routine basis. UNAIDS requests countries to submit these data on the 31st of March every year through an on-line reporting tool. The tool features several quality checks in order to avoid reporting errors; UNAIDS further validates the data, comparing them with information from alternative sources.*

Construction of Data for Analysis (ART Cov). The analysis makes use of ART coverage measured as the share of treated individuals among infected individuals. Formally, this variable is defined as ART Coverage (out of Infected Individuals) = number ART treated / number HIV-infected. As alternative measure for the robustness analysis, the results are cross-validated using the number of treated individuals out of the total population. Formally, this variable is defined as

*Further information can be obtained from: `https://www.unaids.org/en/dataanalysis/knowyourresponse/HIVdata_estimates`.

ART Coverage (percentage population) = number ART treated / total population. The data set covers 50 African countries over the period 1990-2017. The average ART Coverage (out of Infected Individuals) is 0.12, ranging from a minimum of 0 to a maximum of 0.85 (Swaziland in 2017). The identification strategy makes use of data for 53 low and middle income countries outside Africa for which ART coverage is available.

A.1.6 Data: Antiretroviral Therapy (ART) Costs and Prices

Data on the time-series of ART Prices and Production Costs are based on the combination of information from two different sources: The WHO Global Price Reporting Mechanism (GPRM) and the Global Fund Pooled Procurement Mechanism Reference Pricing. The WHO Global Price Reporting Mechanism (GPRM) was created in 2003 to support transparency in the market of antiretroviral (ARV) drugs. Until 2013, GPRM reported prices and volumes of ARV drugs sold on international markets covering 132 countries (35 low-income countries, 44 lower-middle income, 36 upper-middle income and 17 high income countries). The main providers of data were the Global Fund, PEPFAR, UNITAID, and the procurement organizations working with them, such as the Clinton Foundation, Crown Agent, the Global Drug Facility (GDF), the International Dispensary Association (IDA HIV/AIDS), USAID/Deliver, Mission Pharma, Management Sciences for Health (MSH), the Partnership for Supply Chain Management (PFSCMS), the United Nations Development Programme (UNDP), the United Nations Children's Fund (UNICEF), and the WHO/Contracting and Procurement Service (WHO/CPS). From 2004 to 2012 the GPRM covered between 70 and 80 percent of total volume of ARV drug transactions (Perriëns, Habiyambere, Dongmo-Nguimfack, Hirnschall et al. 2014). The analysis here makes use of price data for active pharmaceutical ingredient (API) from GRPM. These data contain the median price for the most relevant treatment regimens and their API over the period 2003-2012. Since 2015, the Global Fund Pooled Procurement Mechanism Reference Pricing has published quarterly reports containing reference prices for ARV medicines. Reports from the Global Fund were retrieved from `https://www.theglobalfund.org/en/sourcing-management/health-products/antiretrovirals/` and`https://www.who.int/hiv/amds/gprm/en/`.

Construction of Data for Analysis – Prices (ART Price). The main analysis focuses on the median price of a specific and widely used first line treatment for adults, ZDV-3TC-EFV, which represents a combination of three reverse-transcriptase inhibitors: 300mg of Zidovudine (ZDV), 150mg of Lamivudine (3TC) and 600 mg of Efavirenz (EFV).[†] Since data are available for the period between 2003 and 2012 and from 2015 to 2017, data for the years 2013 and 2014 have been linearly interpolated. The prices for the ZDV-3TC-EFV first line treatment ranges from 644$ US per patient per year in 2003 to 102$ US in 2017. For comparability with the results based on ART coverage in non-African countries, prices are converted into a reverse index.[‡]

Construction of Data for Analysis – Costs (ART Cost). The production costs of the same first line treatment ZDV-3TC-EFV are available only for selected years, namely 2005, 2007, 2010 and 2012. The time-series of production cost were constructed as follows. First, exploiting prices and

[†]The analysis focuses on first line regimens for adults, which represent the most widely used treatments of the time and were substantially less expensive than second line treatments. This particular first line regimen is considered the most effective regimen and is the one recommended by WHO. Furthermore, because of its higher initial price it was initially not widely used in low and middle income countries. Alternative regimens (in particular the second first line regimen ZDV-3TC-NVP) are used for robustness checks on the instrumentation.

[‡]In particular, the price index for year t is constructed as $price\_index_t = (price_{2003}/price_t) - 1$.

costs for available years, we computed the mark-up of pharmaceutical companies (ARV medicine prices/API costs). Second, this mark-up is assumed to be constant before 2005 and after 2012, when cost information is not available; in this way it is possible to compute, in a very conservative way, costs over the periods 2003-2005 and 2013-2017 by combining the predicted mark-ups with the complete time-series of price data. Third, for the missing years between 2005 and 2012, we interpolated the data to build a continuous estimate of the production costs. The API production cost for ZDV-3TC-EFV ranges from a maximum of 477$ in 2003 to a minimum of 86$ per patient per year in 2017. For comparability with the results based on ART coverage in non-African countries, costs are converted into a reverse index.[§]

Construction of Data for Analysis – Synthetic Price Index (Synth. Price). As alternative, a synthetic index of global prices is constructed only exploiting information about the initial price prior to the expansion of ART demand (and thus potential influence of donors on the price development). This synthetic price index is therefore, by construction, unrelated to political interventions and to any other sort of demand-driven price decline. Concretely, a time series of synthetic prices for the first line treatment for adults, ZDV-3TC-EFV, is constructed following previous research on the evolution of drug prices after the end of patent exclusivity, and after the introduction of generic drugs (with the related increase in competition). Existing evidence shows that market prices typically display a sharp initial decline that is followed by more moderate reductions as market prices converge to the limit price, which ensures non-negative profits by generic producers (in terms of a minimum mark-up over production cost). The documented patterns are compatible with a proportional reduction of the mark-up in each year (Perriëns et al. 2014, Conti and Berndt 2014, Dave, Hartzema and Kesselheim 2017). The synthetic price index is obtained by computing the initial extra mark-up for the regimen ZDV-3TC-EFV in 2003 and then constructing the series of prices that would have been observed on the global markets if the mark-up were reduced each year after 2003 by a fixed proportion x.[¶]

A.1.7 Data: Other Variables and Sources

A.1.7.1 Country-Level Data

- **Time Trends for African Regions**: The main specification accounts for differential trends in different regions of Africa, based on the classification of subregions according to the United Nations geoscheme for Africa. Countries are coded as follows: *Central Africa:* Burundi, Cameroon, Central African Republic, Chad, Congo, Dem. Rep. Congo, Rep. Equatorial Guinea, Gabon; *East Africa*: Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Somalia, South Sudan, Sudan, Tanzania, Uganda; *North Africa*: Algeria, Egypt, Arab Rep. Mauritania, Morocco, Tunisia; *Southern Africa*: Angola, Botswana, Eswatini (Swaziland), Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia, Zimbabwe;

[§]In particular, the cost index for year t is constructed as $cost\_index_t = (cost_{2003}/cost_t) - 1$.

[¶]Specifically, the construction uses data on the price for the first line regimen ZDV-3TC-EFV in 2003, P_0, and the average price in the years from 2015 to 2017, P_{lim}, which corresponds to the minimum price since price and production costs for the ZDV-3TC-EFV regimen effectively stabilized after 2015. With a mark-up in the first year given by $M_0 = P_0 - P_{lim}$, the synthetic price index for the subsequent years is computed as $\bar{P}_t = M_{t-1}(1-x)$, where $x \in (0,1)$ denotes a fixed proportional reduction in the mark-up in each year, and with the mark-up each year given by $M_{t-1} = \bar{P}_{t-1} - P_{lim}$. As baseline, the mark-up is assumed to be reduced by 15 percent per year ($x = 0.15$); robustness checks are conducted for $x = 0.2$ and $x = 0.25$. For comparability with the series of actual prices and costs, the synthetic price index for year t is computed as $price\_index_t = (price_{2003}/\bar{P}_t) - 1$.

West Africa: Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo.

- **GDELT Data**: Robustness was conducted for data on violent events collected by the GDELT project (Global Database of Events, Language, and Tone). GDELT contains global, machine-coded and georeferenced information of events of various types based on open source data from news media collected from numerous websites. GDELT data and documentation can be accessed at `https://www.gdeltproject.org/data.html`. Relevant events have been extracted based on the CAMEO classification for "protests" (classification 14, which also includes non-violent and violent protests, as well as riots). As result of the machine-based coding process, geolocalization of GDELT data is often unreliable or misleading.(Raleigh and Kishi 2019) Consequently, data are applied to country-level analysis only.

- **GDP**: GDP data, in constant 2010 US$, are taken from the World Bank data platform (`https://data.worldbank.org/indicator/NY.GDP.MKTP.KD`). GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2010 U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 2010 official exchange rates. For a few countries, where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

- **Population**: Population data are taken from United Nations Population Division, Census reports, Eurostat, United Nations Statistical Division, U.S. Census Bureau and Secretariat of the Pacific Community and downloaded from the World Bank data platform (`https://data.worldbank.org/indicator/SP.POP.TOTL`). Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values represent mid-year estimates.

- **Life Expectancy**: Life expectancy data are taken from United Nations Population Division and Census and downloaded from World Bank data platform (`https://data.worldbank.org/indicator/SP.DYN.LE00.IN`). Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of her birth were to stay the same throughout her life.

- **Malaria prevalence**: Malaria prevalence data are collected by WHO and downloaded from the World Bank data platform (`https://data.worldbank.org/indicator/SH.MLR.INCD.P3`). Malaria incidence is measured as the number of new cases per year per 1000 population at risk.

- **Malaria treatment prices**: Malaria treatment prices are collected by the Bill and Melinda Gates Foundation. The analysis focuses on the price of the most relevant drug against malaria: Artesiminin. Information about the price for artesiminin between 2004 and 2015 is obtained from the report "Novel Artemisimin Manufacturing Technologies: Request for Proposal" published by the Bill and Melinda Gates Foundation.[‖]

[‖](`https://www.gatesfoundation.org/How-We-Work/General-Information/Grant-Opportunities`).

- **Global Fund**: Global Fund data measure the amount of aid (in USD) disbursed by the Global Fund to a country in a given year. Data have been downloaded from the Global Fund data platform (`https://data.theglobalfund.org/investments/home`).
- **Democracy**: The Institutionalized Democracy score ranges between 0 and 10, with a higher score representing more democratic institutions. The combined Polity score is a composite of the Institutionalized Democracy score and a corresponding score of Institutionalized Autocracy, which is subtracted from the Institutionalized Democracy score. The Revised Combined Polity Score (Polity 2) represents a modified version of the Polity score and ranges from -10 to +10. Data have been downloaded from the Polity V Project dataset "Political Regime Characteristics and Transitions, 1800-2018" (`http://www.systemicpeace.org/inscrdata.html`).
- **Institutional Quality**: The quality of institutions is measured using indices in six broad dimensions of governance, based on data from the Worldwide Governance Indicators (2020 Update, data have been downloaded from `http://www.govindicators.org`). The dimensions include Voice and Accountability (va), Political Stability and Absence of Violence/Terrorism (pv), Government Effectiveness (ge), Regulatory Quality (rq), Rule of Law (rl), and Control of Corruption (cc). Each index represents an estimate of governance quality in standard normal units, ranging from approximately -2.5 (weak) to 2.5 (strong) governance performance.

A.1.7.2 Sub-national Level Data

- **Malaria Prevalence**: Malaria prevalence at the sub-national level (administrative level-1 unit) has been constructed using DHS survey data (`https://www.statcompiler.com/en/`). DHS collects information about children who had malaria in the 5 years prior the interview. This measure is used as a proxy for malaria prevalence in a given region, using for each country the survey closest to 2001. The data set covers 103 regions across 10 countries.

- **Trust in Institutions**: Trust in institutions is constructed from the Afrobarometer project, using survey data from waves 1–6 (covering the period 1999-2016) (BenYishay, Rotberg, Wells, Lv, Goodman, Kovacevic and Runfola 2017). Afrobarometer surveys measure the social and political atmosphere in a country through face-to-face interviews with a random sample of 1200-2400 people per country. The surveys cover 12 countries during the first wave and up to 36 countries during the sixth wave. Survey responses are associated to administrative regions based on the latitude and longitude of survey respondents' locations. The analysis focuses on trust in institutional representatives, relying on individual answers to questions on trust. For each question, respondents had four different answer categories, two related to positive and two related to negative responses, measured by a categorical variable ranging from 1 to 4 (or 0 to 3). The detailed wording of the questions can be found in the Afrobarometer codebooks (`https://www.afrobarometer.org/data/merged-data`). The questions refer to trust in
  - Parliament (item Q43B in wave 2, Q55B in wave 3, Q49B in wave 4, Q59B in wave 5, Q52B in wave 6)
  - Local Government (item Q43E in wave 2, Q43E in wave 2, Q55D in wave 3, Q49D in wave 4, Q59E in wave 5, Q52E in wave 6)

  - Police (item *trspol* in wave 1, Q43I in wave 2, Q55H in wave 3, Q49G in wave 4, Q59H in wave 5, Q52H in wave 6)

- **Policy Approval**: Approval of policies is constructed from the Afrobarometer project, using survey data from waves 1–6 (covering the period 1999-2016) similar to trust in institutions (BenYishay et al. 2017). The analysis focuses responses to questions about how well the government handles different matters. For each question, respondents had four different answer categories, two related to positive and two related to negative responses. Approval is coded as binary variable, distinguishing between replies "very badly/fairly badly" and "fairly well/very well". The detailed wording of the questions can be found in the Afrobarometer codebooks (`https://www.afrobarometer.org/data/merged-data`). The questions refer to approval in the following dimensions:

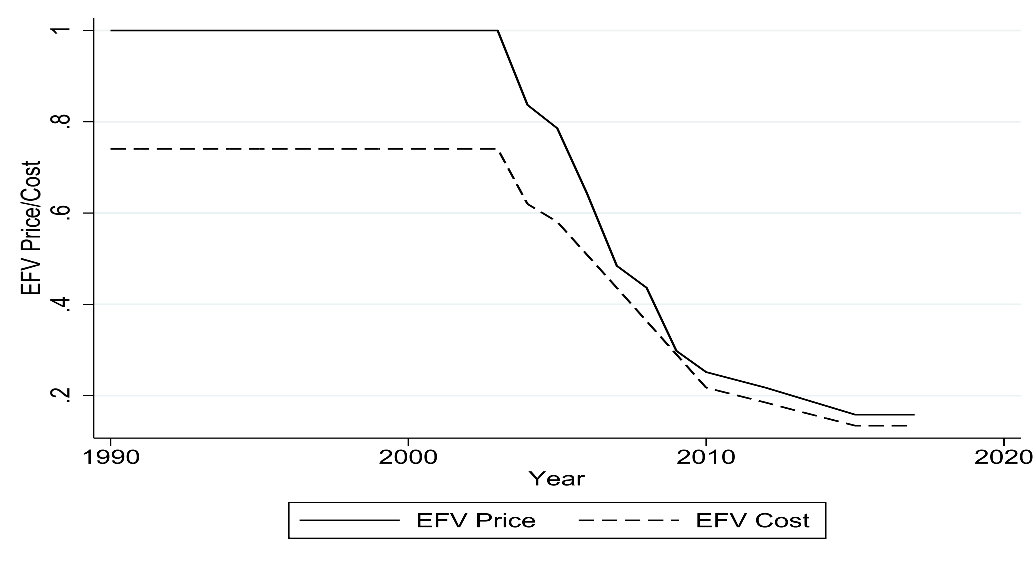
  - Approval to the handling of combating HIV/AIDS (item *pfghiv* in wave 1, Q45L in wave 2, Q65K in wave 3, Q57L in wave 4, Q65M in wave 5).
  - Approval to addressing educational needs (item *pfgedu* in wave 1, Q45g in wave 2, Q65g in wave 3, Q57h in wave 4, q65h in wave 5, Q66h in wave 6).
  - Approval to economic policy (average of share of positive answers to questions referring to managing the economy, creating jobs, keeping prices stable, and reducing inequality):
    * managing the economy (item Q45A in wave 2, Q65A in wave 3, Q57A in wave 4, Q65A in wave 5, Q66A in wave 6)
    * job creation (item Q45B in wave 2, Q65B in wave 3, Q57C in wave 4, Q65C in wave 5, Q66C in wave 6)
    * price stability (item Q45C in wave 2, Q65C in wave 3, Q57D in wave 4, Q65D in wave 5, Q66D in wave 6)
    * reducing the income between rich and poor (item Q45D in wave 2, Q65D in wave 3, Q57E in wave 4, Q65E in wave 5, Q66E in wave 6)
  - Approval to health policy (related to improving basic health services, item *pfghlt* in wave 1, Q45F in wave 2, Q65F in wave 3, Q57G in wave 4, Q65G in wave 5, Q66G in wave 6).
  - Approval to policy aimed at reducing crime (item Q45E in wave 2, Q65E in wave 3, Q57F in wave 4, Q65F in wave 5, Q66F in wave 6).

A.2 Identification

Identification Assumptions. The identification strategy is based on the interaction of cross-country heterogeneity in HIV exposure and thus scope for ART expansion and time-varying measures of ART expansion. For each specific combination of measures, the crucial assumption for identification is that this interaction is exogenous. While conceptually capturing the same underlying phenomenon, the different instruments of the variation in ART access over time differ in terms of data quality and potential concerns regarding the validity of the identifying assumptions.

ART Price: The median world price of ART treatment regimens represents a valid instrument, as it is exogenous to the intensity of social and political pressure or other country-time-specific factors that might affect ART coverage and conflict simultaneously. This implies that the instrument is only indirectly informative about the availability of ART treatments in a country but it has the advantage that the instrument does not respond, by construction, to the country-specific level of social violence or any policy intervention specifically targeted at a given country and given year. An advantage of this instrument is that, conceptually, it is more directly related to actual ART treatment in a country as compared to information on ART coverage outside Africa since the reduction in prices constitutes the ultimate driver of the increase in ART coverage. A potential concern for the quantitative interpretation is that a reduction in the prices paid by a government frees budget resources that can be used for alternative policies and, accordingly, lead to a reduction of e.g. protests or strikes. Limitations of this instrument are related to shorter time coverage of data compared to ART coverage outside Africa. Moreover, to the extent that prices for ART treatments might be determined by monopolistic pricing of pharmaceutical multinational corporations, international organizations might have had an indirect effect through their influence on price negotiations. This would show up in terms of a decline in prices due to lower mark-ups over costs, raising concerns about simultaneity.

Figure A2: GLOBAL VARIATION IN PRICE AND COST OF ART (ART PRICE, ART COST)



Note: The plot captures the global variation in the median world price of ART treatment regimens ZDV-3TC-EFV (ART Price) used in the baseline instrumentation in combination with cross-sectional heterogeneity in the scope for ART expansion, as well as the alternative construct based on the cost of the ZDV-3TC-EFV treatment regimens (ART Cost). Levels are normalized to highest median price in the sample.

ART Cost: The conceptual advantage of this instrument is that the decline in global production costs is largely related to the increase in the amount of treatments produced by international laboratories worldwide. The reduction in costs of production maps also into the reduction in prices, but the time variation of the two series differs because of variation in the markups charged by pharmaceutical companies, particularly due to increasing competition associated with the introduction of active principles produced as generic. The validity of the ART cost instrument is based on similar arguments as that of ART prices, but has the appealing feature of not relying on changes of markups of pharmaceutical companies, which might be influenced by political pressure. This makes the information about cost even less susceptible to pressures by international organizations since variation is related to an increase in research competition and patent expiration. Hence, conceptually, the use of global production costs is the preferred instrument. However, this instrument is subject to more severe data limitations in terms of availability and coverage, which requires interpolation of data for years with missing information. This reduces the variability of the measure and leads to a slightly lower strength of the first stage regression.

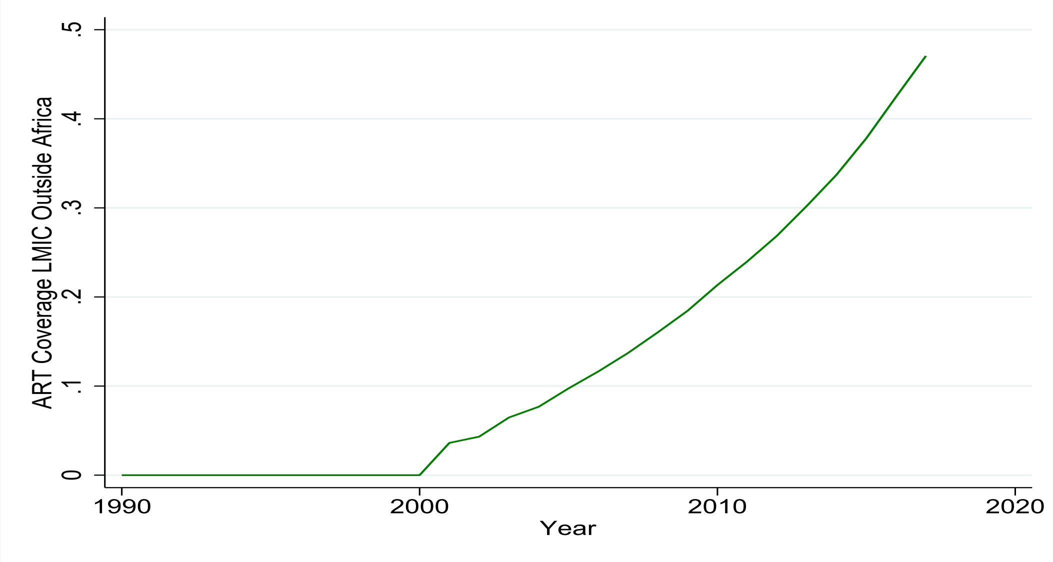
Synthetic Price: The synthetic price instrument is based on price data prior to the major expansion of the first line of ART treatment in 2003, and on price data after the major expansion (2015-2017). For the intermediate time period, the price index is constructed based on the assumption of a constant proportional decline of the mark-up in each year. This decline approximates the global dynamics of treatment costs and prices. The appealing feature of this price index is that only two data points are involved in its construction, alleviating potential concerns about a demand-driven price decline that violates the exclusion restriction due to systematic variation in prices in response to an ART expansion in particular countries.

ART Cov: The ART coverage in other low and middle income countries outside Africa captures effective variation in access, and thus comes closest to the variation captured by the instrumented variable (ART coverage in African countries). The use of global ART coverage outside Africa is conceptually not affected by the level of ART coverage in a specific country. Moreover, data quality and coverage is good and the inclusion of year fixed effects accounts for global shocks. However, a direct role of international actors or organizations in extending ART coverage worldwide could raise potential concerns about simultaneity.

Instrument Selection. A battery of statistical tests was performed to verify the first stage relevance and instrument validity. In light of the use of multiple instruments (ART Price, ART Cost, Synth. Price, ART Cov), Sargan-Hansen tests were performed on a series of 2SLS regressions which included every possible combination of the four instruments. The null hypothesis of the joint validity of all instruments was never rejected. Since for no possible combination of instruments the null hypothesis could be rejected, this suggests that at least one instrument per regression is valid. Likewise, tests of redundancy of instruments revealed that none of the instruments is redundant in the sense that asymptotic efficiency of the estimation is improved by using them. Since the instruments are highly correlated, the null of orthogonality is rejected for each combination of instruments. These results are reassuring even if (by construction) not definitive about the validity of the instruments in terms of exclusion restriction or about the dominance of one particular instrument. At the same time, they suggest the use of a single instrument at a time, rather than a combination of instruments.

Alternative Instrument for Cross-Country Exposure and Treatment Scope: Geography-Based Exposure. Another potential concern refers to the exogeneity of the cross-sectional variation in scope for ART expansion, as proxied by HIV prevalence in 2001. To investigate the robustness of the results with respect to the measure of cross-country heterogeneity in HIV prevalence in 2001 as measure of exposure and thus scope for ART expansion, the analysis has been repeated for the purely geography-based measure of HIV exposure as a function of effective, geography-based dis-

Figure A3: GLOBAL VARIATION IN ART COVERAGE (ART COV)



Note: The plot captures the global variation in ART Coverage (ART Cov) in Low-/Middle-Income Countries that is used in the baseline instrumentation in combination with cross-sectional heterogeneity in the scope for ART expansion.

tance from Kinshasa, the historical starting point of the HIV epidemic in Africa. By construction, this measure is not driven by institutional, cultural or political features that could have affected the evolution of the HIV epidemic in a country and that might invalidate the exclusion restrictions.

Identification Using Sub-National Variation. An alternative approach to identify the coefficient of interest is to use data at the level of sub-national regions. The advantage of this approach is that the estimation of the coefficient of interest can be conducted in an empirical specification that includes region fixed effects and country-specific time trends. This specification thereby implicitly accounts for many of the confounds for identification at the country level. In particular, health policies are mostly under the control of national governments; international aid by donors and international organizations as well as regulations of patents, procurements of treatments and agreements with pharmaceutical companies are typically organized at the country level; strikes, demonstrations and protests exerting pressure on health provision are likely to trigger responses by national governments and donors only if they are sufficiently visible and important at country levels; social disruptions of lower scale, or even intimate partner level violence, should not be expected to have a major impact on national or international policies. The identification of the effect from variation within countries thus absorbs many of these potential confounds in country effects and trends.

The disadvantage of this approach is that without reliable geo-referenced and time-varying data on ART coverage at the region level it is not possible to conduct an analysis based on a 2SLS approach as at the country level. Instead, the analysis is based on an intention-to-treat approach that relates social violence directly to the instrumental variables in terms of cross-region differences in the scope for treatment, Z_r, interacted with time variation in global access to ART. The corresponding empirical model is given by,

$$Violence_{r,t} = \phi \cdot Z_r \cdot ART_{IV,t} + \gamma X_{r,t} + \delta_r + \zeta_t + \rho_c \cdot t + \varepsilon_{r,t} \,, \qquad \text{(ITT)}$$

where violent events at the level of sub-national, administrative regions r in year t are the dependent variable; the term $Z_r \cdot ART_{IV,t}$ represents the interaction between the scope for ART treatments in terms of HIV prevalence across regions prior to the ART expansion, and the time variation in ART access as described in the baseline analysis. Contrary to country-level data, HIV prevalence is not available for the same year (2001) in all regions; instead, Z_r measures the HIV prevalence in the respective region in the year closest to 2001 for which data are available. $X_{r,t}$ are region-level controls, δ_r and ζ_t represent region and year fixed effects, respectively, and $\rho_c \cdot t$ represents a country-specific linear trend. Throughout, the main effect (linear term) of HIV prevalence, Z_r, is absorbed by the (sub-national) regional fixed effects, and the time-varying instrument for ART coverage, $ART_{IV,t}$, is absorbed by the year fixed effects. The validity of the region level analysis implies similar identification assumptions as at the country level.

A.3 Additional Tables

A.3.1 Descriptive Statistics

Table A1: Summary Statistics, Country Level

	(1)					
	count	mean	min	max	p50	sd
Social Violence, SCAD	1394	11.879	0.000	617.000	4.000	31.316
Social Violence(log), SCAD	1394	1.610	0.000	6.426	1.609	1.281
Social Violence (per 100K capita), SCAD	1394	0.082	0.000	2.089	0.034	0.143
Social Violence (log per 100K capita), SCAD	1394	0.072	0.000	1.128	0.034	0.109
Protests/Riots, ACLED	1044	38.703	0.000	1782.000	5.000	123.419
Protests/Riots (log), ACLED	1044	2.063	0.000	7.486	1.792	1.668
ART treatment	1394	0.117	0.000	0.850	0.000	0.184

Table A2: Summary Statistics, Subnational Level

	(1)					
	count	mean	min	max	p50	sd
Social Violence, SCAD	4760	0.791	0.000	61.000	0.000	2.836
Social Violence (log), SCAD	4760	0.291	0.000	4.127	0.000	0.589
Social Violence (per 100K capita), SCAD	4760	0.078	0.000	39.369	0.000	0.715
Social Violence (log per 100K capita), SCAD	4760	0.047	0.000	3.698	0.000	0.165
Protests/Riots, ACLED	3570	2.785	0.000	556.000	0.000	12.404
Protests/Riots (log), ACLED	3570	0.600	0.000	6.323	0.000	0.939
Intimate Partner Violence (share)	219	0.202	0.020	0.575	0.180	0.097

A.4 Supplementary Results

A.4.1 2SLS Estimates: First Stage Results

Table A3: FIRST STAGE RESULTS: BASELINE SPECIFICATION

	ART TREATMENT					
	2SLS	ART TREATMENT (STANDARDISED)				
	(1)	(2)	(3)	(4)	(5)	(6)
$Z_{c,2001} \times ARTIV,t$	1.328***	1.529***	0.185***	22.071***	0.193***	0.209***
	(0.229)	(0.273)	(0.031)	(3.748)	(0.057)	(0.063)
$Z_{i,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{geo,16K}$	$HIV_{geo,16K}$
$ART_{IV,t}$	ART Price	ART Cost	ART Synth. Price	ART Cov	ART Price	ART Synth. Price
Observations	1,394	1,394	1,394	1,394	1,366	1,366
Clusters	50	50	50	50	49	49
Kleibergen-Paap	33.77	31.42	35.14	34.69	11.40	11.14
Country f.e.	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√
Population	√	√	√	√	√	√

Note: Coefficient estimates (OLS). Estimates represent first stage results for the corresponding outcome equations in Tables 1 and 2 of the main text. Dependent variable: ART coverage (relative to infected) in a year at country level, based on data from UNAIDS. Instruments are interactions between cross-sectional variation in the scope for ART treatment, $Z_{i,2001}$ ($i = c$ at country level and $i = r$ at region level), and a time-varying measure of ART expansion, $ART_{IV,t}$, see text for details. Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level.

A.4.2 2SLS Estimates: Raw vs. Standardized Coefficients

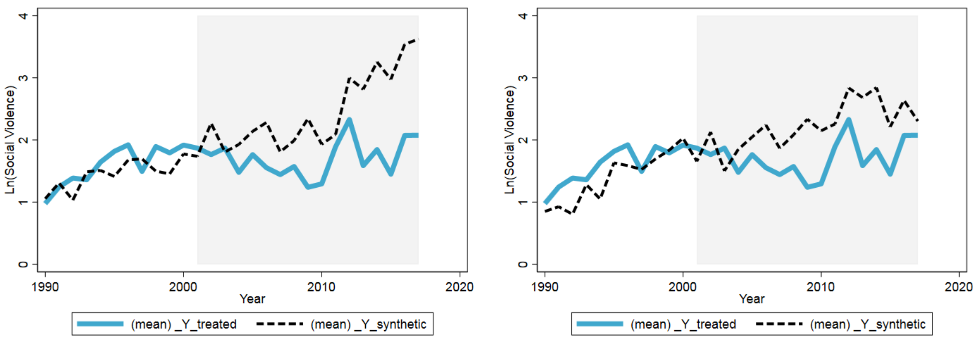
Table A4: RAW COEFFICIENTS

	OLS	2SLS	2SLS - ALTERNATIVE IV CONSTRUCTS					ITT	
	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ART	-1.393**	-4.261**	-4.208**	-4.114**	-4.406**	-5.278**	-5.414**		
	(0.691)	(1.596)	(1.591)	(1.591)	(1.711)	(2.551)	(2.534)		
$Z_{c,2001} \times ART IV,t$								-1.283***	-0.764***
								(0.473)	(0.156)
$Z_{i,2001}$		$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{geo,16K}$	$HIV_{geo,16K}$	$HIV_{c,2001}$	$HIV_{r,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Synth. Price	ART Cov	ART Price	ART Synth. Price	ART Price	ART Price
Observations	1,394	1,394	1,394	1,394	1,394	1,366	1,366	1,394	4,760
Clusters	50	50	50	50	50	49	49	50	170
Adj-R2	0.23	0.17	0.18	0.18	0.17	0.08	0.07	0.23	0.09
Kleibergen-Paap		33.77	31.42	35.14	34.69	11.40	11.14		
Country f.e.	√	√	√	√	√	√	√	√	×
Year f.e.	√	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√	√
Region f.e.	×	×	×	×	×	×	×	×	√

Note: Coefficient estimates. Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#\text{events}+1)$) at country level (Columns 1 to 8) and at sub-national level (administrative regions) (Column 9); data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Column 1: ordinary least squares estimates. Columns 2-8: 2SLS estimates of the effect on violent events of instrumented ART coverage; results of first stage regressions are not reported and analogous to Table A3. Columns 8-9: coefficients from intent-to-treat regressions of the effect of instruments for ART coverage on violent events. Instruments are interactions between cross-sectional variation in the scope for ART treatment, $Z_{i,2001}$ ($i = c$ at country level and $i = r$ at region level), and a time-varying measure of ART expansion, $ART_{IV,t}$; see text for details. Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; sub-national region-level specification includes controls for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level (Columns 1-8) or sub-national region level (Column 9).

A.4.3 Robustness of Identification: Additional Results

A.4.3.1 Synthetic Control Approach: Alternative Specification Based on HIV Prevalence



(a) Top 25% vs. Bottom 25%

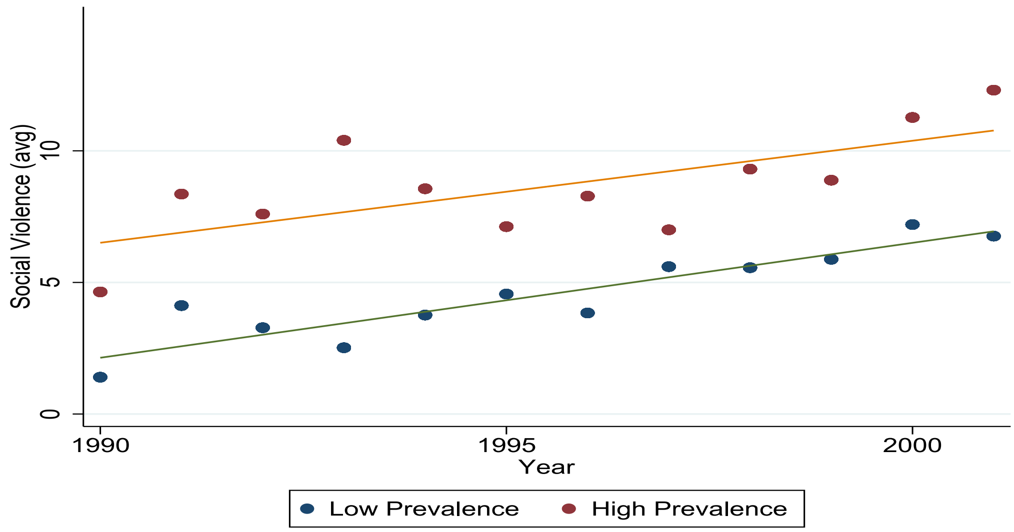
(b) Top 25% vs. Bottom 10%

Figure A4: ART Expansion and Social Violence: Synthetic Control Approach

Note: Results based on the synthetic control method. For each treated unit, the incidence of social violence is computed under the average treatment and for the synthetic counterfactual. The graph plots averages across all treated units. With the intervention period beginning in 2001, the synthetic control is computed for each treated unit by minimizing the mean squared prediction error (MSPE) relative to the treated units during the pre-intervention period 1990 to 2000. As predictor variables for the construction of the weighted counterfactual of each treated unit, the procedure uses the average log number of conflict events, population and HIV prevalence (all measured between 1990 to 2000), the fraction of the country area within 100 km from the coast, the fraction of desert and of tropical forest, latitude and longitude.

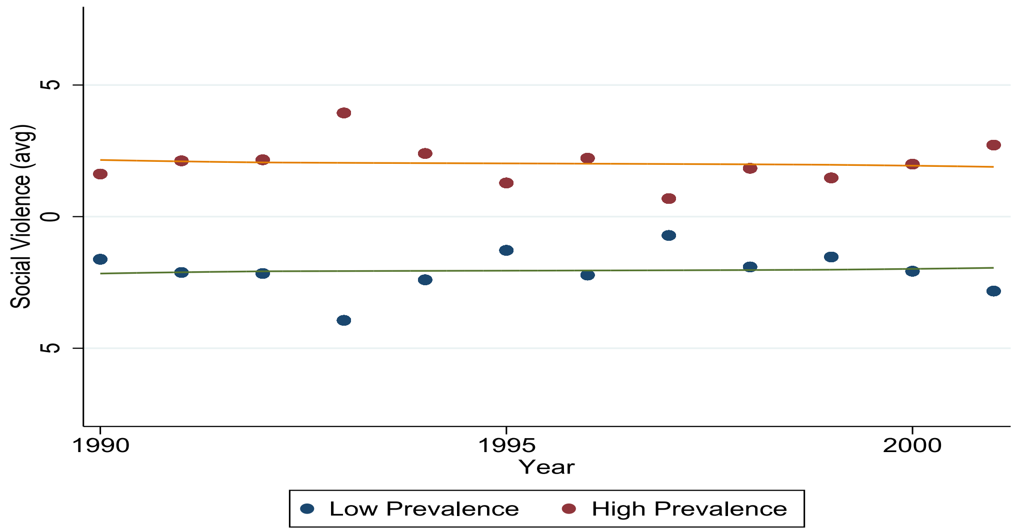
A.4.3.2 Identification: Parallel Trends prior to ART Expansion

Figure A5: PARALLEL TRENDS: GROUP AVERAGES



Note: Scatter plot of the average number of riots for countries with high and low HIV prevalence (threshold: median in 2001). The variable has been demeaned using the average number of events for each group over the period pre-2001 and post-2001, respectively, resembling the re-scaling when including group-specific fixed effects for each period. Linear fit for the two groups over the two periods, pre-2001 and post-2001.

Figure A6: PARALLEL TRENDS: GROUP-YEAR AVERAGES



Note: Scatter plot of the average number of riots for countries with high and low HIV prevalence (threshold: median in 2001). Variables have been demeaned using the average number of events for a given year, resembling the re-scaling when including year-fixed effects. Local polynomial fit (bandwidth=2) for the two groups over the two periods, pre-2001 and post-2001.

A.4.3.3 Robustness: Alternative Base Years

Table A5: MAIN SPECIFICATION WITH ALTERNATIVE BASE YEARS (SAME TREND)

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA					
	REFERENCE YEAR: 2002			REFERENCE YEAR: 2003		
	(1)	(2)	(3)	(4)	(5)	(6)
ART treatment	-0.941**	-0.931**	-0.981**	-0.916**	-0.908**	-0.963**
	(0.377)	(0.375)	(0.403)	(0.393)	(0.391)	(0.418)
$Z_{i,2001}$	$HIV_{c,2002}$	$HIV_{c,2002}$	$HIV_{c,2002}$	$HIV_{c,2003}$	$HIV_{c,2003}$	$HIV_{c,2003}$
$ART_{IV,t}$	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50
Adj-R2	0.18	0.18	0.17	0.18	0.18	0.17
Kleibergen-Paap	32.22	30.03	33.26	30.83	28.80	31.96
Country f.e.	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√
Population	√	√	√	√	√	√

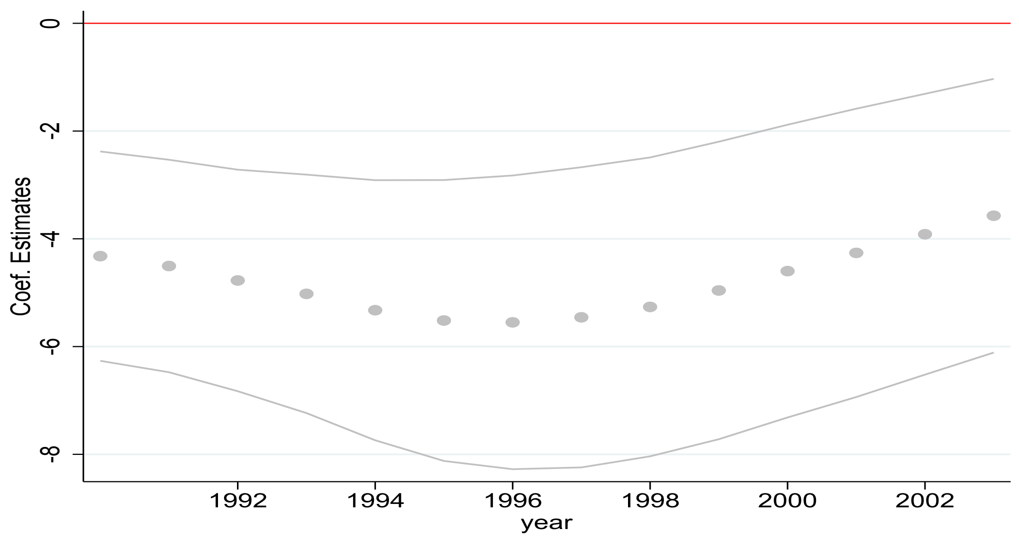
Note: 2SLS estimates. The specifications replicate those in Table 1 Column (2) and Table 2 Columns (1), (2), (4) in main text. Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#\text{events}+1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Columns 1-3: Instruments are interactions between HIV prevalence in a country in 2002 and different time-varying measures (ART coverage in countries outside Africa, price of ART treatment, cost of main agents of ART). Columns 4-6: Instruments are interactions between HIV prevalence in a country in 2003 and different time-varying measures (ART coverage in countries outside Africa, price of ART treatment, cost of main agents of ART). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level.

Table A6: MAIN SPECIFICATION WITH ALTERNATIVE BASE YEARS AND TRENDS

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA					
	REFERENCE YEAR: 2002			REFERENCE YEAR: 2003		
	(1)	(2)	(3)	(4)	(5)	(6)
ART treatment	-0.941**	-0.931**	-0.981**	-0.916**	-0.908**	-0.963**
	(0.377)	(0.375)	(0.403)	(0.393)	(0.391)	(0.418)
$Z_{i,2001}$	$HIV_{c,2002}$	$HIV_{c,2002}$	$HIV_{c,2002}$	$HIV_{c,2003}$	$HIV_{c,2003}$	$HIV_{c,2003}$
$ART_{IV,t}$	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50
Adj-R2	0.18	0.18	0.17	0.18	0.18	0.17
Kleibergen-Paap	32.22	30.03	33.26	30.83	28.80	31.96
Country f.e.	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√
Population	√	√	√	√	√	√

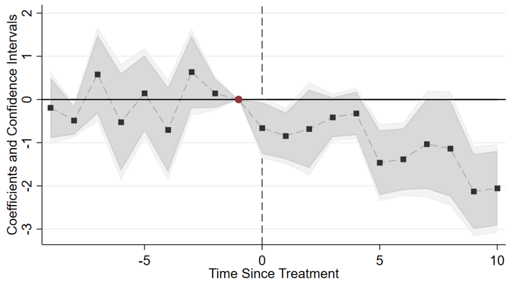
Note: 2SLS estimates. The specifications replicate those in Table 1 Column (2) and Table 2 Columns (1), (2), (4) in main text. Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events + 1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Columns 1-3: Instruments are interactions between HIV prevalence in a country in 2002 and different time-varying measures (ART coverage in countries outside Africa, price of ART treatment, cost of main agents of ART); linear time trend interacted with HIV prevalence in a country in 2002. Columns 4-6: Instruments are interactions between HIV prevalence in a country in 2003 and different time-varying measures (ART coverage in countries outside Africa, price of ART treatment, cost of main agents of ART); linear time trend interacted with HIV prevalence in a country in 2003. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level.

Figure A7: Coefficient Plots for Different Base Years T in $HIV_{c,T}$

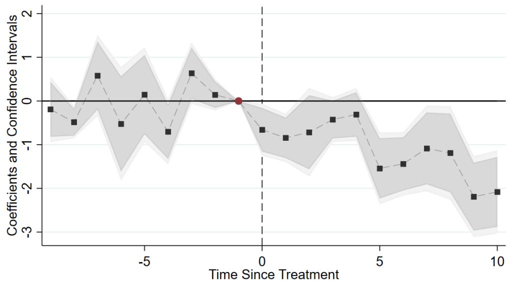


Note: The figure plots the coefficient of interest (dots) from the 2SLS model, obtained for different reference years T in the construction of the instrument $HIV_{c,T} \cdot ART_{IV,t}$ (Instrument: ART Coverage outside Africa). Lines show the corresponding 90-% confidence interval. The specification is the analogue of Table 1 Column (2) in the paper.

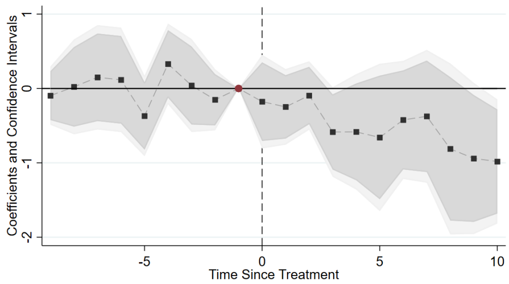
Figure A8: REDUCED FORM ESTIMATES – EVENT STUDY PLOTS



(a) ITT with Instrument $HIV_{c,2001} \times$ART Price



(b) ITT with Instrument $HIV_{c,2001} \times$ART Cost



(c) ITT with Instrument $HIV_{c,2001} \times$ART Cov

Note: The figure plots event study graphs for the coefficient of interest from the ITT model. The empirical specification is as in Table 1 Column (2) of the paper. The estimation is conducted using the routine devised by Chaisemartin and Haultfoeuille (2020). Panel (a): Instruments are $HIV_{c,2001} \times$ART Price as in Table 1 Column (2). Panel (b): Instruments are $HIV_{c,2001} \times$ART Cost as in Table 2 Column (2). Panel (c): Instruments are $HIV_{c,2001} \times$ART Cost as in Table 2 Column (4). Dark shades show the corresponding 90-% confidence interval, light shades the corresponding 95% confidence interval.

A.4.3.4 Robustness of Instrument: Alternative Price Data and Production Costs Data

Table A7: ALTERNATIVE PRICE AND PRODUCTION COSTS DATA

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA						
		COUNTRY LEVEL			SUBNATIONAL LEVEL		
	OLS	2SLS			ITT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ART treatment	-0.316**	-0.910**	-0.953**	-0.999**			
	(0.157)	(0.363)	(0.368)	(0.388)			
$Z_{c,2001} \times ARTIV,t$					-0.182***	-0.179***	-0.215***
					(0.036)	(0.035)	(0.046)
$Z_{i,2001}$		$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394	4,760	4,760	4,760
Clusters	50	50	50	50	170	170	170
Adj-R2	0.23	0.18	0.18	0.17	0.09	0.09	0.09
Kleibergen-Paap		40.97	38.66	34.69			
Country f.e.	√	√	√	√	×	×	×
Region f.e.	n.a.	n.a.	n.a.	n.a.	√	√	√
Year f.e.	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√

Note: Coefficient estimates. Dependent variable: natural logarithm of the number of social violence events in a year (measured as ln(#events + 1)) at country level (Columns 1 to 4) and at sub-national level (administrative regions) (Columns 5 to 7); data source: SCAD database. ART coverage: Data source is UNAIDS. Column 1: ordinary least squares estimates; Columns 2-4: 2SLS estimates; Columns 5-7: intent-to-treat regressions of the effect of instruments for ART coverage on violent events at sub-national region level; instrument $HIV_{i,2001} \cdot ART_{IV,t}$ ($i = c$ at country level and $i = r$ at region level). Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; all sub-national region-level specifications control for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

Results in Columns (1), (2), and (5) are identical to the corresponding columns in Table 1 of the main text. Instruments in Columns (3) and (6) are interactions between HIV prevalence in a country in 2001 and time-varying measures of the cost of ART treatment based on second first line regimen ZDV-3TC-NVP. Instruments in Columns (4) and (7) are interactions between HIV prevalence in a country in 2001 and time-varying measures of cost of API of second first line regimen ZDV-3TC-NVP. See Section A.1.6 for details.

A.4.3.5 Robustness of Instrument: Alternative Specifications for Treatment Scope and Intensity

Table A8: ALTERNATIVE SPECIFICATIONS OF INSTRUMENT:

Panel A	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA				
	(1)	(2)	(3)	(4)	(5)
ART treatment	-0.966**	-0.978*	-1.361**	-1.233**	-1.197**
	(0.362)	(0.506)	(0.613)	(0.587)	(0.578)
$Z_{i,2001}$	$HIV_{c,2001}$	HIV_{geo}	$HIV_{geo,10K}$	$HIV_{geo,16K}$	$HIV_{geo,20K}$
$ART_{IV,t}$	ART Price	ART Price	ART Price	ART Price	ART Price
Observations	1,394	1,366	1,366	1,366	1,366
Countries	50	49	49	49	49
Adj-R2	0.17	0.14	0.03	0.07	0.08
Kleibergen-Paap	33.77	7.24	11.61	11.76	11.40

Panel B	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA				
	(1)	(2)	(3)	(4)	(5)
ART	-0.966**	-0.938**	-0.933**	-0.922**	-1.227**
	(0.362)	(0.366)	(0.361)	(0.356)	(0.575)
$Z_{i,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{geo,20K}$
$ART_{IV,t}$	ART Price	Synth. Price (15%)	Synth. Price (20%)	Synth. Price (25%)	Synth. Price (25%)
Mean					
Observations	1,394	1,394	1,394	1,394	1,366
Regions	50	50	50	50	49
R2	0.22	0.23	0.23	0.23	0.13
Region f.e.	√	√	√	√	√
Year f.e.	√	√	√	√	√
Time Trend	√	√	√	√	√
HIV Trend	√	√	√	√	√
Population	√	√	√	√	√

Note: 2SLS estimates. Dependent variable: natural logarithm of the number of social violence events in a year (measured as $\ln(\#events+1)$) at country level; data source: SCAD database. ART coverage: Data source is UNAIDS. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Results are obtained with combinations of different measures for the instrument $Z_{c,2001} \cdot ART_{IV,t}$:

- Column A1: $Z_{c,2001}$: HIV prevalence in country in 2001; $ART_{IV,t}$: ART Price (Baseline)
- Column A2: $Z_{c,2001}$: walking distance to Kinshasa (fast marching method), no population density requirement; $ART_{IV,t}$: ART Price.
- Column A3: $Z_{c,2001}$: walking distance to Kinshasa (fast marching method), population density requirement: 10,000; $ART_{IV,t}$: ART Price.
- Column A4: $Z_{c,2001}$: walking distance to Kinshasa (fast marching method), population density requirement: above 20th decile (ca. 16,000); $ART_{IV,t}$: ART Price.
- Column A5: $Z_{c,2001}$: walking distance to Kinshasa (fast marching method), population density requirement: 20,000; $ART_{IV,t}$: ART Price.
- Column B1: $Z_{c,2001}$: HIV prevalence in country in 2001; $ART_{IV,t}$: evolution of price of the main first line ART treatments for adults, actual. (Baseline)
- Column B2: $Z_{c,2001}$: HIV prevalence in country in 2001; $ART_{IV,t}$: evolution of price of the main first line ART treatments for adults, linear decline 15% p.a.
- Column B3: $Z_{c,2001}$: HIV prevalence in country in 2001; $ART_{IV,t}$: evolution of price of the main first line ART treatments for adults, linear decline 20% p.a.
- Column B4: $Z_{c,2001}$: HIV prevalence in country in 2001; $ART_{IV,t}$: evolution of price of the main first line ART treatments for adults, linear decline 25% p.a.
- Column B5: $Z_{c,2001}$: walking distance to Kinshasa (fast marching method), population density requirement: 20,000; $ART_{IV,t}$: evolution of price of the main first line ART treatments for adults, linear decline 25% p.a.

A.4.3.6 Falsification of Instrument: Malaria

Table A9: FALSIFICATION OF INSTRUMENT: MALARIA PREVALENCE AND TREATMENT

	ART TREATMENT			
	(1)	(2)	(3)	(4)
$X_{i,2001} \times ART_{IV,t}$	0.004	-0.046	-0.045	-0.049
	(0.003)	(0.071)	(0.070)	(0.082)
$X_{i,2001}$	$HIV_{c,2001}$	$Malaria_{c,2001}$	$Malaria_{c,2001}$	$Malaria_{c,2001}$
$ART_{IV,t}$	Malaria Price	ART Price	ART Cost	ART Cov
Observations	1,296	1,338	1,338	1,338
Clusters	50	48	48	48
Kleibergen-Paap	2.00	0.42	0.42	0.35
Country f.e	√	√	√	√
Year f.e	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√

Note: Coefficient estimates (OLS). Dependent variable: ART coverage based on data from UNAIDS. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Instruments:

- Column (1): Interaction between HIV prevalence in a country in 2001 and time variation in median price of malaria drug Artesiminin.
- Column (2): Interaction between malaria prevalence in a country in 2001 and time variation in median price of ART treatment.
- Column (3): Interaction between malaria prevalence in a country in 2001 and time variation in median cost of ART treatment.
- Column (4): Interaction between malaria prevalence in a country in 2001 and time variation in ART coverage in low-medium income countries outside Africa.

A.4.3.7 Placebo Instrument: Institutional Quality

Table A10: PLACEBO 1: REPLACING $Z_{c,2001} \cdot ART_{IV,t}$ BY $X_{c,2001} \cdot ART_{IV,t}$ – FIRST AND SECOND STAGE

Panel A: First Stage	ART TREATMENT						
$X_{c,2001}$	$HIV_{c,2001}$ (1)	$Polity_{c,2001}$ (2)	$Polity2_{c,2001}$ (3)	$Democracyscore_{c,2001}$ (4)	$GlobalFund_{c,2001}$ (5)	$GDPpc_{c,2001}$ (6)	$SCADRiots_{c,2001}$ (7)
Instrument	0.169***	-0.011	0.045	-0.013	0.153***	-0.001	0.062
	(0.029)	(0.047)	(0.060)	(0.046)	(0.050)	(0.052)	(0.078)
Kleibergen-Paap	33.77	0.05	0.56	0.08	9.48	0.00	0.64
Observations	1,394	1,338	1,338	1,338	1,394	1,310	1,394
Clusters	50	48	48	48	50	47	50
Panel B: Second Stage	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA						
$X_{c,2001}$	$HIV_{c,2001}$ (1)	$Polity_{c,2001}$ (2)	$Polity2_{c,2001}$ (3)	$Democracyscore_{c,2001}$ (4)	$GlobalFund_{c,2001}$ (5)	$GDPpc_{c,2001}$ (6)	$SCADRiots_{c,2001}$ (7)
ART	-0.966**	-6.609	-0.755	-5.458	-0.941	-91.176	-2.188
	(0.362)	(32.467)	(2.255)	(22.679)	(0.605)	(6178.312)	(2.516)
Observations	1,394	1,338	1,338	1,338	1,394	1,310	1,394
Clusters	50	48	48	48	50	47	50
Country f.e.	√	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√
Share Trend	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√

Note: Panel A: Coefficient estimates (2SLS – first stage). Dependent variable: ART coverage based on data from UNAIDS. Panel B: Coefficient estimates (2SLS – second stage). Dependent variable: natural logarithm of the number of social violence events in a year (measured as $\ln(\#events + 1)$) at country level. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Instruments: $X_{c,2001} \cdot ART_{IV,t}$ with $ART_I V, t$: ART Coverage outside Africa, and $X_{c,2001}$ measured as: Column 1: HIV prevalence in country in 2001 (baseline). Column 2: Polity-score in country in 2001. Column 3: Polity-2 score in country in 2001. Column 4: Institutionalized Democracy score (Polity V) in country in 2001. Column 5: amount of aid (in USD) disbursed by the Global Fund to a country in 2001. Column 6: GDP per capita (log) in country in 2001. Column 7: SCAD Riots (natural logarithm of the number of social violence events) in country in 2001.

Table A11: PLACEBO 2: REPLACING $ZV_{c,2001} \cdot ART_{IV,t}$ BY $X_{c,2001} \cdot ART_{IV,t}$
– FIRST AND SECOND STAGE

Panel A: First Stage	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA						
$X_{c,2001}$	$HIV2001_{c,2001}$ (8)	$Voice\&Accountability_{c,2001}$ (9)	$PoliticalStability_{c,2001}$ (10)	$GovEffectiveness_{c,2001}$ (11)	$RegulatoryQuality_{c,2001}$ (12)	$RuleofLaw_{c,2001}$ (13)	$Corruption_{c,2001}$ (14)
Instrument	0.169***	0.100	0.039	0.098	0.113	0.135*	0.091
	(0.029)	(0.074)	(0.062)	(0.085)	(0.081)	(0.070)	(0.083)
Kleibergen-Paap	33.77	1.85	0.40	1.35	1.94	3.70	1.20
Observations	1,394	1,366	1,366	1,366	1,366	1,366	1,366
Clusters	50	49	49	49	49	49	49

Panel B: Second Stage	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA						
$X_{c,2001}$	$HIV2001_{c,2001}$ (8)	$Voice\&Accountability_{c,2001}$ (9)	$PoliticalStability_{c,2001}$ (10)	$GovEffectiveness_{c,2001}$ (11)	$RegulatoryQuality_{c,2001}$ (12)	$RuleofLaw_{c,2001}$ (13)	$Corruption_{c,2001}$ (14)
ART	-0.966**	0.217	2.135	1.316	1.300	1.274	1.251
	(0.362)	(1.452)	(4.379)	(2.000)	(1.614)	(1.301)	(2.144)
Observations	1,394	1,366	1,366	1,366	1,366	1,366	1,366
Clusters	50	49	49	49	49	49	49
Country f.e.	√	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√
Share Trend	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√

Note: Panel A: Coefficient estimates (2SLS – first stage). Dependent variable: ART coverage based on data from UNAIDS. Panel B: Coefficient estimates (2SLS – second stage). Dependent variable: natural logarithm of the number of social violence events in a year (measured as $\ln(\#\text{events}+1)$) at country level. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Instruments: $X_{c,2001} \cdot ART_{IV,t}$ with ART_IV,t: median price of ART treatment (ART Price), and $X_{c,2001}$ measured as: Column 8: HIV prevalence in country in 2001 (baseline). Column 9: Index of Voice and Accountability score in country in 2001. Column 10: Index of Political Stability in country in 2001. Column 11: Index of Government Effectiveness in country in 2001. Column 12: Index of Regulary Quality country in 2001. Column 13: Index of Rule of Law in country in 2001. Column 14: Index of Corruption in country in 2001.

A.4.3.8 Overidentification: Controlling for Institutional Quality Interactions

Table A12: OVERIDENTIFICATION 1: CONTROLLING FOR PLACEBO-IV $X_{c,2001} \cdot ART_{IV,t}$ – SECOND STAGE RESULTS

Panel A	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA						
$X_{c,2001}$	$HIV_{c,2001}$ (1)	$Polity_{c,2001}$ (2)	$Polity2_{c,2001}$ (3)	$Democracyscore_{c,2001}$ (4)	$GlobalFund_{c,2001}$ (5)	$GDPpc_{c,2001}$ (6)	$SCADRiots_{c,2001}$ (7)
ART	-0.966**	-0.885**	-0.873**	-0.885**	-0.935**	-0.958**	-0.994***
	(0.362)	(0.355)	(0.381)	(0.357)	(0.458)	(0.385)	(0.363)
$X_{c,2001} \times ARTIV,t$		0.029	-0.018	0.025	-0.014	-0.083	0.054
		(0.079)	(0.065)	(0.078)	(0.090)	(0.081)	(0.039)
Observations	1,394	1,338	1,338	1,338	1,394	1,310	1,394
Clusters	50	48	48	48	50	47	50
Adj-R2	0.17	0.16	0.17	0.16	0.18	0.16	0.17
Kleibergen-Paap	33.77	35.35	31.05	35.22	14.12	26.59	32.41

Panel B	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA						
$X_{c,2001}$	$HIV2001_{c,2001}$ (8)	$Voice\&Accountability_{c,2001}$ (9)	$PoliticalStability_{c,2001}$ (10)	$GovEffectiveness_{c,2001}$ (11)	$RegulatoryQuality_{c,2001}$ (12)	$RuleofLaw_{c,2001}$ (13)	$Corruption_{c,2001}$ (14)
ART	-0.966**	-0.917**	-0.882**	-1.011**	-1.003**	-1.004**	-0.964**
	(0.362)	(0.393)	(0.379)	(0.402)	(0.401)	(0.396)	(0.397)
$X_{c,2001} \times ARTIV,t$		0.009	-0.042	0.106	0.098	0.125	0.080
		(0.105)	(0.084)	(0.110)	(0.111)	(0.117)	(0.102)
Observations	1,394	1,366	1,366	1,366	1,366	1,366	1,366
Clusters	50	49	49	49	49	49	49
Adj-R2	0.17	0.15	0.16	0.14	0.14	0.14	0.15
Kleibergen-Paap	33.77	23.55	27.79	17.19	14.71	14.74	15.71
Country f.e.	√	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√

Note: Both Panels: Coefficient estimates (2SLS – second stage). Dependent variable: natural logarithm of the number of social violence events in a year (measured as $\ln(\#events + 1)$) at country level. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
ART treatment instrument: $HIV_{c,2001} \cdot ART_{IV,t}$ with ART_IV,t: median price of ART treatment (ART_Price_t). Additional controls $X_{c,2001} \cdot ART\_Price_t$ with $X_{c,2001}$ measured as: Column 1: No additional control (baseline). Column 2: Polity-score in country in 2001. Column 3: Polity-2 score in country in 2001. Column 4: Institutionalized Democracy score (Polity-V) in country in 2001. Column 5: amount of aid (in USD) disbursed by the Global Fund to a country in 2001. Column 6: GDP per capita (log) in country in 2001. Column 7: SCAD Riots (natural logarithm of the number of social violence events) in country in 2001. Column 8: HIV prevalence in country in 2001 (baseline). Column 9: Index of Voice and Accountability score in country in 2001. Column 10: Index of Political Stability in country in 2001. Column 11: Index of Government Effectiveness in country in 2001. Column 12: Index of Regulary Quality country in 2001. Column 13: Index of Rule of Law in country in 2001. Column 14: Index of Corruption in country in 2001.

Table A13: OVERIDENTIFICATION 2: CONTROLLING FOR PLACEBO-IV $X_{c,2001} \cdot ART_{IV,t}$ – ITT RESULTS

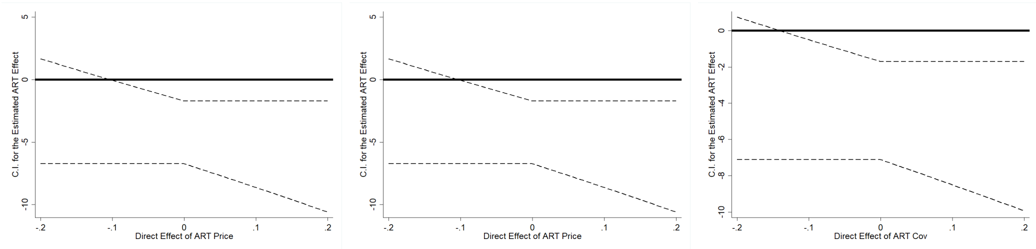
Panel A	Social Violence (log events) - SCAD Data						
$X_{c,2001}$	$HIV_{c,2001}$ (1)	$Polity_{c,2001}$ (2)	$Polity2_{c,2001}$ (3)	$Democracyscore_{c,2001}$ (4)	$GlobalFund_{c,2001}$ (5)	$GDPpc_{c,2001}$ (6)	$SCADRiots_{c,2001}$ (7)
ART treatment	-0.163***	-0.150**	-0.145**	-0.150**	-0.139**	-0.151**	-0.167***
	(0.060)	(0.059)	(0.064)	(0.059)	(0.064)	(0.061)	(0.061)
$X_{c,2001} \times ARTIV,t$		0.014	-0.043	0.013	-0.061	-0.101*	0.054
		(0.056)	(0.058)	(0.054)	(0.056)	(0.051)	(0.059)
Observations	1,394	1,338	1,338	1,338	1,394	1,310	1,394
Clusters	50	48	48	48	50	47	50
Adj-R2	0.23	0.22	0.22	0.22	0.23	0.23	0.23

Panel B	Social Violence (log events) - SCAD Data						
$X_{c,2001}$	$HIV2001_{c,2001}$ (8)	$Voice\&Accountability_{c,2001}$ (9)	$PoliticalStability_{c,2001}$ (10)	$GovEffectiveness_{c,2001}$ (11)	$RegulatoryQuality_{c,2001}$ (12)	$RuleofLaw_{c,2001}$ (13)	$Corruption_{c,2001}$ (14)
ART treatment	-0.163***	-0.143**	-0.143**	-0.150**	-0.148**	-0.147**	-0.146**
	(0.060)	(0.066)	(0.063)	(0.062)	(0.061)	(0.063)	(0.062)
$X_{c,2001} \times ARTIV,t$		-0.075	-0.066	-0.003	-0.021	-0.033	-0.047
		(0.086)	(0.074)	(0.089)	(0.065)	(0.082)	(0.085)
Observations	1,394	1,366	1,366	1,366	1,366	1,366	1,366
Clusters	50	49	49	49	49	49	49
Adj-R2	0.23	0.22	0.22	0.22	0.22	0.22	0.22
Country f.e.	√	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√

Note: Both Panels: Coefficient estimates (intention-to-treat), OLS. Dependent variable: natural logarithm of the number of social violence events in a year (measured as $\ln(\#events+1)$) at country level. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
ART treatment instrument: $HIV_{c,2001} \cdot ART_{IV,t}$ with ART_IV,t: median price of ART treatment (ART_Price_t). Additional controls $X_{c,2001} \cdot ART\_Price_t$ with $X_{c,2001}$ measured as: Column 1: No additional control (baseline). Column 2: Polity-score in country in 2001. Column 3: Polity-2 score in country in 2001. Column 4: Institutionalized Democracy score (Polity-V) in country in 2001. Column 5: amount of aid (in USD) disbursed by the Global Fund to a country in 2001. Column 6: GDP per capita (log) in country in 2001. Column 7: SCAD Riots (natural logarithm of the number of social violence events) in country in 2001. Column 8: HIV prevalence in country in 2001 (baseline). Column 9: Index of Voice and Accountability score in country in 2001. Column 10: Index of Political Stability in country in 2001. Column 11: Index of Government Effectiveness in country in 2001. Column 12: Index of Regulary Quality country in 2001. Column 13: Index of Rule of Law in country in 2001. Column 14: Index of Corruption in country in 2001.

A.4.3.9 Relaxing the Exclusion Restriction of Strict Exogeneity

Figure A9: EFFECT OF INTEREST UNDER PARTIAL EXOGENEITY



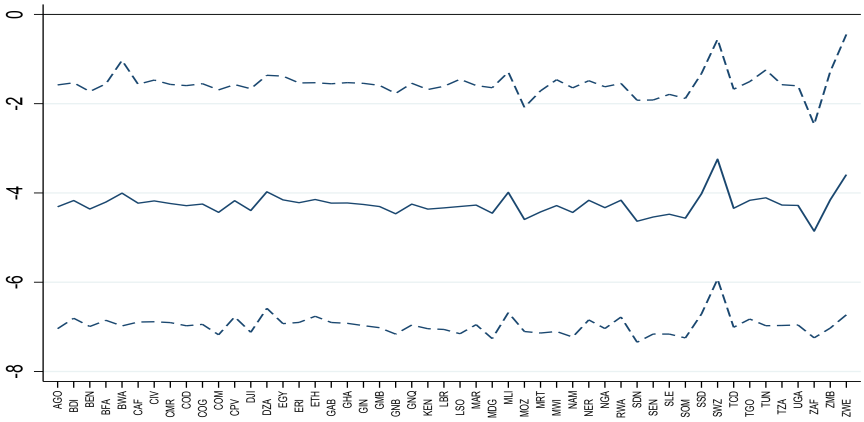
(a) ART Price (b) ART Cost (c) ART Coverage

Note: Coefficient estimates (2SLS). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events+1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Estimates for different instruments $HIV_{c,2001} \cdot ART_{IV,t}$ if the instrument has a direct effect (depicted on the horizontal axis) on the outcome (Conley, Hansen and Rossi 2012).

A.4.4 Robustness: Samples and Specification

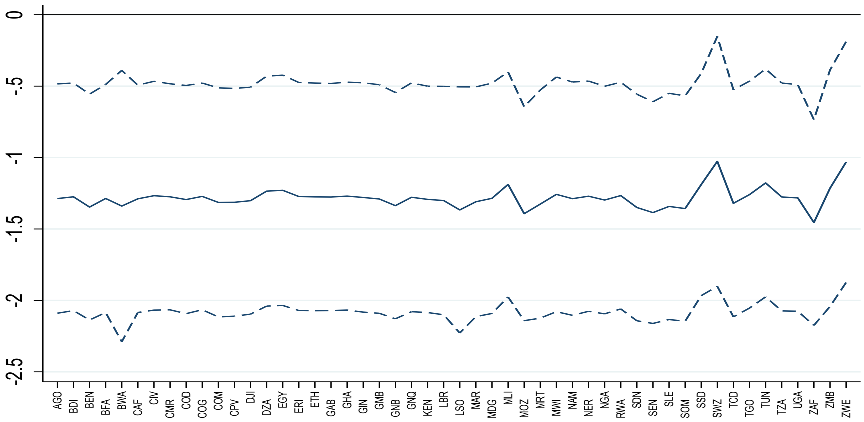
A.4.4.1 Eliminating Single Countries

Figure A10: SENSITIVITY OF RESULTS WHEN EXCLUDING COUNTRIES – 2SLS RESULTS



Note: The plot shows the coefficient of interest (and the corresponding 90% confidence band) obtained with the 2SLS estimation (OLS/2SLS–Stage 2) with instruments HIV prevalence in country c in year 2001 and ART Coverage outside Africa in year t, when the corresponding country shown at the bottom of the figure is excluded from the estimation sample.

Figure A11: SENSITIVITY OF RESULTS WHEN EXCLUDING COUNTRIES – ITT RESUTS



Note: The plot shows the coefficient of interest (and the corresponding 90% confidence band) obtained with the ITT estimation (ITT), iwth instruments HIV prevalence in country c in year 2001, ART Coverage outside Africa in year t, when the corresponding country shown at the bottom of the figure is excluded from the estimation sample.

A.4.4.2 Accounting for Non-Linear Trends in African Regions

Table A14: ACCOUNTING FOR NON-LINEAR REGION TRENDS

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA					
	(1)	(2)	(3)	(4)	(5)	(6)
ART	-0.966**	-0.954**	-0.999**	-0.963**	-0.951**	-0.996**
	(0.362)	(0.361)	(0.388)	(0.362)	(0.361)	(0.388)
$Z_{i,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$
$ART_{IV,t}$	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50
Adj-R2	0.17	0.18	0.17	0.18	0.18	0.17
Kleibergen-Paap	33.77	31.42	34.69	33.82	31.47	34.73
Country f.e.	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√
Population	√	√	√	√	√	√
Regeion Non-Linear Trends	×	×	×	√	√	√

2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events+1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (median price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
All specifications control for distinct linear (Columns (1)-(3)) and quadratic (Columns (4)-(6)) time trends for each respective macro region in Africa.

A.4.4.3 Alternative Samples

Table A15: ALTERNATIVE SAMPLES

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA								
SAMPLE	SUB-SAHARAN AFRICA			HIGH PREVALENCE 2001			HIGH PREVALENCE 1990		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ART	-0.855**	-0.835**	-0.901**	-1.261***	-1.274***	-1.363***	-1.982**	-2.077**	-2.207**
	(0.402)	(0.400)	(0.426)	(0.438)	(0.432)	(0.450)	(0.786)	(0.809)	(0.890)
$HIV_{i,2001} \times ART_{IV,t}$	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,254	1,254	1,254	1,058	1,058	1,058	616	616	616
Clusters	45	45	45	38	38	38	22	22	22
Adj-R2	0.13	0.14	0.13	0.05	0.04	0.02	-0.22	-0.25	-0.31
Kleibergen-Paap	31.27	29.33	33.05	28.30	26.26	31.53	9.48	8.61	9.06
Country f.e.	√	√	√	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√	√

Note: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events+1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (median price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Samples:

- Columns 1-3: 2SLS estimates for sub-Sahara Africa.
- Columns 4-6: 2SLS estimates for countries with high HIV prevalence in 2001 (above 1% of population infected).
- Columns 7-9: 2SLS estimates for countries with high HIV prevalence in 1990 (above 1% of population infected).

A.4.4.4 Health Aid, Income and Democracy

Table A16: AID HEALTH, INCOME AND DEMOCRACY

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ART	-0.937**	-0.928**	-0.964**	-0.997**	-0.978**	-1.035**	-0.897**	-0.881**	-0.932**	-0.936**	-0.916**	-0.970**
	(0.368)	(0.367)	(0.399)	(0.377)	(0.376)	(0.408)	(0.360)	(0.357)	(0.386)	(0.388)	(0.386)	(0.424)
$HIV_{i,2001} \times ART_{IV,t}$	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,299	1,299	1,299	1,340	1,340	1,340	1,268	1,268	1,268
Clusters	50	50	50	48	48	48	50	50	50	48	48	48
Adj-R2	0.18	0.18	0.18	0.15	0.16	0.15	0.18	0.18	0.17	0.18	0.19	0.18
Kleibergen-Paap	36.87	34.20	36.16	30.65	28.54	31.22	33.32	30.83	34.40	32.04	29.56	30.44
Country f.e	√	√	√	√	√	√	√	√	√	√	√	√
Year f.e	√	√	√	√	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√	√	√	√	√
Health Aid	√	√	√	×	×	×	√	×	×	√	√	√
Income	×	×	×	√	√	√	×	×	×	√	√	√
Democracy	×	×	×	×	×	×	√	√	√	√	√	√

Note: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events + 1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (median price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Additional control variables:

- Columns 1-3: Amount of aid (in USD) disbursed by the Global Fund to a country in a given year.
- Columns 4-6: GDP per capita.
- Columns 7-9: Democracy (Institutionalized Democracy Index, Polity V).
- Columns 10-12: Amount of aid (in USD) disbursed by the Global Fund to a country in a given year, GDP per capita, Democracy (Institutionalized Democracy Index, Polity V).

A.4.4.5 Accounting for Education

Table A17: ACCOUNTING FOR PRIMARY SCHOOL ENROLMENT

	PRIMARY SCHOOL ENROLLMENT			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	2.522	-1.828	-2.022	-2.643
	(3.922)	(5.810)	(5.825)	(5.508)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,117	1,117	1,117	1,117
Clusters	50	50	50	50
Adj-R2	0.49	0.48	0.48	0.48
Kleibergen-Paap		23.86	22.65	28.40
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	-0.255	-1.130***	-1.108**	-1.122**
	(0.153)	(0.421)	(0.422)	(0.450)
Primary Enrollment	0.004	0.005	0.005	0.005
	(0.003)	(0.004)	(0.004)	(0.004)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,117	1,117	1,117	1,117
Clusters	50	50	50	50
Adj-R2	0.22	0.13	0.14	0.13
Kleibergen-Paap		23.80	22.61	28.16
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Primary Education	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates. Dependent variable in top panel: Primary School Enrolment; Dependent variable in bottom panel: natural logarithm of the number of social violence events in a year (measured as $\ln(\#events+1)$) at country level; data source: SCAD database. Column 1: ordinary least squares estimates, Columns 2-4: 2SLS estimates with instrument $HIV_{i,2001} \cdot ART_{IV,t}$ ($i = c$ at country level), interactions between HIV prevalence in a country in 2001, $HIV_{c,2001}$ and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level.

Table A18: ACCOUNTING FOR SECONDARY SCHOOL ENROLMENT

	SECONDARY SCHOOL ENROLLMENT			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	5.011**	-1.724	-1.555	-3.612
	(2.034)	(9.493)	(9.257)	(9.584)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	809	809	809	809
Clusters	50	50	50	50
Adj-R2	0.78	0.75	0.75	0.73
Kleibergen-Paap		15.78	15.25	20.02
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	-0.201	-1.301**	-1.291**	-1.282**
	(0.173)	(0.576)	(0.570)	(0.605)
Secondary Enrollment	-0.004	0.011	0.011	0.010
	(0.008)	(0.010)	(0.010)	(0.011)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	809	809	809	809
Clusters	50	50	50	50
Adj-R2	0.22	0.10	0.10	0.10
Kleibergen-Paap		16.35	15.73	18.40
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Primary Education	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates. Dependent variable in top panel: Primary School Enrolment; Dependent variable in bottom panel: natural logarithm of the number of social violence events in a year (measured as $\ln(\#\text{events}+1)$) at country level; data source: SCAD database. Column 1: ordinary least squares estimates, Columns 2-4: 2SLS estimates with instrument $HIV_{i,2001} \cdot ART_{IV,t}$ ($i = c$ at country level), interactions between HIV prevalence in a country in 2001, $HIV_{c,2001}$ and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level.

A.4.5 Robustness: Alternative Coding for ART and Social Violence

A.4.5.1 ART Coverage: Alternative Measure

Table A19: ART COVERAGE: ALTERNATIVE MEASURE

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA						
		COUNTRY LEVEL			SUBNATIONAL LEVEL		
	OLS	2SLS			ITT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ART	-0.153***	-0.177***	-0.174***	-0.178***			
	(0.054)	(0.065)	(0.064)	(0.064)			
$Z_{c,2001} \times ARTIV,t$					-0.166***	-0.157***	-0.215***
					(0.034)	(0.032)	(0.046)
$HIV_{i,2001} \times ART_{IV,t}$		ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394	4,760	4,760	4,760
Clusters	50	50	50	50	170	170	170
Adj-R2	0.23	0.23	0.23	0.23	0.09	0.09	0.09
Kleibergen-Paap		134.17	126.83	112.04			
Country f.e.	√	√	√	√	×	×	×
Region f.e.	n.a.	n.a.	n.a.	n.a.	√	√	√
Year f.e.	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√

Note: Coefficient estimates. Dependent variable: natural logarithm of the number of social violence events in a year (measured as $\ln(\#events + 1)$) at country level (Columns 1 to 4) and at sub-national level (administrative regions) (Columns 5 to 7); data source: SCAD database. Column 1: ordinary least squares estimates, Columns 2-4: 2SLS estimates with instrument $HIV_{i,2001} \cdot ART_{IV,t}$ ($i = c$ at country level), interactions between HIV prevalence in a country in 2001, $HIV_{c,2001}$ and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Columns 5-7: intent-to-treat regressions of the effect of instrument $HIV_{i,2001} \cdot ART_{IV,t}$ ($i = r$ at region level) and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa), on violent events. Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; all sub-national region-level specifications control for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level (Columns 1-4) or sub-national region level (Columns 5-7).
ART treatment: ART coverage measured as population percentage of all individuals who receive antiretroviral therapy based on data from UNAIDS. (Baseline specification: percentage of all individuals living with HIV who receive antiretroviral therapy.)

A.4.5.2 Social Violence, SCAD (Log Events Per Population)

Table A20: EFFECT OF ART EXPANSION ON VIOLENCE IN AFRICA: SCAD EVENTS PER CAPITA

	SOCIAL VIOLENCE (LOG EVENTS PER POPULATION) - SCAD DATA								
	OLS	2SLS	2SLS - ALTERNATIVE IV CONSTRUCTS					ITT	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ART	-0.195**	-0.125**	-0.122**	-0.130**	-0.148*	-0.216**	-0.224**		
	(0.082)	(0.060)	(0.058)	(0.061)	(0.074)	(0.107)	(0.108)		
$Z_{c,2001} \times ARTIV,t$								-0.022**	-0.042***
								(0.010)	(0.012)
$Z_{i,2001}$		$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{geo,16K}$	$HIV_{geo,16K}$	$HIV_{c,2001}$	$HIV_{r,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Synth. Price	ART Cov	ART Price	ART Synth. Price	ART Price	ART Price
Observations	1,394	1,394	1,394	1,394	1,394	1,366	1,366	1,394	4,760
Clusters	50	50	50	50	50	49	49	50	170
Adj-R2	0.08	0.00	0.01	0.00	-0.05	-0.33	0.11	0.08	0.04
Kleibergen-Paap		34.56	32.13	35.14	36.01	11.40	11.14		
Country f.e.	√	√	√	√	√	√	√	√	×
Year f.e.	√	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√	√
Region f.e.	×	×	×	×	×	×	×	×	√

Note: Coefficient estimates for standardized explanatory variables. Dependent variable: natural logarithm of the number of social violence events per 100,000 persons in a year (measured as $\ln(\#\text{events/population} + 1)$) at country level (Columns 1 to 8) and at sub-national level (administrative regions) (Column 9); data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS, measure standardized. Column 1: ordinary least squares estimates. Columns 2-7: 2SLS estimates of the effect on violent events of instrumented ART coverage; results of first stage regressions are reported in Appendix Table A3. Columns 8-9: coefficients from intent-to-treat regressions of the effect of instrument for ART coverage on violent events. Instruments are interactions between cross-sectional variation in the scope for ART treatment, $Z_{i,2001}$ ($i = c$ at country level and $i = r$ at region level), and a time-varying measure of ART expansion, $ART_{IV,t}$; the interaction term has been standardized; see text for details. Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; sub-national region-level specification includes controls for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level (Columns 1-8) or sub-national region level (Column 9).

Summary statistics of unconditional means: 11.9 events of social violence (1.6 log events) per country/year, and 0.79 events (0.3 log events) per sub-national region/year. Dependent variable: 0.082 events of social violence per 100,000 individuals (0.072 log events per capita) per country/year, 0.078 events of social violence per 100,000 individuals (0.047 log events per capita) per sub-national region/year. ART coverage: unconditional mean 0.12. Summary statistics are also contained in Appendix A.3.1.

A.4.5.3 Different Events and Participants

Table A21: DIFFERENT EVENTS AND PARTICIPANTS, COUNTRY ANALYSIS

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA							
Panel A	ART PRICE							
	(1) No Strikes	(2) Only Strikes	(3) Health Workers	(4) No Health Workers	(5) Civil Servants	(6) No Civil Servants	(7) NGO	(8) No NGO
ART	-0.899**	-0.504*	-0.121	-0.963***	-0.226	-0.960***	-0.160	-0.935**
	(0.401)	(0.266)	(0.095)	(0.354)	(0.178)	(0.350)	(0.143)	(0.369)
Mean	10.70	1.18	0.19	11.69	0.54	11.34	0.34	11.54
Observations	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50	50	50
Adj-R2	0.20	-0.03	-0.02	0.17	-0.00	0.18	0.12	0.17
Kleibergen-Paap	33.77	33.77	33.77	33.77	33.77	33.77	33.77	33.77
Panel B	ART COST							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ART	-0.869**	-0.515*	-0.137	-0.946**	-0.253	-0.934***	-0.171	-0.920**
	(0.395)	(0.264)	(0.096)	(0.354)	(0.182)	(0.348)	(0.151)	(0.368)
Mean	10.70	1.18	0.19	11.69	0.54	11.34	0.34	11.54
Observations	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50	50	50
Adj-R2	0.21	-0.03	-0.02	0.18	-0.01	0.18	0.12	0.17
Kleibergen-Paap	31.42	31.42	31.42	31.42	31.42	31.42	31.42	31.42
Panel C	ART COVERAGE							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ART	-0.924**	-0.581**	-0.114	-0.985**	-0.368*	-0.945**	-0.168	-0.977**
	(0.410)	(0.254)	(0.093)	(0.378)	(0.193)	(0.365)	(0.174)	(0.392)
Mean	10.70	1.18	0.19	11.69	0.54	11.34	0.34	11.54
Observations	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50	50	50
Adj-R2	0.20	-0.05	-0.02	0.17	-0.03	0.18	0.12	0.17
Kleibergen-Paap	34.69	34.69	34.69	34.69	34.69	34.69	34.69	34.69
Country f.e	√	√	√	√	√	√	√	√
Year f.e	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√

Note: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events of a particular type in a year (measured as $\ln(\#\text{events}+1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (Panel A: price of ART treatment; Panel B: cost of main agents of ART; Panel C: ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Different event types and participants based on narratives in SCAD documentation. Only events with the respective words in narratives are included (or excluded) in the respective columns.

Table A22: EVENTS AND PARTICIPANTS, SUB-NATIONAL ANALYSIS

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA							
Panel A	ART PRICE							
	(1) No Strikes	(2) Only Strikes	(3) Health Workers	(4) No Health Workers	(5) Civil Servants	(6) No Civil Servants	(7) NGO	(8) No NGO
$HIV_{r,2001} \times ART_{IV,t}$	-0.103***	-0.037**	-0.006	-0.165***	-0.016**	-0.159***	0.007	-0.166***
	(0.028)	(0.014)	(0.004)	(0.034)	(0.007)	(0.033)	(0.008)	(0.034)
Mean	0.74	0.06	0.01	0.78	0.03	0.76	0.02	0.77
Observations	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760
Clusters	170	170	170	170	170	170	170	170
Adj-R2	0.07	-0.01	-0.01	0.09	-0.01	0.08	-0.00	0.09
Panel B	ART COST							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Z_{r,2001} \times ART_{IV,t}$	-0.097***	-0.036***	-0.006	-0.156***	-0.016**	-0.150***	0.007	-0.157***
	(0.027)	(0.014)	(0.004)	(0.032)	(0.007)	(0.031)	(0.008)	(0.033)
Mean	0.74	0.06	0.01	0.78	0.03	0.76	0.02	0.77
Observations	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760
Clusters	170	170	170	170	170	170	170	170
Adj-R2	0.07	-0.01	-0.01	0.08	-0.01	0.08	-0.00	0.08
Panel C	ART COV							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Z_{r,2001} \times ART_{IV,t}$	-0.138***	-0.045**	-0.006	-0.215***	-0.033***	-0.198***	0.010	-0.216***
	(0.037)	(0.018)	(0.007)	(0.046)	(0.012)	(0.044)	(0.012)	(0.046)
Mean	0.74	0.06	0.01	0.78	0.03	0.76	0.02	0.77
Observations	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760
Clusters	170	170	170	170	170	170	170	170
Adj-R2	0.07	-0.01	-0.01	0.08	-0.01	0.08	-0.00	0.08
Region f.e	√	√	√	√	√	√	√	√
Year f.e	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√

Coefficient estimates (ITT). Dependent variable: natural logarithm of the number of social conflict events of a particular type in a year (measured as $\ln(\#events + 1)$) at sub-national region level; data source: SCAD database. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (Panel A: price of ART treatment; Panel B: cost of main agents of ART; Panel C: ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the sub-national region level.
Different event types and participants based on narratives in SCAD documentation. Only events with the respective words in narratives are included (or excluded) in the respective columns.

A.4.6 Alternative Outcomes: Life Expectancy and GDP growth

Table A23: ALTERNATIVE OUTCOMES: GDP PER CAPITA (LOG)

	GDP P.C. (LOG)			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	0.088	0.088	0.093	0.069
	(0.063)	(0.080)	(0.082)	(0.084)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,299	1,299	1,299	1,299
Clusters	48	48	48	48
Adj-R2	0.33	0.33	0.33	0.33
Kleibergen-Paap		30.30	28.20	31.01
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: ln GDP per capita; data source: World Bank. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

Table A24: ALTERNATIVE OUTCOMES: GROWTH OF GDP PER CAPITA (LOG)

	GROWTH OF GDP P.C. (LOG)			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	0.011	0.039	0.036	0.026
	(0.009)	(0.030)	(0.028)	(0.021)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,251	1,251	1,251	1,251
Clusters	47	47	47	47
Adj-R2	0.02	-0.00	0.00	0.01
Kleibergen-Paap		28.22	26.06	28.21
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: growth of ln GDP per capita; data source: World Bank. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

Table A25: ALTERNATIVE OUTCOMES: LIFE EXPECTANCY

	LIFE EXPECTANCY (LOG)			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	0.075***	0.323***	0.325***	0.328***
	(0.022)	(0.050)	(0.052)	(0.049)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394
Clusters	50	50	50	50
Adj-R2	0.64	-0.07	-0.08	-0.10
Kleibergen-Paap		33.77	31.42	34.69
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: life expectancy at birth; data source: World Bank. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

A.4.7 Mediation Analysis: Economic Prosperity and Health

Table A26: MEDIATION: ART EXPANSION, INCOME, AND SOCIAL VIOLENCE

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
GDP p.c. (log)	-0.205*	-11.379	-10.625	-15.013
	(0.114)	(11.104)	(10.056)	(19.318)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,299	1,299	1,299	1,299
Clusters	48	48	48	48
Adj-R2	0.21	-8.81	-7.63	-15.63
Kleibergen-Paap		1.09	1.16	0.64
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events+1)$) at country level. Data source: SCAD database. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Instrumented variable: ln GDP per capita. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

Table A27: MEDIATION: ART EXPANSION, INCOME, AND SOCIAL VIOLENCE (UCDP)

	ONGOING ARMED CONFLICTS (LOG EVENTS) - UCDP DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
GDP p.c. (log)	-0.247	0.857	0.635	2.848
	(0.224)	(5.911)	(5.637)	(8.921)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,299	1,299	1,299	1,299
Clusters	48	48	48	48
Adj-R2	0.03	-0.01	0.00	-0.34
Kleibergen-Paap		1.09	1.16	0.64
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#\text{events}+1)$) at country level. Data source: UCDP database. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Instrumented variable: ln GDP per capita. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

Table A28: MEDIATION: ART EXPANSION, GDP PER CAPITA GROWTH, AND SOCIAL VIOLENCE

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
Growth of GDP p.c. (log)	-0.826	-26.771	-28.066	-41.486
	(0.587)	(21.275)	(22.254)	(34.714)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,251	1,251	1,251	1,251
Clusters	47	47	47	47
Adj-R2	0.19	-3.29	-3.64	-8.34
Kleibergen-Paap		1.47	1.49	1.42
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#\text{events}+1)$) at country level. Data source: SCAD database. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Instrumented variable: Life expectancy. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

Table A29: MEDIATION: ART EXPANSION, GDP PER CAPITA GROWTH, AND SOCIAL VIOLENCE (UCDP)

	ONGOING ARMED CONFLICTS (LOG EVENTS) - UCDP DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
Growth of GDP p.c. (log)	-2.614**	-3.940	-4.606	-2.926
	(1.009)	(13.087)	(14.115)	(21.203)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,251	1,251	1,251	1,251
Clusters	47	47	47	47
Adj-R2	0.04	0.03	0.03	0.04
Kleibergen-Paap		1.47	1.49	1.42
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events + 1)$) at country level. Data source: UCDP database. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Instrumented variable: GDP life expectancy. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

Table A30: MEDIATION: ART EXPANSION, LIFE EXPECTANCY, AND SOCIAL VIOLENCE

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
Life Expectancy (log)	-1.555*	-2.989***	-2.938***	-3.046***
	(0.847)	(1.026)	(1.016)	(1.049)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394
Clusters	50	50	50	50
Adj-R2	0.23	0.22	0.22	0.22
Kleibergen-Paap		140.01	133.44	143.01
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#\text{events}+1)$) at country level. Data source: SCAD database. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Instrumented variable: Life expectancy. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

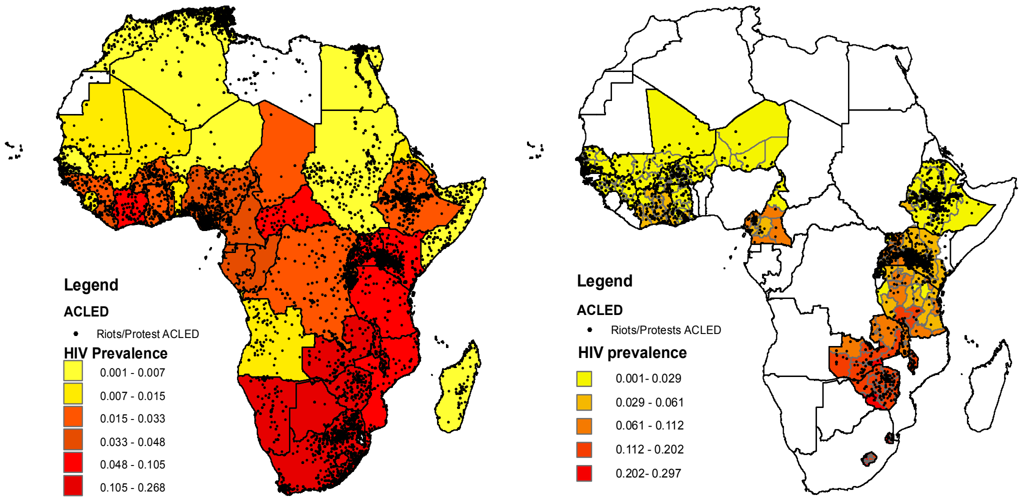
Table A31: MEDIATION: ART EXPANSION, LIFE EXPECTANCY, AND SOCIAL VIOLENCE (UCDP)

	ONGOING ARMED CONFLICTS (LOG EVENTS) - UCDP DATA			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
Life Expectancy (log)	-3.638**	-0.357	-0.396	0.038
	(1.636)	(1.485)	(1.491)	(1.594)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394
Clusters	50	50	50	50
Adj-R2	0.05	0.02	0.03	0.02
Kleibergen-Paap		140.01	133.44	143.01
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#events+1)$) at country level. Data source: UCDP database. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART; ART coverage in countries outside Africa). Instrumented variable: GDP life expectancy. Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

A.4.7.1 Social Violence, ACLED

Figure A12: HIV PREVALENCE AND SOCIAL VIOLENCE IN AFRICA: ACLED



(a) Country Sample (b) Sub-National Sample

Note: See Appendix A.3.1 for summary statistics.

Table A32: EFFECT OF ART EXPANSION ON VIOLENCE IN AFRICA: ACLED

	Social Violence (log events per population) - ACLED Data								
	OLS	2SLS	2SLS - Alternative IV Constructs					ITT	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ART	-0.483	-1.512*	-1.611*	-1.430*	-1.809*	-1.556**	-1.530*		
	(0.920)	(0.778)	(0.809)	(0.738)	(0.912)	(0.715)	(0.763)		
$Z_{c,2001} \times ARTIV,t$								-0.221**	-0.182***
								(0.091)	(0.049)
$Z_{i,2001}$		$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{geo,16K}$	$HIV_{geo,16K}$	$HIV_{c,2001}$	$HIV_{r,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Synth. Price	ART Cov	ART Price	ART Synth. Price	ART Price	ART Price
Observations	1,044	1,044	1,044	1,044	1,044	1,023	1,023	1,044	3,570
Clusters	50	50	50	50	50	49	49	50	170
Adj-R2	0.45	0.32	0.30	0.33	0.26	0.29	0.29	0.45	0.33
Kleibergen-Paap		13.25	11.33	13.52	7.66	9.91	9.06		
Country f.e.	√	√	√	√	√	√	√	√	×
Year f.e.	√	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√	√
Region f.e.	×	×	×	×	×	×	×	×	√

Note: Coefficient estimates for standardized explanatory variables. Dependent variable: natural logarithm of the number of social violence events per 100,000 persons in a year (measured as $\ln(\#\text{events/population}+1)$) at country level (Columns 1 to 8) and at sub-national level (administrative regions) (Column 9); data source: ACLED database, events are protests and riots. ART treatment: ART coverage based on data from UNAIDS, measure standardized. Column 1: ordinary least squares estimates. Columns 2-7: 2SLS estimates of the effect on violent events of instrumented ART coverage; results of first stage regressions are reported in Appendix Table A33. Columns 8-9: coefficients from intent-to-treat regressions of the effect of instrument for ART coverage on violent events. Instruments are interactions between cross-sectional variation in the scope for ART treatment, $Z_{i,2001}$ ($i = c$ at country level and $i = r$ at region level), and a time-varying measure of ART expansion, $ART_{IV,t}$; the interaction term has been standardized; see text for details. Results for time period 1997–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; sub-national region-level specification includes controls for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level (Columns 1-8) or sub-national region level (Column 9).

Summary statistics of unconditional means: 38.7 events of social violence (2.1 log events) per country/year, and 2.8 events (0.6 log events) per sub-national region/year. ART coverage: unconditional mean 0.12. Summary statistics are also contained in Appendix A.3.1.

Table A33: FIRST STAGE RESULTS: TABLE A32

	ART TREATMENT (STANDARDISED)					
	2SLS	2SLS - ALTERNATIVE IV CONSTRUCTS				
	(1)	(2)	(3)	(4)	(5)	(6)
$Z_{c,2001} \times ARTIV,t$	1.154***	1.289***	0.180***	21.032***	0.196***	0.229***
	(0.317)	(0.383)	(0.049)	(7.601)	(0.062)	(0.076)
$Z_{i,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{c,2001}$	$HIV_{geo,16K}$	$HIV_{geo,16K}$
$ART_{IV,t}$	ART Price	ART Cost	ART Synth. Price	ART Cov	ART Price	ART Synth. Price
Observations	1,044	1,044	1,044	1,044	1,023	1,023
Clusters	50	50	50	50	49	49
Kleibergen-Paap	13.25	11.33	13.52	7.66	9.91	9.06
Country f.e.	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√
Population	√	√	√	√	√	√

Note: Coefficient estimates (OLS). Estimates represent first stage results for the corresponding outcome equations (columns) in Figure ED2. Dependent variable: ART coverage (relative to infected) in a year at country level, based on data from UNAIDS. Instruments are interactions between cross-sectional variation in the scope for ART treatment, $Z_{i,2001}$ ($i = c$ at country level and $i = r$ at region level), and a time-varying measure of ART expansion, $ART_{IV,t}$, see text for details. Results for time period 1997–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level.

A.4.7.2 Social Violence, GDELT

Table A34: SOCIAL VIOLENCE, GDELT

	SOCIAL VIOLENCE (LOG EVENTS) - GDELT			
	(1)	(2)	(3)	(4)
ART	-0.284	-0.800**	-0.761*	-0.719*
	(0.189)	(0.371)	(0.382)	(0.389)
$HIV_{c,2001} \times ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394
Clusters	50	50	50	50
Adj-R2	0.72	0.71	0.71	0.71
Kleibergen-Paap		33.77	31.42	34.69
Country f.e	√	√	√	√
Year f.e	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√

Note: Coefficient estimates, Column 1: OLS, Columns 2-4: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#\text{events}+1)$) at country level; data source: GDELT database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment; cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.

A.4.7.3 Large-Scale Armed Conflicts

Table A35: ART Expansion and Armed Conflict (UCDP)

	Ongoing Armed Conflicts (log events) - UCDP Data			
	OLS	2SLS		
	(1)	(2)	(3)	(4)
ART	-0.521*	-0.115	-0.128	0.012
	(0.291)	(0.479)	(0.483)	(0.523)
$Z_{i,2001}$		$HIV2001_{c,2001}$	$HIV2001_{c,2001}$	$HIV2001_{c,2001}$
$ART_{IV,t}$		ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394
Clusters	50	50	50	50
Adj-R2	0.04	0.03	0.03	0.02
Kleibergen-Paap		33.77	31.42	34.69
Country f.e.	√	√	√	√
Year f.e.	√	√	√	√
Time Trend	√	√	√	√
HIV Trend	√	√	√	√
Population	√	√	√	√
Region f.e.	√	√	√	√

2SLS estimates (second stage coefficients). Dependent variable: Armed conflict; data source: UCDP database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Specifications in Columns (4)-(6) control for UCDP conflict events, measured along the intensive margin (ln number of events in a given year).

A.4.7.4 Casualties and Size of Events

Table A36: CASUALTIES AND SIZE OF EVENTS

	Social Violence (log events) - SCAD Data											
Panel A: Country Level	Casualties		Participants		Casualties		Participants		Casualties		Participants	
	No Casualties (1)	Casualties (2)	Few (3)	Many (4)	No Casualties (5)	Casualties (6)	Few (7)	Many (8)	No Casualties (9)	Casualties (10)	Few (11)	Many (12)
ART	-0.785**	-0.479	-0.640	-0.711***	-0.761**	-0.466	-0.639	-0.670***	-0.846**	-0.525	-0.716*	-0.675***
	(0.321)	(0.383)	(0.391)	(0.215)	(0.318)	(0.385)	(0.389)	(0.216)	(0.341)	(0.397)	(0.395)	(0.231)
$HIV_{r,2001} \times ART_{IV,t}$	ART Price	ART Price	ART Price	ART Price	ART Cost	ART Cost	ART Cost	ART Cost	ART Cov	ART Cov	ART Cov	ART Cov
Mean	6.41	5.56	8.34	3.42	6.41	5.56	8.34	3.42	6.41	5.56	8.34	3.42
Observations	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50	50	50	50	50	50	50
Adj-R2	0.12	0.17	0.18	0.06	0.13	0.17	0.18	0.07	0.11	0.17	0.17	0.07
Kleibergen-Paap	33.77	33.77	33.77	33.77	31.42	31.42	31.42	31.42	34.69	34.69	34.69	34.69
Country f.e	√	√	√	√	√	√	√	√	√	√	√	√
Year f.e	√	√	√	√	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√	√	√	√	√

Panel B: Subnational Level	Casualties		Participants		Casualties		Participants		Casualties		Participants	
	No Casualties (1)	Casualties (2)	Few (3)	Many (4)	No Casualties (5)	Casualties (6)	Few (7)	Many (8)	No Casualties (9)	Casualties (10)	Few (11)	Many (12)
$HIV_{r,2001} \times ART_{IV,t}$	-0.126***	-0.058***	-0.106***	-0.076***	-0.116***	-0.058***	-0.101***	-0.070***	-0.153***	-0.089***	-0.139***	-0.092***
	(0.030)	(0.020)	(0.028)	(0.020)	(0.028)	(0.020)	(0.027)	(0.019)	(0.038)	(0.028)	(0.036)	(0.026)
$HIV_{r,2001} \times ART_{IV,t}$	ART Price	ART Price	ART Price	ART Price	ART Cost	ART Cost	ART Cost	ART Cost	ART Cov	ART Cov	ART Cov	ART Cov
Mean	0.48	0.32	0.48	0.25	0.48	0.32	0.48	0.25	0.48	0.32	0.48	0.25
Observations	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760	4,760
Clusters	170	170	170	170	170	170	170	170	170	170	170	170
Adj-R2	0.05	0.06	0.05	0.01	0.05	0.06	0.05	0.01	0.05	0.06	0.05	0.00
Region f.e	√	√	√	√	√	√	√	√	√	√	√	√
Year f.e	√	√	√	√	√	√	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√	√	√	√	√	√	√
Population	√	√	√	√	√	√	√	√	√	√	√	√

Note: Panel (a): 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as ln(#events + 1)) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Panel (b): Coefficient estimates (ITT). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as ln(#events + 1)) at sub-national region level; data source: SCAD database. Both panels: Results for time period 1990–2017. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; all sub-national region-level specifications control for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level (Panel a) or sub-national region level (Panel b).
Severity and size of events:

- Casualties (Columns 1-2, 5-6, 8-10): Events with no casualties vs. events with at least one casualty.
- Participants (Columns 3-4, 7-8, 11-12): Events with ≤ 100 participants vs. events with > 100 participants.

A.4.7.5 Ongoing Armed Conflicts

Table A37: ARMED CONFLICT (UCDP) AS ADDITIONAL CONTROL VARIABLE

	SOCIAL VIOLENCE (LOG EVENTS) - SCAD DATA					
	(1)	(2)	(3)	(4)	(5)	(6)
ART	-0.966**	-0.954**	-0.999**	-0.946***	-0.931***	-1.001***
	(0.362)	(0.361)	(0.388)	(0.333)	(0.331)	(0.357)
$HIV_{c,2001} \times ART_{IV,t}$	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	1,394	1,394	1,394	1,394	1,394	1,394
Clusters	50	50	50	50	50	50
Adj-R2	0.17	0.18	0.17	0.24	0.24	0.22
Kleibergen-Paap	33.77	31.42	34.69	33.87	31.46	34.88
Country f.e.	√	√	√	√	√	√
Year f.e.	√	√	√	√	√	√
Time Trend	√	√	√	√	√	√
HIV Trend	√	√	√	√	√	√
Population	√	√	√	√	√	√
UCDP Events	×	×	×	√	√	√

2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events in a year (measured as $\ln(\#\text{events}+1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. Instruments are interactions between HIV prevalence in a country in 2001 and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). Results for time period 1990–2017. All specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population. */**/*** indicate significance at 10%/5%/1%, respectively, standard errors in parentheses clustered at the country level.
Specifications in Columns (4)-(6) control for UCDP conflict events, measured along the intensive margin (ln number of events in a given year).

A.4.7.6 Intimate Partner Violence, DHS

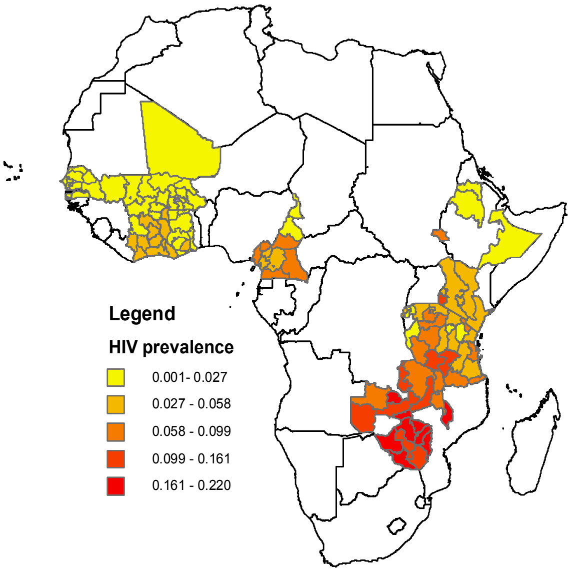
The DHS survey data for intimate partner violence only contain information for 124 regions with 219 observations in total. This requires the estimation of a modified empirical framework, because the specification with region fixed effects and year fixed effect would be too demanding for estimation. Consequently, different from the main analysis, the empirical specification contains a time trend and country fixed effects, which capture unobservable variation at the country level related to institutions or variation in data collection. The empirical framework is given by

$$Violence_{r,t} = HIV_r \cdot ART_{IV,t} + \zeta \cdot t + HIV_r \cdot t + \delta_c + \varepsilon_{r,t} \,, \tag{1}$$

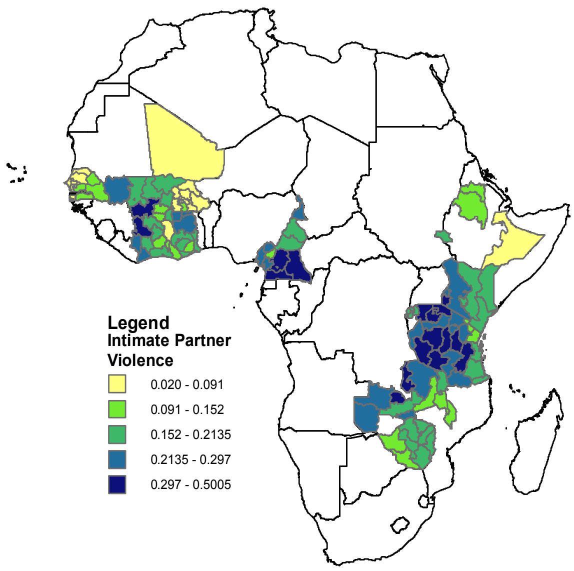
where

- $Violence_{r,t}$ is incidence of social violence in subnational region r in year t;
- $HIV_r \cdot ART_{IV,t}$ represents the instruments as described in the baseline analysis;
- $\zeta \cdot t$ is a linear time trend;
- $HIV_r \cdot t$ is a trend of HIV prevalence, allowing for different trends according to pre-expansion HIV prevalence;
- δ_c represents a country fixed effect.

Figure A13: INTIMATE PARTNER VIOLENCE, DHS



(a) HIV Prevalence



(b) Intimate Partner Violence

	INTIMATE PARTNER VIOLENCE - DHS DATA					
	(1)	(2)	(3)	(4)	(5)	(6)
$HIV r, 2001 \times ART_{IV,t}$	-0.012**	-0.013**	-0.015**	-0.017*	-0.020**	-0.030**
	(0.005)	(0.005)	(0.007)	(0.009)	(0.009)	(0.012)
$HIV r, 2001 \times ART_{IV,t}$	ART Price	ART Cost	ART Cov	ART Price	ART Cost	ART Cov
Observations	219	219	219	219	219	219
Clusters	124	124	124	124	124	124
Adj-R2	0.34	0.34	0.34	0.34	0.35	0.35
Kleibergen-Paap						
Country f.e.	√	√	√	√	√	√
Year Trend	×	×	×	√	√	√
HIV prevalence Trend	×	×	×	√	√	√

Note Panel (c): coefficient estimates (ITT). Dependent variable: percentage of women aged 15-49 who have experienced physical violence in the past 12 months (often or sometimes) at sub-national level (administrative regions); data source: DHS. ART treatment: intent-to-treat regressions of the effect of instruments for ART coverage on violent events, instruments constructed as interactions between HIV prevalence in a region in 2001 and different time-varying measures (price of ART treatment, cost of main agents of ART, ART coverage in countries outside Africa). All specifications as described in (1). */**/*** indicate significance at 10%/5%/1%, respectively. Standard errors in parentheses clustered at the sub-national region level.

A.4.8 Channels: Tables

A.4.8.1 Social Violence: Types and Motives

This section contains detailed estimation results that form the basis of some results presented in Figure 4 in the main text. Estimates are based on SCAD data (see data description for details).

Table A38: SOCIAL VIOLENCE: TYPES AND MOTIVE

Panel A: Country Level	TYPE OF EVENT		MAIN MOTIVE		
Dependent Variable	(1) Spontaneous	(2) Organized	(3) Elections	(4) Economic grievance	(5) Human rights
ART	0.188	-1.376***	-0.377*	-0.535**	-0.468
	(0.221)	(0.392)	(0.196)	(0.265)	(0.330)
$HIV_{c,2001} \times ART_{IV,t}$	ART Price	ART Price	ART Price	ART Price	ART Price
Observations	1,394	1,394	1,394	1,394	1,394
Countries	50	50	50	50	50
Adj-R2	0.11	0.09	-0.03	0.06	0.01
Kleibergen-Paap	33.77	33.77	33.77	33.77	33.77
Country f.e	√	√	√	√	√
Year f.e	√	√	√	√	√
Time Trend	√	√	√	√	√
HIV Trend	√	√	√	√	√
Population	√	√	√	√	√
Panel B: Subnational Level:	TYPE OF EVENT		MAIN MOTIVE		
Dependent Variable	(1) Spontaneous	(2) Organized	(3) Elections	(4) Economic grievance	(5) Human rights
$HIV_{r,2001} \times ART_{IV,t}$	-0.014	-0.177***	-0.018*	-0.049***	-0.050***
	(0.014)	(0.033)	(0.011)	(0.018)	(0.019)
$HIV_{r,2001} \times ART_{IV,t}$	ART Price	ART Price	ART Price	ART Price	ART Price
Mean					
Observations	4,760	4,760	4,760	4,760	4,760
Regions	170	170	170	170	170
R2	0.07	0.12	0.02	0.03	0.04
Region f.e.	√	√	√	√	√
Year f.e.	√	√	√	√	√
Time Trend	√	√	√	√	√
HIV Trend	√	√	√	√	√
Population	√	√	√	√	√

Note: Panel A: 2SLS estimates (second stage coefficients). Dependent variable: natural logarithm of the number of social conflict events of a particular type in a year (measured as $\ln(\#\text{events}+1)$) at country level; data source: SCAD database. ART treatment: ART coverage based on data from UNAIDS. All specifications control for country effects, year effects, macro-region linear time trends, and population. HIV trend: linear time trend interacted with average HIV prevalence in 2001. Panel B: Coefficient estimates (ITT). Dependent variable: natural logarithm of the number of social conflict events of a particular type in a year (measured as $\ln(\#\text{events}+1)$) at sub-national region level. All country-level specifications control for country effects, year effects, macro-region linear time trends, linear time trend interacted with HIV prevalence in a country in 2001, and population; all sub-national region-level specifications control for region effects, year effects, country-specific linear time trends, linear time trend interacted with average region-level HIV prevalence, and population. Both panels: Instruments are interactions between HIV prevalence in a country in 2001 and time-varying ART coverage in countries outside Africa. Results for time period 1990–2017. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the country level (Panel a) or sub-national region level (Panel b).
Different event types and participants based on narratives in SCAD documentation. Only events with the respective words in narratives are included in the respective columns.

A.4.8.2 Individual Trust and Approval of Policy

This section contains detailed estimation results that form the basis of some results presented in Figure 6 in the main text. By documenting how trust in institutions or approval of government policy is affected by ART coverage, the estimates provide insights for the mechanism underlying the main results. The analysis is based on survey data from the Afrobarometer. Given the data structure of Afrobarometer surveys, which are collected in different rounds, the specification of the empirical framework needs to be slightly adjusted in comparison to the baseline analysis. In particular, year fixed effects are replaced by fixed effects for Afrobarometer round. These round fixed effects also account for variation in the precise wording of survey questions across waves. The empirical model is

$$Response_{r,t} = HIV_r \cdot ART_{IV,t} + \zeta_t + HIV_r \cdot t + \delta_r + \varepsilon_{r,t}\ , \tag{2}$$

where

- $Response_{r,t}$ is the survey response of respondents in region r in survey round t to various questions about trust in institutions (parliament, local government, policy) or to questions about how the current government handles certain policies (related to HIV/AIDS, basic health provision, management of the economy, or combating crime);
- $HIV_r \cdot ART_{IV,t}$ represents the instruments as described in the baseline analysis;
- ζ_t round fixed effects;
- $HIV_r \cdot t$ is a trend of HIV prevalence, allowing for different trends according to pre-expansion HIV prevalence across rounds;
- δ_r: region fixed effects.

Table A39: APPROVAL TO GOVERNMENT POLICIES

PANEL A	SPECIFIC POLICIES		GENERAL POLICIES		
	HIV/AIDS	Education	Economy	Health	Crime
	(1)	(2)	(3)	(4)	(5)
$HIV_{r,2001} \times ART_{IV,t}$	0.088***	-0.005	0.084**	0.088***	0.119***
	(0.029)	(0.030)	(0.032)	(0.029)	(0.032)
$HIV_{r,2001} \times ART_{IV,t}$	ART Price	ART Price	ART Price	ART Price	ART Price
Mean	0.83	0.79	0.60	0.77	0.30
Observations	337	390	390	337	369
Regions	110	112	112	110	110
R2	0.19	0.26	0.25	0.19	0.22

PANEL B	SPECIFIC POLICIES		GENERAL POLICIES		
	HIV/AIDS	Education	Economy	Health	Crime
	(1)	(2)	(3)	(4)	(5)
$HIV_{r,2001} \times ART_{IV,t}$	0.142***	0.007	0.099***	0.142***	0.130***
	(0.041)	(0.040)	(0.036)	(0.041)	(0.041)
$HIV_{r,2001} \times ART_{IV,t}$	ART Cost	ART Cost	ART Cost	ART Cost	ART Cost
Mean	0.83	0.79	0.60	0.77	0.30
Observations	337	390	390	337	369
Regions	110	112	112	110	110
R2	0.23	0.26	0.25	0.23	0.19

PANEL C	SPECIFIC POLICIES		GENERAL POLICIES		
	HIV/AIDS	Education	Economy	Health	Crime
	(1)	(2)	(3)	(4)	(5)
$HIV_{r,2001} \times ART_{IV,t}$	0.334***	-0.025	0.255***	0.202**	0.134**
	(0.104)	(0.094)	(0.077)	(0.082)	(0.066)
Instrument	ART Cov	ART Cov	ART Cov	ART Cov	ART Cov
Mean	0.83	0.79	0.60	0.77	0.30
Observations	337	390	390	390	390
Regions	110	112	112	112	112
R2	0.23	0.26	0.61	0.22	0.82
Region fixed effects	√	√	√	√	√
Year fixed effects	√	√	√	√	√
HIV prevalence Trend	√	√	√	√	√

Notes: Coefficient estimates (ITT). Dependent variable: Survey responses to questions about how well the policy of the current government handles societal problems (various dimensions); original answers are in categories from 1 to 4, with 1-2 negative, 3-4 positive; the dependent variable is the share of positive answers (3-4). Data source: Afrobarometer. ART treatment: intent-to-treat regressions of the effect of instruments for ART coverage on violent events, instruments constructed as interactions between HIV prevalence in a region in 2001 and time-varying measures of the median price of ART treatment (ART Price). All specifications as described in equation (2). */**/*** indicate significance at 10%/5%/1%, respectively. Standard errors in parentheses clustered at the sub-national region level.

Table A40: INDIVIDUAL TRUST IN INSTITUTIONS

PANEL A	TRUST IN INSTITUTIONS		LAW AND ORDER
	Parliament (1)	Local Government (2)	Police (3)
$HIV_{r,2001} \times ART_{IV,t}$	0.058**	0.039	-0.014
	(0.024)	(0.024)	(0.016)
$HIV_{r,2001} \times ART_{IV,t}$	ART Price	ART Price	ART Price
Mean	0.83	0.79	0.73
Observations	294	300	381
Regions	112	112	112
R2	0.62	0.68	0.80

PANEL B	TRUST IN INSTITUTIONS		LAW AND ORDER
	Parliament (1)	Local Government (2)	Police (3)
$HIV_{r,2001} \times ART_{IV,t}$	0.068**	0.055**	-0.017
	(0.028)	(0.027)	(0.020)
$HIV_{r,2001} \times ART_{IV,t}$	ART Cost	ART Cost	ART Cost
Mean	0.83	0.79	0.73
Observations	294	300	381
Regions	112	112	112
R2	0.62	0.68	0.80

PANEL C	TRUST IN INSTITUTIONS		LAW AND ORDER
	Parliament (1)	Local Government (2)	Police (3)
$HIV_{r,2001} \times ART_{IV,t}$	0.165***	0.136**	0.082
	(0.061)	(0.056)	(0.056)
$HIV_{r,2001} \times ART_{IV,t}$	ART Cov	ART Cov	ART Cov
Mean	0.83	0.79	0.73
Observations	294	300	381
Regions	112	112	112
R2	0.62	0.68	0.80
Region fixed effects	√	√	√
Year fixed effects	√	√	√
HIV prevalence Trend	√	√	√

Notes: Coefficient estimates (ITT). Dependent variable: Survey responses to questions about trust in institutions (various dimensions); original answers are in categories from 1 to 4, with 1-2 negative, 3-4 positive; the dependent variable is the share of positive answers (3-4). Data source: Afrobarometer. ART treatment: intent-to-treat regressions of the effect of instruments for ART coverage on violent events, instruments constructed as interactions between HIV prevalence in a region in 2001 and time-varying measures of the median price of ART treatment (ART Price). All specifications as described in equation (2). */**/*** indicate significance at 10%/5%/1%, respectively. Standard errors in parentheses clustered at the sub-national region level.

References

Allen, Treb and Costas Arkolakis, "Trade and the Topography of the Spatial Economy," *Quarterly Journal of Economics*, 2014, *129* (3), 1085–1140.

BenYishay, Ariel, Renee Rotberg, Jessica Wells, Zhonghui Lv, Seth Goodman, Lidia Kovacevic, and Dan Runfola, "Geocoding afrobarometer rounds 1-6: Methodology & data quality," *AidData. Available online at http://geo.aiddata.org*, 2017.

Center for International Earth Science Information Network - CIESIN, "Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11," 2018.

Conley, Timothy G., Christian B. Hansen, and Peter E. Rossi, "Plausibly Exogenous," *Review of Economics and Statistics*, 2012, *94* (1), 260–272.

Conti, Rena. M. and Ernst. R. Berndt, "Speciality Drug Prices and Utilization After Loss of U.S Patent Exclusivity," *NBER*, 2014, (20016).

Dave, Chintan V., Abraham Hartzema, and Aaron S. Kesselheim, "Prices of Generic Drugs Associated with Numbers of Manufacturers," *New England Journal of Medicine*, 2017, *377* (26), 2597–2598.

de Chaisemartin, Clément and Xavier D'Haultfoeuille, "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects," *American Economic Review*, 2020, *110* (9), 2964–2996.

Faria, Nuno R., Andrew Rambaut, Marc A. Suchard, Guy Baele, Trevor Bedford, Melissa J. Ward, Andrew J. Tatem, João D. Sousa, Nimalan Arinaminpathy, Jacques Pépin, David Posada, Martine Peeters, Oliver G. Pybus, and Philippe Lemey, "The early spread and epidemic ignition of HIV-1 in human populations," *Science*, 2014, *346* (6205), 56–61.

Gao, F., E. Bailes, D.L. Robertson, Y. Chen, C.M. Rodenburg, S.F. Michael, L.B. Cummins, L.O. Arthur, M. Peeters, G.M. Shaw, P.M. Sharp, and B.H. Hahn, "Origin of HIV-1 in the chimpanzee Pan troglodytes troglodytes," *Nature*, 1999, (397), 436–441.

Kalipeni, Ezekiel. and Leo C. Zulu, "HIV and AIDS in Africa: a geographic analysis at multiple spatial scales," *GeoJournal*, 2012, *77*, 505–523.

Perriëns, Joseph H, Vincent Habiyambere, Boniface Dongmo-Nguimfack, Gottfried Hirnschall et al., "Prices paid for adult and paediatric antiretroviral treatment by low-and middle-income countries in 2012: high, low or just right?," *Antiviral Therapy*, 2014, *19* (Suppl 3), 39–47.

Raleigh, Clionadh and Roudabeh Kishi, "Comparing Conflict Data: Similarities and Differences Across Conflict Datasets," *ACLED Documentation, available online: www.acleddata.com/wp-content/uploads/2019/09/ACLED-Comparison_8.2019.pdf*, 2019.

—— **, Andrew Linke, Havard Hegre, and Joakim Karlsen**, "Introducing ACLED-Armed Conflict Location and Event Data," *Journal of Peace Research*, 2010, *47* (5), 651–660.

Salehyan, Idean, Cullen S Hendrix, Jesse Hamner, Christina Case, Christopher Linebarger, Emily Stull, and Jennifer Williams, "Social conflict in Africa: A new database," *International Interactions*, 2012, *38* (4), 503–511.

Sethian, J. A., "A Fast Marching Level Set Method for Monotonically Advancing Fronts," *Proceedings of the National Academy of Sciences*, February 1996, *93* (4), 1591–1595.

——, "Fast Marching Methods," *SIAM Review*, 1999, *41* (2), 199–235.

Sundberg, Ralph and Erik Melander, "Introducing the UCDP Georeferenced Event Dataset," *Journal of Peace Research*, 2013, *50* (4), 523–532.

Tatem, Andrew J., "WorldPop, Open Data for Spatial Demography," *Scientific Data*, January 2017, *4* (1), 170004.

Health Policies for Women Empowerment:

Evidences from Malawi's Antiretroviral Therapy for HIV campaign

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Abstract

Can major health interventions promote women empowerment? Focusing on rural Malawi, I study the effect of Antiretroviral Therapy (ART) to combat the HIV/AIDS epidemic on women empowerment. To identify the effect, I use the ART roll-out campaign launched by the Malawian government starting in 2004. Based on the scope and accessibility of treatment, I calculate an index to measure the benefit of ART to a community. Women in communities that have benefited the most from the treatment, both in terms of the number of beneficiaries and access, experienced an increase in decision-making and a decrease in experiencing physical violence. The rise in women empowerment can be explained by the positive effect of health improvement on economic empowerment and human capital formation. This paper calls for a central role of health interventions in future women empowerment campaigns.

Keywords: HIV, Women Empowerment, Health Interventions, ART expansion, Africa, Malawi

JEL Codes: I15, I18, I38, J16, O10

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1 Introduction

Promoting women empowerment is crucial for sustainable development (UN (2000); UN Assembly (2015); Page and Pande (2018); Duflo (2012)). All over the world, cultural norms, stereotypes, and gender-based violence still prevent women from accessing proper education, economic resource, and health. Recently COVID-19 pandemic has dramatically shown that some health shocks may affect women more than men in terms of their impact on well-being (Etheridge and Spantig (2020)), occupation (Adams-Prassl et al. (2020)), and workload in the household (Farré et al. (2020)). Similar negative effects of a health shock on women empowerment have been observed in the context of the HIV/AIDS epidemic in Sub-Saharan Africa (SSA). Over 25 million people still live with HIV in SSA, and the deaths from HIV/AIDS are still 600 thousand per year. Cultural and biological factors make women in the African continent more exposed to HIV, and today a young woman is twice as likely to become HIV positive than a young man (Anderson (2018)).[1] International organizations have argued that there is a relationship between HIV/AIDS and women empowerment. Gender-based violence, lack of education, and poverty may make women more exposed to the virus, while the spread of the HIV/AIDS epidemic negatively affected women economic empowerment, reducing women work productivity, and women human capital, especially through a negative effect on women education. This negative relationship seems to go beyond the direct effect of being ill on empowerment, but it extends to the general population. Previous literature, as Conroy et al. (2013); Baranov et al. (2015), has shown how in HIV-endemic areas this virus has shaped beliefs and incentives affecting people's decision-making process regardless of their illness. At the same time, while being more exposed to the virus, the female population has also a higher chance to receive proper care for HIV. Since the early 2000s, the UN has implemented policies to reduce the Mother-to-Child transmission of HIV. As a result of these programs, women are more likely than men to know about their

[1] https://www.unaids.org/en/resources/documents/2018/women_girls_hiv

HIV status and being on treatment.[2] Both the COVID-19 and HIV/AIDS epidemics suggest an important and strong relationship between health and women empowerment. However, whether major health interventions may play a role in empowering women still remains unexplored.

The HIV pandemic and its management in Malawi provide a unique natural experiment to answer this question. HIV virus started spreading in Africa during the 70s, and, by 2000, over 36 million in the world were living with the virus (UNAIDS (2000)). Although the first antiretroviral therapy (ART) was approved in the US in 1987, ART was not available in the African continent until 2001 because of its prohibitive cost. In 2001, thanks to international organizations and public opinion campaigns, generic drugs for HIV were introduced in the market, leading to a massive drop in the price and cost of ART. The drop in drug prices allowed countries, often with the support of international organizations, to start ART rollout campaigns. In 2004, the Malawian government, with the support of the Global Fund, started a program aiming to provide free ART in the health facilities of the country. In the early 2000s Malawi was one of the poorest countries in the world and one of the most plagued by the HIV epidemic, with a prevalence of 14.9% among the adult population (World Bank, 2000). The impact of this campaign on health in the country has been massive, because of the HIV pandemic life expectancy dropped to 45 years in 2000, and started increasing toward the end of the decade of the millennium reaching 55 years in 2010 and over 64 years by 2019 (World Bank). Beyond the direct effect of ART on life expectancy, we observe a positive impact on work productivity and supply, mental health, saving and investment in human capital on both HIV-positive and negative people (Baranov et al. (2015); Baranov and Kohler (2018); Dickerson et al. (2020)). Recent literature has shown how ART rollout has promoted economic growth (Tompsett (2020)) and reduced social violence in the African continent (Berlanda et al. (2022)). Despite evidence of spillover effects of major health policies, there is still no evidence of an effect of them on women empowerment.

[2] `https://www.unaids.org/sites/default/files/media_asset/live-life-positively-know-your-hiv-status_en.pdf`

In this paper, I will show how major health intervention, such as ART rollout, has a positive impact on women empowerment, defined as *power to achieve goals and ends*.[3] I perform my analysis using a repeated cross-section of rural clusters of Demographic Health Surveys (DHS), from 4 waves conducted in Malawi between 2000 and 2016[4]. Since information on the number of people receiving ART is not available at the sub-national level, I rely on a proxy to identify the communities that benefited the most from ART availability. To do so, I exploit the geographical variation of the scope of the treatment and the access to it. I measure the scope of treatment using HIV prevalence in 2000 for each cluster. In this way, I capture the number of potential beneficiaries of the treatment in each community at the peak of the HIV pandemic. The second source of information I use is effective access to the treatment. Using data on health facilities' location, road network, and first geography, I construct a measure of access to health for each cluster in my sample. Proximity to facilities is a crucial determinant of access to health services in rural SSA. I then construct a measure of benefit from ART using the interaction of these two terms.

In this work, I perform a pre-post analysis resembling a non-staggered difference-in-difference approach. Because of data availability, I do not have information about the timing of treatment provision for each clinic, so I assume that each health facility started providing ART in 2004. This approach can be viewed as a conservative one, since considering all clinics treated at the same time would eventually imply an attenuation bias. In my baseline analysis, I include all the health facilities of the country in 2013, but results are robust if I restrict the clinics only to the ones actually providing ART in 2013 or to the public ones. I find that higher exposure to treatment, both in terms of the number of beneficiaries and access, has led to an increase in women empowerment after 2004. In particular, higher exposure to ART is associated with more decision-making by women, and a lower likelihood of experiencing physical violence. Despite the set of fixed effects included in the analysis, there is the possibility that, with my analysis,

[3]Following Demographic Health Surveys guidelines (`https://dhsprogram.com/pubs/pdf/CR20/CR20.pdf`), I define empowerment as *power to achieve goals and ends* and not as power *over* others.

[4]DHS collected 4 waves in Malawi over the period 2000-2016: 2000, 2004, 2010, 2015-16

I am capturing some variation due to other policies or cultural factors that may have affected women empowerment after 2004 and access to treatment. These concerns are relaxed, since possible confounders, such as education campaigns, cultural norms, and measures to sustain women occupation, are ruled out as drivers of the results. The main channels, through which ART expansion affected women empowerment, are economic empowerment, through a positive effect on women participation in the labor market, and a human capital channel, through a positive effect on young women education.

This paper contributes to the literature in several ways. The first contribution concerns the understanding of the relationship between HIV/AIDS epidemic and women empowerment. Previous literature has studied how lack of empowerment and poverty expose women to HIV/AIDS epidemic in Africa (Türmen (2003); Mufune (2015); Ramjee and Daniels (2013)), showing a relationship between lack of empowerment and poor health (Bashemera et al. (2013)). This work first provides an example of how health interventions are viable instruments for policymakers to promote women empowerment. A second contribution is providing new insight into the spillover effects of major health interventions in the context of HIV/AIDS epidemic. This paper complements previous literature on the effect of ART availability. Previous works have provided evidence of the impact of ART on fostering productivity and time devoted to work (Baranov et al. (2015)), on investment choices (Baranov and Kohler (2018)), on economic growth (Tompsett (2020)), and on social stability (Berlanda et al. (2022)). This paper complements this literature by providing evidence about the effect of ART on the extensive margin of female labor supply and investment in education. Finally, this work contributes to the literature studying the relationship between health and human capital. Becker (2007) provides a theoretical framework explicitly introducing health in a human capital model. The following literature showed that, according to Becker's prediction, improving health has a positive effect on productivity (Hokayem and Ziliak (2014)), and promotes investment and human capital accumulation (Goodman-Bacon (2021); Papageorge et al. (2021)).

The remainder of the paper is organized as follows. Section 2 provides background on Malawi and its ART roll-out campaign. Section 3 describes the data used for the analysis. Section 4 describes the empirical approach used in the paper, and Section 5 discusses the main findings. Section 6 investigates the channels through which health policies affect women empowerment. Section 7 discusses the results and concludes.

2 Background

Management of the HIV pandemic in Malawi provides a unique setting to study the effect of the introduction of ART on women empowerment. Malawi is a land-locked low-income country in Eastern Africa, with an estimated population of 18.6 million people in 2019 (World Bank, 2019). With a GDP per capita of 583$, Malawi is one of the poorest countries in the world and over 80% of the population lives in rural areas, and the country's economy heavily relies on agriculture. The HIV/AIDS pandemic is the main public health issue in Malawi, where 10.6% of the adult population (15-64) was living with HIV in 2016.[5] This epidemic disproportionately affects women: in the adult population HIV prevalence among women is 12.8%, compared with 8.2% among men. Women and girls in Malawi experience worse living conditions and opportunities than their male counterparts, as shown by socio-economic indicators about education and labor outcomes (WEF (2021); Bank (2021)). In 2021, the secondary education gender parity ratio in the country was still 84%, with a proportion of over 60 men for 40 women in universities. Due to a lack of resources, women-managed plots in the agricultural sector, the most important for the economy, are 25% less productive than the ones managed by men. The major obstacle to gender equality and women empowerment in the country is often identified in the lack of access to economic resources.[6] The combination of these factors, lack of access to education and resources, make women more exposed to poverty and then increases their exposure to HIV (Mufune (2015); Anderson (2018)). At the same time, as shown by Baranov et al. (2015), exposure to HIV in Malawi has reduced people's labor provision, and it is true especially for women, because of their traditional

[5]Malawi Population-Based HIV Impact Assessment (MPHIA), 2015-16

[6]`https://www.usaid.gov/gender-equality-and-womens-empowerment`

caregiver role in the household. The HIV pandemic creates a vicious circle in which the disease creates poverty and, at the same time, poor people are more exposed to the disease, because of their behavior and deteriorating health conditions. This loop affects women more than men, and it results in even lower access to economic resources, with a detrimental effect on women empowerment.

ART rollout campaign. Despite the first Antiretroviral Therapy (ART) being discovered in the US in 1987, the treatment was not available in the African continent because of its prohibitive price. Only in the early 2000s, thanks to public opinion and international institutions' support, the price dropped dramatically and the treatment became available worldwide.[7] Before 2004 ART in Malawi was de facto not available, and only 3000 people out of approximately 930000 HIV-positive people were on ART. In 2003 Malawian government announced that it would have provided free ART to all HIV people in the country eligible for treatment.[8] One important feature of the ART rollout in Malawi was that it happened mainly through already existing clinics and hospitals. Because of very rigorous requirements for clinics, the expansion of the program was slow and by the end of 2005, only 60 health facilities were providing ART. Starting in 2006, in order to maximize ART coverage in the country, the Malawian government relaxed the standards for health facilities to access the program, making eligible all clinics with at least one data clerk (Baranov and Kohler (2018)) As a result of this change in the policy, by end of 2010, the number of clinics providing ART was over 300, reaching a total of 716 ART clinics in the country by 2015 (Jahn et al. (2016)).

Geographical coverage has been crucial for the success of the program since enrollment and adherence to the program are very costly for patients. ART recipients are required to visit a health facility every two weeks in the first month after the treatment began.

[7]In 2001 ART drugs price dropped from over 10000 $ to less than 1000$ per person/year (Tompsett (2020)).

[8]Eligibility for ART depended, according to WHO guidelines of the time, on the lymphocyte count of a patient. In 2004 were eligible all the patients in clinical stages 3 and 4 disease or patients with lymphocyte counts below 200 cells/μL

They should then visit once per month in the following semester and after that once every 3 months. For this reason distance from a health facility has been crucial for access and adherence to treatment in Malawi (Koole et al. (2014)).

3 Data

To study the effect of ART availability on women empowerment in Malawi, I use survey data collected by the Demographic and Health Surveys Program (DHS). The surveys are conducted in the years 2000, 2004, 2010, and 2015. As units of observation for the analysis, I use clusters, groupings of households that participated in the surveys, located in rural areas of the country. For each cluster DHS reports the GPS coordinates, however, in order to ensure respondent confidentiality, latitude and longitude are randomly displaced by a few kilometers.[9] The resulting dataset is a repeated cross-section containing a total of 2210 rural clusters over the 4 waves of the DHS survey.[10] I match each DHS cluster with the respective administrative unit, assigning each to the respective Region, Province, and Traditional Authority Area.[11] In the analysis, I exploit variation across DHS clusters within waves and Traditional Authority Areas. For each unit of observation, I compute then indicators of women empowerment according to DHS guidelines and I create a measure of exposure to ART in the country. Table A1 reports summary statistics of the variables described in Section 3.

Women Empowerment Indicators: Decision Making. Following DHS guidelines[12], I define empowerment as *power to achieve goals and ends* and not as power *over*

[9] Clusters are divided between urban clusters, which contain an error ranging between 0 and 2 km, and rural clusters, which contain an error ranging between 0 and 5 km. There is moreover a 1% of rural clusters displaced between 0 and 10 kilometers. The displacement is anyway restricted so that the points stay within the country and within the DHS survey region.

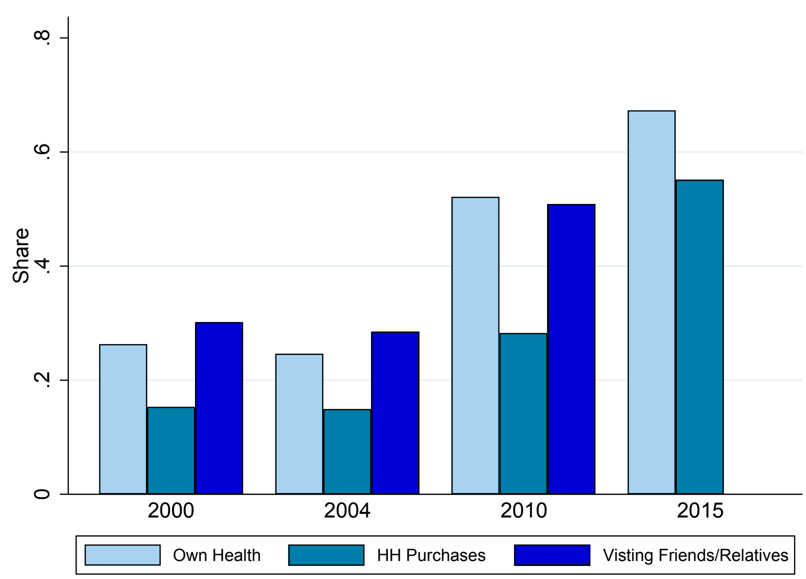
[10] More specifically, I have 435 rural clusters for the 2000 wave, 445 for the 2004 wave, 669 for the 2010 wave, and 661 for the 2015 wave.

[11] To do so, I construct a 5 km buffer around each rural cluster, then I assigned it to the most likely administrative unit

[12] `https://dhsprogram.com/pubs/pdf/CR20/CR20.pdf`

others. DHS measures women empowerment in terms of control over various aspects of life and the surrounding environment. The main indicator of women empowerment in the Malawi surveys is participation in decision-making. The relevant questions about women's decision-making are contained in Individual Recode (IR), the DHS dataset containing one record for every eligible woman as defined by the household schedule. DHS questionnaires aim to investigate decisional power in different spheres of a woman's life: the personal sphere, asking about decisions on respondents' own health, the family sphere, asking about big purchases decisions in the household, and the public sphere, asking about decisions on visiting friends or relatives. For each cluster and wave, I compute the share of married women participating in decision-making, according to DHS guidelines[13], data are shown in Figure 1. Figure 1 displays an increase in women partic-

Figure 1: Women Empowerment Indicators: Decision Making



Notes: The figure shows the time evolution of decision-making indicators over time. Light blue bars (*Own Health*) show the time evolution of the share of currently married women participating in decision-making about their own health. Bright blue bars (*HH Purchases*) show the time evolution of the share of currently married women participating in decision-making about big purchases in the household. Blue bars (*Visitng Friends/Relatives*) shows the time evolution of the share of currently married women participating in decision-making about visits to friends and relatives. Data are from DHS collected in Malawi over the period 2000-2016.

[13]`https://dhsprogram.com/data/Guide-to-DHS-Statistics/Participation_in_Decision_Making.htm`

ipating in each of the decisions over time, with a dramatic increase after the year 2004. Following DHS guidelines, I define as *empowered* the women participating in all the decisions discussed above. I create two outcome variables that capture the decision-making process. The first variable, labeled as *All Decisions*, is the share of women participating in all the decisions available in each specific year. The second variable, labeled as *Own Health & HH Purchases*, restricts the analysis only to the two decisions, the health and household ones, for which I have information in all 4 waves.

Women Empowerment Indicators: Domestic Violence. As an alternative proxy for women empowerment, following UN directive (Walby (2007)), I use data on women experiencing physical violence. DHS surveys from 2004 ask women if they have experienced physical violence in the 12 months before the interview. I use then this information to compute the share of women in my sample who experienced physical violence in the 12 months before the interview at the cluster-wave level.

Additional Women Empowerment Indicator: Attitude Towards Intimate Partner Violence (IPV). As a measure of women empowerment, I use data on women's and men's attitudes toward Intimate Partner Violence. DHS surveys from 2000 ask women and men under which circumstances they find justifiable if a husband exerts physical violence on his spouse. The questionnaire contemplates abroad series of answers regarding aspects of women's life in the household, in the community, or in their sexual life. This variable takes value one for individuals who never justify violence. I use then this information to compute the share of women and men who never justify IPV in each cluster.

Benefit from ART provision program. As discussed in Section 2, in 2004, the Malawian government started a program to provide free ART to HIV-infected people in 9 hospitals situated in urban areas of the country. In the following years, the program expanded to other clinics in the country, both in urban and rural areas. Since I don't have detailed data on the program provision, to evaluate the effect of this policy, I use two time-invariant measures to evaluate the beneficial effect of ART availability at the cluster level. The first one is the share of the adult population (15-49) living with HIV in 2000. This variable is meant to capture the share of the population benefiting from ART in a cluster. Considering the random displacement of the clusters, I assigned to each cluster the average HIV prevalence in 2000 within a radius of 5 km from the GPS coordinates in the survey. Panel (a) of Figure 2, shows the spatial distribution of HIV prevalence in the country. In the sample HIV prevalence in 2000 ranges between around 9% and 32% with an average value of around 17%.

The second measure is an interaction between the number of beneficiaries, given by the number of HIV-positive people in 2000, and the effective access to treatment, given by proximity to the closest health facility. In the baseline analysis, I construct two different measures of proximity to a health facility. The first one is the walking distance of each cluster from the closest health facility (panel (b) of Figure 2). Using the software AccessMod (Ray and Ebener (2008)) I constructed a Friction Surface Raster combining raster images of roads (Google Street View), rivers, land cover (Figure A1), and data on topography (Figure A2). Following Palk et al. (2020), I defined the walking speed for each cell of the Friction Surface Raster, and I computed the distance in minutes from the closest health facility for each cell of the grid (Table A4). The final result is a map of access to health by walking at a resolution of 30 meters $\times$30 meters. I assigned then to each cluster the average value within a 5 km radius from it, taking into account the coordinates randomization made by DHS to grant anonymity of the respondents. In the rural clusters sample, the average walking time of each cluster from the closest health facility is 98 minutes, ranging between 28.9 and over 470 minutes. The second, and simpler, measure of proximity is given by the inverse geodesic distance from the closest facility measured in kilometers.[14] As robustness, I then construct other two measures of proximity based on the linear and logarithmic transformation of distance.

[14]More specifically $Proximity_{c,h} = \frac{1}{1+distance_{c,h}}$, where c represent the cluster and h the closest health facility.

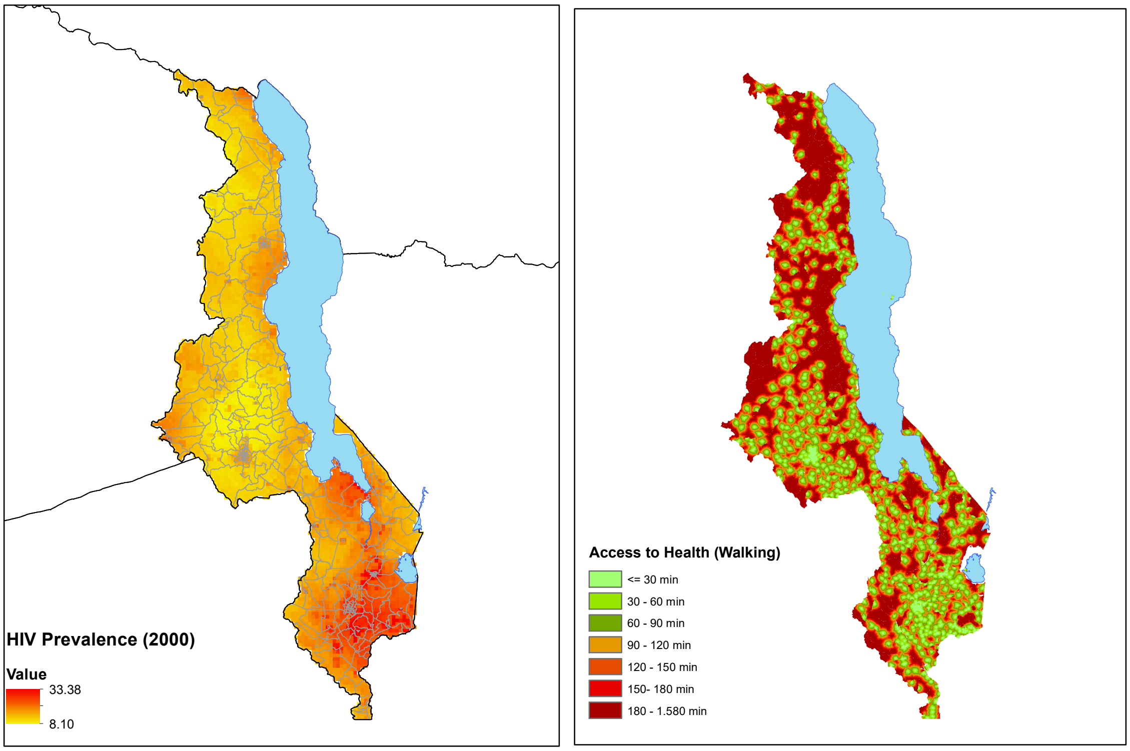
[15] In my sample the average distance of each cluster from the closest health facility is 4.4 km, ranging between clusters located within 1 km from the closest health facility to clusters that are more than 24 km far from the closest structure. To allow comparability between the measures I have converted the walking time in 15 minutes units, which represent the average speed to cover 1 km walking. Distance from health structures is a reliable proxy for access to health care in Africa (Guenther et al. (2012)), and in particular, is a significant predictor for access and adherence to ART in rural areas (Koole et al. (2014)). The combination of these two elements, HIV prevalence, and proximity, captures the potential benefit in a DHS cluster from ART provision after 2004: the greater the number of recipients, the greater the benefit of ART availability and, at the same time, the closer a health facility is, the higher is the probability of actually receiving the treatment.

Data on HIV prevalence are from Institute for Health Metrics and Evaluation (IHME)(Sartorius et al. (2021)). Using data on HIV and geographical location from surveys and sentinel surveillance of antenatal care clinics, IHME produced estimates for HIV prevalence among the adult population. The estimates are produced at 5×5 km grid level and cover 47 countries in Africa for a period between 2000 and 2017. In the analysis, I use HIV prevalence in 2000 in Malawi, in order to capture the HIV epidemic in the country right before ART became available in the African continent.

Data on health facilities come from Malawi DHS Service Provision Assessment (SPA) 2013-2014. This survey contains data on health facilities active in Malawi between 2013 and 2014, providing information about location, type of facility, and the services provided for 997 health facilities. In the analysis, I exploit as robustness information about the owner of the clinic, namely if it's public or private, and if in 2013 the clinic was part of the ART program provision. Figure A3, shows the spatial distribution of health facilities in Malawi, and it reports information about who manages each facility.

[15] More specifically, define the maximum distance of a cluster from a clinic in the sample as $dist_{max}$. Then: $LinearProximity_{c,h} = 1 + (dist_{max} - distance_{c,h})$ and $LnProximity_{c,h} = ln(1 + (dist_{max} - distance_{c,h}))$, where c represent the cluster and h the closest health facility.

Figure 2: Exposure to Treatment



(a) HIV Prevalence (b) Health Facilities

Notes: Panel (a) shows the spatial distribution of HIV prevalence in Malawi in 2000; data source: IHME, Sartorius et al. (2021). Panel (b) shows the distance in minutes of each location in Malawi from the closes health facility; data source: author's computations.

Additional Data. In my analysis, I use the information on women's employment status, educational attainment, and living in a polygynous household[16]. All those variables are constructed using DHS surveys over the period 2000 and 2015-16. The women employment indicator measures the share of married women who have been employed in the 12 months before the interview.[17] As educational attainment measure I use the share of women who completed primary education, and I compute this measure both for the married women in my baseline analysis and for all the young women (15-24) in DHS

[16] Polygyny is defined as the marriage of a man with several women

[17] `https://dhsprogram.com/data/Guide-to-DHS-Statistics/Employment_and_Occupation.htm`

surveys.[18] Finally, I use the information on the number of co-wives that a woman has to determine the share of married women living in polygynous households.[19]

4 Empirical Strategy

4.1 A Graphical Illustration

As discussed in section 2, the HIV pandemic disproportionately affects women in the African continent. Lack of women empowerment, cultural norms, and biology are crucial factors in explaining why women in Africa are more affected by HIV (Anderson (2018); Türmen (2003); Kim et al. (2008); Ramjee and Daniels (2013)). Figure 3 shows the time evolution of the raw mean of the main outcome variables discussed in Section 3. The summary statistics show a large improvement in women empowerment after 2004, which coincided with the ART rollout campaign to combat the HIV epidemic. Despite it being a simple correlation, these first pieces of graphical evidence suggest a potential relationship between ART provision and an improvement in women empowerment in the country.

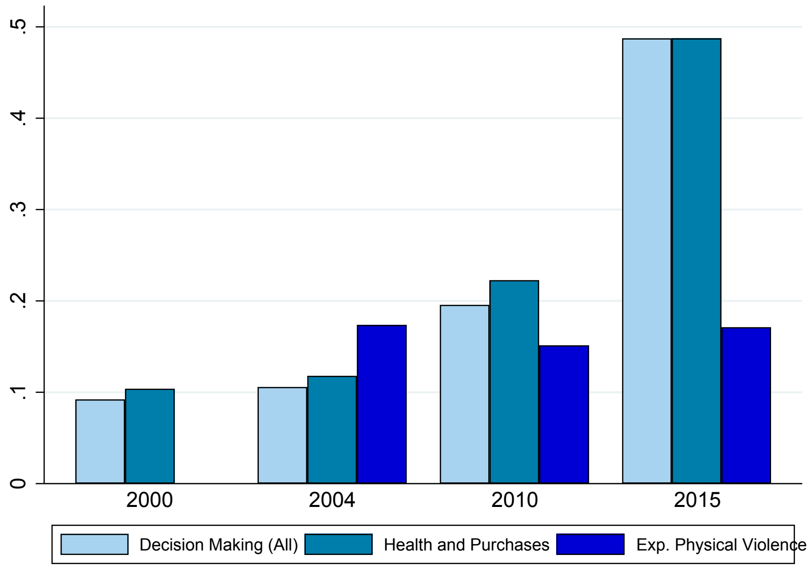
4.2 Baseline Analysis

I study the impact of ART availability on women empowerment indicators in Malawi using a repeated cross-section of (2210) DHS clusters, from four DHS rounds conducted between 2000 and 2016. I exploit the Malawian government's campaign started in 2004 to provide ART free of charge in health facilities described in Section 2. The implementation of this policy has been staggered over time across the country. It is then crucial that the timing of the policy has been exogenous to women's condition in the country. According to the literature, Baranov and Kohler (2018), the Malawian government's aim has been

[18] https://dhsprogram.com/data/Guide-to-DHS-Statistics/Educational_Attainment_of_Women_and_Men.htm

[19] https://dhsprogram.com/data/Guide-to-DHS-Statistics/Number_of_Co-Wives_and_Number_of_Wives.htm

Figure 3: Outcome variables



Notes: The figure shows the time evolution of women empowerment indicators over time. Light blue bars (*Decision Making (All)*) show the time evolution of the share of currently married women participating in all the decisions available in each specific year. Bright blue bars (*Own Health & HH Purchases*) show the time evolution of the share of currently married women participating in decision-making about their own health and big purchases in the household. Blue bars (*Physical Violence*) shows the time evolution of the share of currently married women who have experienced physical violence in the 12 months before the interview. Data are from DHS collected in Malawi over the period 2000-2016.

reaching the maximum geographical coverage for ART provision, so the timing of policy implementation should be a concern. In this work, because of data limitation, I adopt a more conservative approach and I assume that every clinic in the country started to provide the treatment after the year 2004. This approach allows me to rule out any potential endogeneity due to the timing of the campaign.

I run a pre-post treatment analysis resembling a Difference in Difference approach (DID). The first difference with a standard DID is that my sample is composed of a repeated cross-section and then it is not possible to include the unit of observation fixed effects. The second difference is that my treatment is continuous and that I consider as treated every unit after 2004. This determines the fact I do not have a not-treated control group after 2004 as in standard DID. The main analysis equation takes the following form:

$$WomEmp_{c,t,a} = \beta \cdot Post_{2004} \cdot Exposure_c + \gamma \cdot Exposure_c + \theta_{r,t} + \eta_a + \epsilon_{c,t,a} \qquad (1)$$

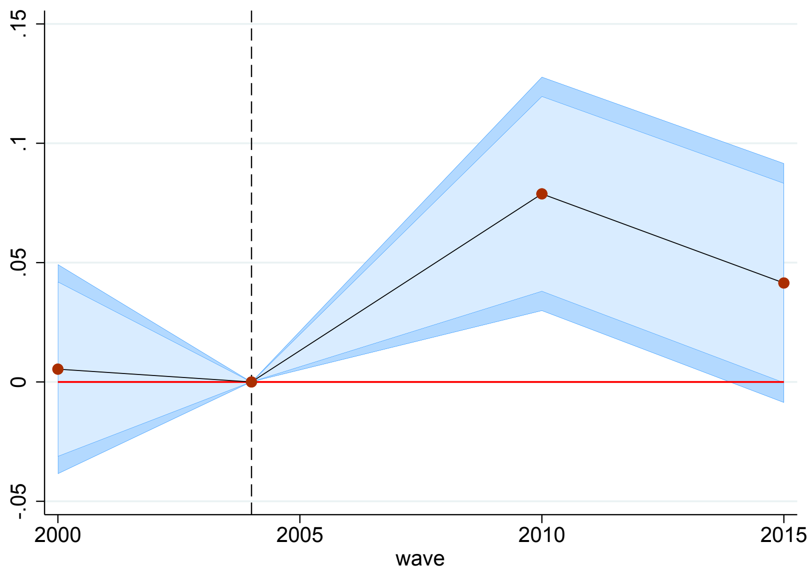
$WomEmp_{c,t}$ represents different women empowerment indicators, measured as the share of women in a cluster participating in decision-making about their life and the share of women who experienced domestic violence in the 12 months preceding the surveys t. $Exposure_c$ is a time-invariant measure of exposure to treatment once it becomes available, I compute this measure at the cluster level exploiting, as discussed in Section 3, geographical variation in the access and scope of the treatment. The first, and simplest, measure relies on the geographical variation in the scope of the treatment, so the number of people benefiting from it, and it is proxied by the HIV prevalence in the year 2000. This measure ($HIV_{2000,c}$) allows a simple interpretation of results, but it doesn't take into account effective access to the treatment. I build then a variable capturing the effective exposure to the treatment, which is a crucial factor to explain access to health in rural areas of SSA. The second measure of $Exposure_c$ relies on the interaction between the scope of treatment and effective access to health measured as proximity to the closest health facility ($\cdot HIV_{2000,c} \cdot Proximity_c$). The rationale for this measure is as follows. First, HIV prevalence in 2000 in a cluster captures the share of the adult population that will benefit from ART once it becomes available. Second, following Koole et al. (2014), distance from health facilities captures how easy, and then likely, it is to access and adhere to the treatment once it's available. The proximity-based exposure indicator increases with the number of beneficiaries and access to treatment. I use as a measure of proximity to health facilities the inverse of the walking distance from the closest health facility and the inverse geodesic distance as discussed in Section 3. I interact then the $Exposure_c$ variable with a binary indicator, $Post_{2004}$, taking value 1 for DHS conducted after 2004: coefficient β captures the potential benefit from access to ART. I expect the relevant coefficient, β_1, to be positive since the higher the number of people who can benefit from the treatment the higher will be the impact of ART once it becomes available.

I include then an exhaustive set of fixed effects: $\theta_{r,t}$ captures fixed effects at region-year[20] level, while η_a captures fixed effects at Traditional Authority area level. In my analysis, I include 204 admin3 areas, allowing me to relax the concerns about the cross-sectional structure of my data, and exploit variation within each admin 3 unit. Standard errors are clustered at the Traditional Authority area level.

DID exercise. Since my identification strategy resembles a DID, I decide to test if the parallel trends assumption holds. In this way, I can be reassured that the policy has been designed without targeting areas in which women empowerment was more lacking. To do so, I define a binary treatment based on HIV prevalence, where I consider as treated only the clusters in which HIV prevalence in 2000 is above the median. In this way, I am not bound by continuous treatment and, more importantly, I am able to identify a control group in my analysis. Considering the relationship between HIV and women empowerment, the biggest concern for identification strategy is that areas with higher HIV prevalence exhibited different trends in women empowerment before 2004. If that was the case, it would be possible that the policy was implemented to empower women in high-prevalence HIV-affected areas as well. Table A2 shows the summary statistics for the two groups before and after 2004. In the period before treatment, we do not observe systematic differences between the two groups in terms of women empowerment indicators, educational outcomes, and participation in the labor force. However, areas with lower HIV prevalence are likely to be located further (half s.e. difference) from health facilities. I then regress the HIV binary indicator with dummy variables for each wave of DHS surveys using as a reference wave the one performed in 2004. Figure 4 plots the marginal effect of a high HIV prevalence in the country and shows how there isn't any trend in HIV prevalence before ART became available, while there is a largely positive effect in the period right after treatment provision started. Because of data limitations, this event study is not exhaustive in removing all the concerns about possible pre-trends in the results. However, combined with the evidence provided in Section 4.1, this exercise suggests that my results are not driven by trends in the pre-treatment period.

[20] With region I refer to the three Administrative 1 units of Malawi: Northern Region, Central Region, and Southern Region

Figure 4: Event Study: Decision Making



Notes: The figure plots the event study graph for the coefficient of interest β from Equation 1. In this analysis, $Exposure_c$ is a binary indicator if the share of HIV in 2000 for the cluster is above the median level. The outcome variable is the share of women participating in all the decisions available (*Decision Making (All)*). The darker blue area shows the 95% confidence interval, the lighter blue area shows the 90% one.

Identification The identification of the effect of exposure to ART on women empowerment in equation 1, β, relies on the assumption that the measure of exposure to treatment is uncorrelated with unobserved or omitted factors in the error term $\epsilon_{c,t}$. Conditional to the set of controls and fixed effects included in the main analysis, the two elements of the measures of exposure to treatment, HIV prevalence and proximity to the closest health facility, are exogenous to women empowerment indicators. Before 2001, ART was not available in the African continent so policymakers didn't have any valid instrument to contrast effectively the epidemic. For this reason, it is safe to assume HIV prevalence in a cluster is related to specific historical, cultural, and social factors. Those factors are taken into account by the vast set of fixed effects included in the regression. In particular, Traditional Authority Areas[21] fixed effects take into account differences in cultural, social, and gender norms that have played a role in the spread of HIV. A

[21] According to UN, Traditional Authorities act as custodians of the cultural and traditional values of community link [Accessed: 09/12/2021]

second crucial aspect is that the clinics' location, and then their distance, is not related to policies affecting women empowerment or ART provision. This could be the case if the government has built new health facilities trying to boost the provision of ART or if health facilities have been used for other policies that could have an impact on women empowerment. Baranov et al. (2015); Baranov and Kohler (2018); Dickerson et al. (2020), have shown how the Malawian government did not target specific areas for the ART roll-out and that it used health facilities already existing in 2004 for policy implementation. The inclusion of Traditional Authority area fixed effects helps again in taking into account any systematic difference in clinic availability due to ethnic and cultural factors. Finally, the inclusion of region-wave fixed effects takes into account any shock change in policy at the national and regional level that may have had an impact on both access to treatment and women empowerment.

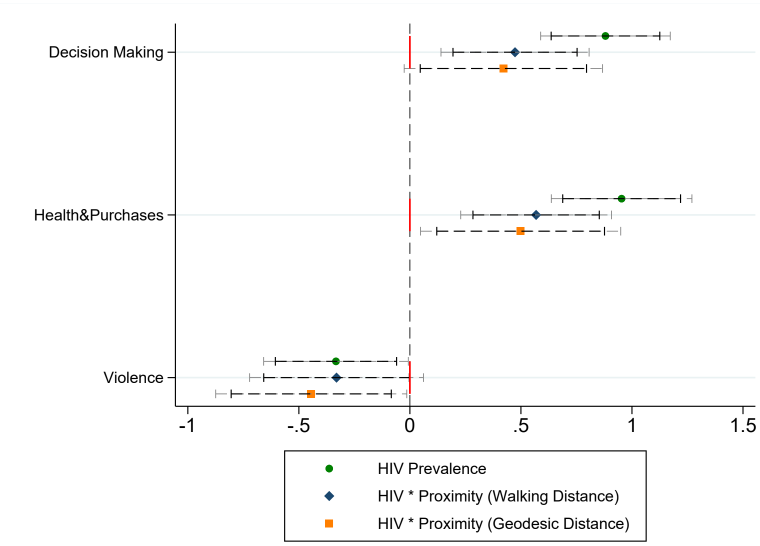
5 Results

Baseline Analysis. Figure 5 and Table A5 report the results for the impact of exposure to ART on women empowerment using the estimation strategies discussed in Section 4. The figure shows results on the share of women taking decisions about their life and women experiencing physical violence.

The first panel shows the results of ART availability on the share of women who report participating in decision-making about different aspects of their own life. The second panel shows results for the decision-making indicator constructed using the sub-sample of decisions, on women's own health and major purchases in the household, covered over the entire period by DHS surveys. Estimates show a positive and statistically significant relationship between both the decision-making variables and the measures of exposure to treatment after the year 2004.

The final panel of the figure reports the effect of ART availability on the share of women experiencing physical violence in the 12 months before the interview. Estimates show a negative and statistically significant correlation between experiencing physical

Figure 5: Baseline Analysis



Notes: OLS Estimates for effect of ART availability on women empowerment, using specification described in equation **??**. I use three proxies to measure exposure to ART. HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment (green dots). An interaction between HIV prevalence and access to the clinic ($HIVxProximity$ (Walking Distance)) that combines the prevalence of HIV with access to ART measured as the inverse walking distance from the closest clinic (blue diamonds). An interaction between HIV prevalence and access to the clinic ($HIVxProximity$ (Geodesic Distance)) that combines the prevalence of HIV with access to ART measured as the inverse geodesic distance from the closest clinic. This variable is meant to capture the exposure to ART combining the number of recipients and effective access to the treatment.
Dependent variables: first panel (*Decision Making (All)*), the share of currently married women participating in all the decisions available in each specific year; second panel (*Health & HH Purchases*), the share of currently married women participating in decision making about their own health and big purchases in the household; third panel (*Physical Violence*), the share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. Black lines show the 95% confidence interval, grey lines show the 90% one.

violence and ART exposure proxies after the year 2004. As an alternative outcome variable, I explore if ART introduction has had an impact on the attitude toward Intimate Partner Violence (IPV). DHS surveys contain information on when a person finds it justifiable that a husband exerts physical violence on his spouse. Table A6 reports the results for this analysis, showing how ART expansion is associated with a higher share of women never justifying IPV. This variable is interesting because it allows us to measure men's attitudes toward it. Surprisingly, more men than women never justify IPV, however, we do not observe any change in their attitude because of ART.

While the OLS analysis shows a strong significant effect of ART on promoting women empowerment, it is not straightforward how to quantify the effect of exposure to ART. To provide an example of that, we can interpret the results for the analysis using only HIV prevalence as a proxy for the benefit of ART. The total effect of a 1 p.p. increase in HIV prevalence in the post period, summing up the effect before and after 2004, is an increase of around 0.74 p.p. on all decision-making variables, and a decrease of 0.18 p.p. on the share of women experiencing physical violence. This means that for the average cluster in terms of HIV prevalence, the introduction of ART implied an increase in decision-making indicators of over 12 p.p. and a decrease in physical violence of around 3 p.p. Concerning decision-making, this effect explains around 30% of the total increase in decision-making indicators observed in the data.

Table A7 reports results for the baseline analysis using different methods to compute geodesic distance. More specifically, rather than using the inverse distance, I use the linear and logarithmic distance from the closest health facility described in Section 3. Results are robust across all different specifications, showing how greater exposure to treatment has led to more women empowerment.

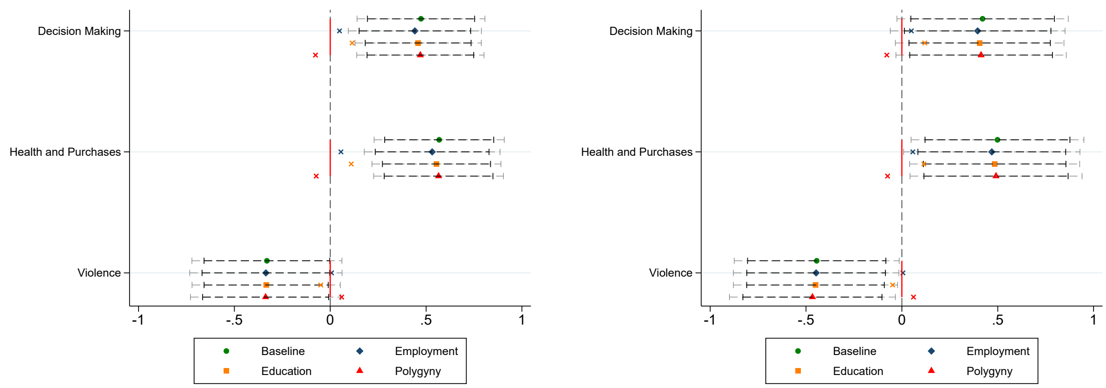
Table A8 reports results for baseline analysis analyzing the effect of ART expansion on the single components of the decision-making indicators. Column (1) presents the results of the baseline analysis. Column (2) shows results for the share of women participating in decision-making about their own health. Column (3) presents results for the share of women taking part in decision-making on big purchases for the household. Finally, column (4) show results for the share of women who participate in decision-making about visiting friends or relatives. Both ART availability proxies show a positive and robust correlation with all the components of the women empowerment indicators.

Robustness. Despite the broad set of fixed effects included in the regression, there could still be some concerns about the validity of the results. The main one is that with my analysis I am capturing some variation due to other policies, such as the implementation of Millennium Development Goals, or cultural factors that may affect women empowerment after 2004. To address this concern I include in my baseline analysis extra controls that, despite they could suffer from endogeneity issues, allow me to control for that. Firstly, I control if the results are driven by improvement in women's education. More educated women are more empowered ones, and over the period of interest of my analysis, the share of women completing primary school grew from 11% in 2000 to over 25% in 2015. Secondly, I control if results are driven by an increase in women's occupation in the country. Women's economic conditions are a key determinant for women empowerment, and over the period of interest economic conditions in the country improved dramatically, with GDP per capita growing from 156$ in 2000 to 380 $ in 2015. Finally, I control if results are driven by changes in cultural norms that limit women empowerment as polygyny[22]. Despite polygyny is not legal in Malawi, in the year 2000 over 18% of women in my sample were living in a polygynous household, and, regardless of government efforts to fight it, in 2015 still almost 15% of the women in the sample were living in this condition. Tables A9, A10 and A11 show the results for baseline analysis once I include each of the controls discussed above. Results from the previous tables are summarized by Figure 6, where I plot the main coefficient for each of the regressions and the single coefficient for the added control variable. The inclusion of each of the controls does not affect baseline results either in terms of the magnitude of the effect or the significance. However, it is interesting to notice how each of these controls has an effect on women empowerment indicators. As expected, both higher education and employment lead to an increase in women empowerment, increasing decision-making. To what concerns physical violence, education is related to a reduction in it while employment does not seem to have any effect on violence. On the other side, living in polygynous household lead to a reduction in women empowerment: polygyny is associated with lower decision-making and a higher chance of experiencing physical violence. In Table A12 I include all three exogenous controls at the same time, and results are still robust both in terms of significance and magnitude. As a further robustness in this direction, I control if my results are driven by a general improvement in men's condition. I control then

[22]Polygyny is defined as the marriage of a man with several women

for men's education (Table A13) and for men's employment (Table A14). Results of the coefficient of interest are qualitatively and quantitatively unaffected, however, while male education seems to be associated with more empowerment their employment rate seems to be uncorrelated to it.

Figure 6: Robustness: control for confounds



(a) Walking Distance (b) Geodesic Distance

Notes: OLS Estimates for effect of ART availability on women empowerment, controlling for potential confounds. I calculate exposure to ART based on the interaction between HIV prevalence and access to the clinic ($HIV \times Proximity$). $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Subfig. a); the inverse geodesic distance from the closest clinic, measured in km (Subfig. b). These variables are meant to capture the exposure to ART combining the number of recipients and effective access to the treatment. Potential confounds: women employment (diamonds), women education (squares), and share of women living in polygynous households (triangles). The marker "X" represents the point estimates for the extra control variable.

Dependent variables: first panel (*Decision Making (All)*), the share of currently married women participating in all the decisions available in each specific year; second panel (*Health & HH Purchases*), the share of currently married women participating in decision making about their own health and big purchases in the household; third panel (*Physical Violence*), the share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. Black lines show the 95% confidence interval, grey lines show the 90% one.

A second potential threat to my analysis is the fact that areas with high or low HIV prevalence present some systematic characteristics affecting my main findings. To test it I construct balance tables for cluster characteristics (Table A2) and for Traditional Authority Areas characteristics (Table A3. Concerning the clusters, I observe that clusters with a higher prevalence of HIV are more likely to show a higher population density and access to health facilities. Then, it could be the case that I am identifying more developed areas of the country and this could lead to my results. Table A15 shows the results once I include the unbalanced characteristic at the cluster level. Results are qualitatively and quantitatively unaffected. As a further robustness test, I include in my analysis the unbalanced characteristic at cluster and TA as flexible controls. The variables considered for this analysis are population density and access to health at the cluster level, and employment rate and primary education at the TAs level. I interact then each of these variables with specific year fixed effects. Results are shown in Table A16. From this analysis, we can notice how baseline results are qualitatively unaffected, and the set of fixed effects included in the regression is never statistically different from zero. However, the introduction of a such number of non-statistically significant controls leads to extra noise in my regression determining less precision in the point estimates for some specifications.

Another possible concern for my identification strategy is that I am capturing a general improvement in health conditions in the country and that my findings are unrelated to the ART roll-out. To test that I perform the same analysis using malaria instead of HIV. The choice of malaria is due to the fact that Malawi is one of the countries with the highest prevalence of this disease in the world, and malaria is one of the most serious issues in the country. I computed malaria prevalence[23] in each cluster in the year 2000, and I construct my exposure measure interacting malaria prevalence with proximity to the closest health facility. Table A17 reports results of the baseline analysis showing no effect of malaria on women empowerment indicators, besides a small effect, in terms of magnitude, on the combination of the three indicators in the walking-time specification. My results are then not due to a general improvement in health conditions in the country but to improvements in the living conditions of HIV-positive people.

Finally, I conduct the baseline analysis using alternative measures of proximity to health facilities. More specifically, using information contained in DHS SPA (2013) on clinics characteristic in the country. I compute then the proximity of each cluster from

[23]Using data from Malaria Atlas Project, I define malaria prevalence as parasite rate for Plasmodium falciparum malaria for children two to ten years of age for the year 2000.

the closest public health facility or from the closest facility providing ART in 2013, and I use then these measures to replace the measures in the baseline. Tables A18 and A19 report the results of this analysis, showing that baseline results are robust to different specifications of proximity.

6 Channels

Promoting women empowerment and gender equality around the world has been one of the main objectives of international policymakers since the start of the millennium. In 2000, United Nations included the promotion of empowerment and gender equality among the 8 Millennium Development Goals (MDGs)(UN (2000)). More specifically, UN's aim was to reduce the gender gap in education, to increase the number of women working in the non-agricultural sector, and women's political representation. Despite the progress made between 2000 and 2015, women empowerment and gender equality have been included too as a cross-cutting issue among the 17 Sustainable Development Goals (SDGs) set up in 2015 by the UN and intended to be achieved by 2030 (UN Assembly (2015)). SDGs don't refer explicitly to women's issues, since the promotion of women empowerment is considered as the *conditio sine qua non* to achieve all the other goals (OECD (2013)). International organizations' strategy to promote women empowerment relies on two main channels: promotion of women's economic empowerment[24] and promotion of education[25]. Through economic empowerment women can gain more power in terms of decision making, both in personal and public life and more independence. Through education, especially of younger cohorts, women can acquire more human capital that can allow them to improve their economic conditions, improve their health, and give them more instruments to increase their decision-making.

How can health policies affect economic empowerment and education outcomes? Concerning labor market outcomes, previous literature has shown that the HIV pandemic

[24] https://africa.unwomen.org/en/what-we-do/economic-empowerment_africa

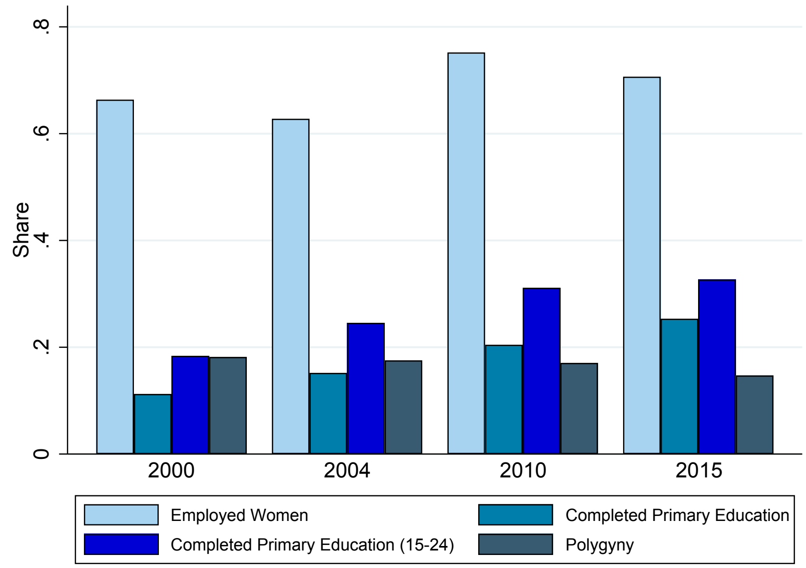
[25] https://www.un.org/en/chronicle/article/importance-educating-girls-and-women-fight-against-poverty-african-rural-communities

reduced workers' productivity and labor provision. This is true especially for women since the burden of taking care of ill members of the family has traditionally been on them. Availability of ART led to a recovery of labor productivity in the continent (Habyarimana et al. (2010); Bor et al. (2012)). Baranov et al. (2015) work shows that ART availability in Malawi led to an increase in labor market outcomes and that this effect is more pronounced for women, because of their traditional role of caregiver. Concerning education, the main references are Chicoine et al. (2021), for empirical evidence, and Becker (2007), for the theoretical framework. Chicoine et al. (2021) shows how the HIV pandemic had a detrimental effect on human capital accumulation, and in particular on education outcomes. Becker (2007) introduces explicitly health as a component of the human capital model, predicting that better health improves educational outcomes. Another prediction of Becker's model is a reduction in the individual discount rate. In the context of the HIV epidemic, this comes through a dramatic increase in HIV-positive people's life expectancy. This improvement in health conditions makes viable both investment in education and gives the incentive to break social norms and personal situations harming women empowerment (Papageorge et al. (2021)).

To investigate potential channels through which ART provision in Malawi has improved women empowerment, I focus on changes in three main outcomes from DHS surveys: women labor outcomes, women education, and social norms. As a measure of labor market outcome, I use the share of women employed in the 12 months before the interview. As a measure of educational attainment, I use the share of women who completed primary school[26], among all women in my sample and among young women (15-24 yo). As a proxy for change in social norms, I use the share of women living in polygynous households. Figure 7 summarize the time evolution of the potential channels over time. Women employment rate follow a pattern similar to the one of women indicator variable used in the main analysis. The average share of employed women in the country is relatively constant until 2004 and, after that, shows a consistent increase. The

[26]Malawian educational system defines as primary education the first 8th grade of schooling and, according to the 1994 Constitution, primary education is mandatory in the country.

Figure 7: Channels

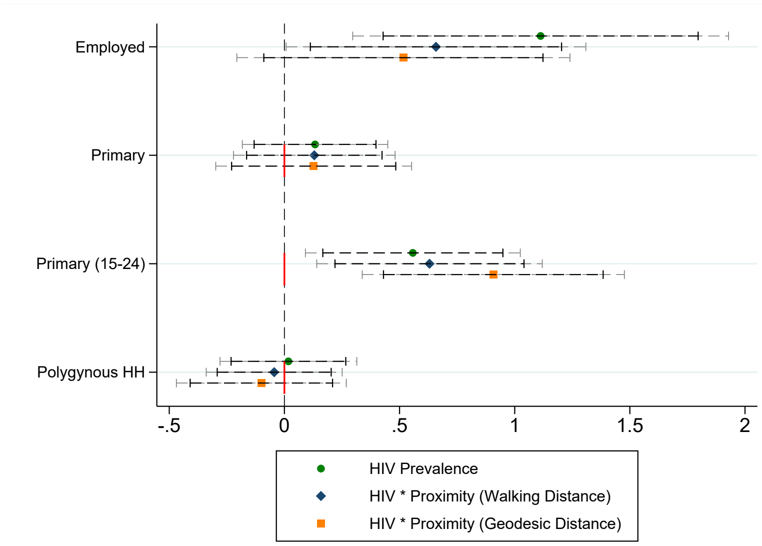


Notes: The figure shows the time evolution of the variables used in the channel analysis. Light blue bars (*Employed Women*) shows the time evolution of the share of currently married women who worked in the 12 months before the interview. Bright blue bars (*Completed Primary Education*) show the time evolution of the share of currently married women who have completed primary education (8 years of schooling). Blue bars (*Completed Primary Education (15-24)*) shows the time evolution of the share of young women (15-24) who have completed primary education (8 years of schooling). Dark grey bars (*Polygyny*) show the time evolution of the share of currently married women who are currently living in polygynous households. Data are from DHS collected in Malawi over the period 2000-2016.

share of women and young women who completed primary school is very low, especially considering that primary education in the country is mandatory since 1994, but it shows an increase over time ranging from around 18% in 2000 to over 32% in the year 2015. The share of women living in polygynous households is relatively constant over time, with an average always higher than 15% of women in my sample.

Figure 8 and Table A20 show the results for the analysis of the channel using the same specification described in section 4. All the specifications of the exposures measures have a positive effect on women employment, even if for the one using geodesic distance the effect is slightly not statistically different from zero (p-value = .16). The effect on education works only through the education of young women, where it's positive and statistically different from zero for all the specifications. The social norms channel, proxied by the share of women living in polygynous households, shows zero effect on health

Figure 8: Channels Analysis



Notes: OLS Estimates for effect of ART availability on women empowerment, using specification descrived in equation **??**. I use three proxies to measure exposure to ART. HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment (green dots). An interaction between HIV prevalence and access to the clinic ($HIVxProximity$ (Walking Distance)) that combines the prevalence of HIV with access to ART measured as the inverse walking distance from the closest clinic (blue diamonds). An interaction between HIV prevalence and access to the clinic ($HIVxProximity$ (Geodesic Distance)) that combines the prevalence of HIV with access to ART measured as the inverse geodesic distance from the closest clinic. This variable is meant to capture the exposure to ART combining the number of recipients and effective access to the treatment.
Dependent variables: first panel (*Employed*) share of currently married women who worked in the 12 months before the interview; second panel (*Primary*) share of currently married women who have completed primary education (8 years of schooling); third panel (*Primary (15-24)*) share of young women (15-24) who have completed primary education (8 years of schooling); fourth panel (*Polygynous HH*) share of currently married women who are currently living in polygynous households. More details on the outcomes variables are provided in Section 3. Black lines show the 95% confidence interval, grey lines show the 90% one.

policies. Table A21 reports the results of the previous analysis using different methods to compute geodesic distance. More specifically, rather than using the inverse distance, I use the linear and logarithmic distance from the closest health facility described in Section 3. These results confirm that employment and education are the main channels through which ART availability has had an effect on women empowerment.

ART availability has an impact on women empowerment in Malawi through its effect on economic employment, as suggested by results for women employment and previous literature. Another channel through which health reforms can affect women empowerment is through human capital, in particular by increasing the education of younger generations. I try to investigate then if ART expansion had a similar effect on men as on women. Figure A4 shows the time evolution for employment and education among the male population in my sample. Table A22 reports the results of the previous analysis on male outcomes. ART expansion appears to not have any effect on men's outcomes. Concerning employment outcomes, this could be explained by the fact that the male employment rate in rural areas of the country has been constant and over 90% throughout the sample. Concerning primary education, the small increase observed in the data is likely to be explained by other education campaigns and then captured by the region-year fixed effects.

7 Conclusions

Showing the positive relationship between ART roll-out in Malawi and women empowerment, this paper provides a first example of how major health interventions are viable instruments to promote women empowerment.

The connection between the HIV/AIDS epidemic spread in Africa and women empowerment is very strong. On the one side, cultural norms, and gender-based violence limit women empowerment and make women more exposed to the virus. On the other side, the spread of HIV negatively has a negative effect on women empowerment, especially on economic empowerment and education, because of the caregiver role of women in most African societies. This creates a vicious circle in which the lower the empowerment the bigger the spread of the virus, and the bigger the spread of HIV and the lower the empowerment.

The introduction of ART has provided an instrument to break this loop. Treatment availability has had a huge impact on reducing new infections and improving the health conditions of people living with HIV. This determined a lower burden on women both in terms of exposure to the virus and caregiving duties. In the context of the HIV/AIDS epidemic in Malawi, the ART roll-out campaign has had a positive impact women empowerment, in particular in terms of decision-making outcomes and violence. This impact is due to the positive effect of ART on women economic empowerment and human capital formation.

The validity of these results extends beyond the HIV/AIDS epidemic in Malawi in Africa. The recent COVID-19 epidemic showed a similar negative effect of epidemics on women empowerment. My results suggest that policymakers should take into account health interventions as instruments to promote empowerment.

References

Adams-Prassl, Abi, Teodora Boneva, Marta Golin, and Christopher Rauh, "Inequality in the impact of the coronavirus shock: Evidence from real time surveys," *Journal of Public economics*, 2020, *189*, 104245.

Anderson, Siwan, "Legal origins and female HIV," *American Economic Review*, 2018, *108* (6), 1407–39.

Assembly, General UN, "Sustainable development goals," *SDGs Transform Our World*, 2015, *2030.*

Bank, World, "Malawi Economic Monitor, December 2021: Addressing Macro and Gender Imbalances," 2021.

Baranov, Victoria and Hans-Peter Kohler, "The impact of AIDS treatment on savings and human capital investment in Malawi," *American Economic Journal: Applied Economics*, 2018, *10* (1), 266–306.

_ **, Daniel Bennett, and Hans-Peter Kohler**, "The indirect impact of antiretroviral therapy: mortality risk, mental health, and HIV-negative labor supply," *Journal of health economics*, 2015, *44*, 195–211.

Bashemera, Domitilla R, Martha J Nhembo, and Grace Benedict, *The role of women's empowerment in influencing HIV testing*, ICF International, 2013.

Becker, Gary S, "Health as human capital: synthesis and extensions," *Oxford economic papers*, 2007, *59* (3), 379–410.

Berlanda, Andrea, Matteo Cervellati, Elena Esposito, Dominic Rohner, and Uwe Sunde, "Medication Against Conflict," *medRxiv*, 2022.

Bor, Jacob, Frank Tanser, Marie-Louise Newell, and Till Bärnighausen, "In a study of a population cohort in South Africa, HIV patients on antiretrovirals had nearly full recovery of employment," *Health affairs*, 2012, *31* (7), 1459–1469.

Chicoine, Luke, Emily Lyons, and Alexia Sahue, "The impact of HIV/AIDS on human capital investment in Sub-Saharan Africa: New evidence," *Journal of Applied Econometrics*, 2021, *36* (6), 842–852.

Conroy, Amy, Sara Yeatman, and Kathryn Dovel, "The social construction of AIDS during a time of evolving access to antiretroviral therapy in rural Malawi," *Culture, health & sexuality*, 2013, *15* (8), 924–937.

Dickerson, Sarah, Victoria Baranov, Jacob Bor, and Jeremy Barofsky, "Treatment as insurance: HIV antiretroviral therapy offers financial risk protection in Malawi," *Health Policy and Planning*, 2020, *35* (6), 676–683.

Duflo, Esther, "Women empowerment and economic development," *Journal of Economic literature*, 2012, *50* (4), 1051–79.

Etheridge, Ben and Lisa Spantig, "The gender gap in mental well-being during the Covid-19 outbreak: evidence from the UK," Technical Report, ISER Working paper series 2020.

Farré, Lídia, Yarine Fawaz, Libertad González, and Jennifer Graves, "How the COVID-19 lockdown affected gender inequality in paid and unpaid work in Spain," 2020.

Goodman-Bacon, Andrew, "The Long-Run Effects of Childhood Insurance Coverage: Medicaid Implementation, Adult Health, and Labor Market Outcomes," *American Economic Review*, 2021, *111* (8), 2550–93.

Guenther, Tanya, Salim Sadruddin, Tiyese Chimuna, Bias Sichamba, Kojo Yeboah-Antwi, Bamody Diakite, Bamadio Modibo, Eric Swedberg, and David R Marsh, "Beyond distance: an approach to measure effective access to case management for sick children in Africa," *The American journal of tropical medicine and hygiene*, 2012, *87* (5 Suppl), 77.

Habyarimana, James, Bekezela Mbakile, and Cristian Pop-Eleches, "The impact of HIV/AIDS and ARV treatment on worker absenteeism implications for African firms," *Journal of Human Resources*, 2010, *45* (4), 809–839.

Hokayem, Charles and James P Ziliak, "Health, human capital, and life cycle labor supply," *American Economic Review*, 2014, *104* (5), 127–31.

Jahn, Andreas, Anthony D Harries, Erik J Schouten, Edwin Libamba, Nathan Ford, Dermot Maher, and Frank Chimbwandira, "Scaling-up antiretroviral therapy in Malawi," *Bulletin of the World Health Organization*, 2016, *94* (10), 772.

Kim, Julia, Paul Pronyk, Tony Barnett, and Charlotte Watts, "Exploring the role of economic empowerment in HIV prevention," *Aids*, 2008, *22*, S57–S71.

Koole, Olivier, Rein MGJ Houben, Themba Mzembe, Thomas P Van Boeckel, Michael Kayange, Andreas Jahn, Frank Chimbwandira, Judith R Glynn, and Amelia C Crampin, "Improved retention of patients starting antiretroviral treatment in Karonga District, northern Malawi, 2005-2012," *Journal of acquired immune deficiency syndromes (1999)*, 2014, *67* (1), e27.

Mufune, Pempelani, "Poverty and HIV/AIDS in Africa: Specifying the connections," *Social Theory & Health*, 2015, *13* (1), 1–29.

OECD, "Gender Equality and Women's Rights in the Post-2015 Agenda—A Foundation for Sustainable Development," 2013.

Page, Lucy and Rohini Pande, "Ending global poverty: Why money isn't enough," *Journal of Economic Perspectives*, 2018, *32* (4), 173–200.

Palk, Laurence, Justin T Okano, Luckson Dullie, and Sally Blower, "Travel time to health-care facilities, mode of transportation, and HIV elimination in Malawi: a geospatial modelling analysis," *The Lancet Global Health*, 2020, *8* (12), e1555–e1564.

Papageorge, Nicholas W, Gwyn C Pauley, Mardge Cohen, Tracey E Wilson, Barton H Hamilton, and Robert A Pollak, "Health, human capital, and domestic violence," *Journal of Human Resources*, 2021, *56* (4), 997–1030.

Ramjee, Gita and Brodie Daniels, "Women and HIV in sub-Saharan Africa," *AIDS research and therapy*, 2013, *10* (1), 1–9.

Ray, Nicolas and Steeve Ebener, "AccessMod 3.0: computing geographic coverage and accessibility to health care services using anisotropic movement of patients," *International journal of health geographics*, 2008, *7* (1), 1–17.

Sartorius, Benn, John D VanderHeide, Mingyou Yang, Erik A Goosmann, Julia Hon, Emily Haeuser, Michael A Cork, Samantha Perkins, Deepa Jahagirdar, Lauren E Schaeffer et al., "Subnational mapping of HIV incidence and mortality among individuals aged 15–49 years in sub-Saharan Africa, 2000–18: a modelling study," *The Lancet HIV*, 2021, *8* (6), e363–e375.

Tompsett, Anna, "The Lazarus drug: the impact of antiretroviral therapy on economic growth," *Journal of Development Economics*, 2020, *143*, 102409.

Türmen, Tomris, "Gender and HIV/aids," *International Journal of Gynecology & Obstetrics*, 2003, *82* (3), 411–418.

UN, United Nations, "Millennium development goals," 2000.

UNAIDS, WHO, "AIDS epidemic update: December 2000. Geneva: Joint United Nations Programme on HIV," *AIDS*, 2000.

Walby, Sylvia, "Indicators to measure violence against women," 2007.

WEF, "The global gender gap report 2021," in "in" World Economic Forum 2021.

A Appendix

The appendix section is organized as follows:

- Data:
  - Table A1 reports the summary statistics of the main variables used in the paper.
  - Table A2 reports the summary statistics of the main variables used in the paper splitting the sample between clusters with high and low HIV prevalence in 2000.
  - Table A3 reports the summary statistics of selected variables from the 1998 Census splitting the sample between Traditional Authority Areas with high and low HIV prevalence in 2000.
  - Figure A1 shows the Land Use Map of Malawi.
  - Figure A2 shows the Digital Elevation Model of Malawi.
  - Figure A3 shows health facility locations in the country, classifying them according to the type of facility.
  - Table A4 shows the travel speed by different landscape characteristics used to calculate access to health.
- Baseline analysis and robustness:
  - Table A5 reports the results of the baseline analysis.
  - Table A6 reports baseline results using as the main outcome variable attitude toward Intimate Partner Violence.
  - Table A7 reports the results of the baseline analysis using alternative measures to the *Proximity* measure used in the main specification (inverse distance).
  - Table A8 reports the results of the baseline analysis showing the effect of ART expansion on each component of the decision-making indicator.
  - Tables A9, A10, A11, A12, A13. and A14 report the results of the baseline analysis introducing potential (endogenous) confounders in the analysis.
  - Tables A15 and A16 report the results once controlling for clusters', or Traditional Authority Areas', characteristics which are unbalanced in the sample.

  - Table A17 reports the results of the placebo analysis where I replace HIV prevalence with Malaria prevalence.
  - Table A18 and A19 reports the results of the baseline analysis using a subsample of clinics in the country, namely clinics providing ART in 2013 and public clinics.

- Channels analysis and robustness:
  - Table A20 reports the results of the channels analysis.
  - Table A21 reports the results of the channels analysis using alternative measures to the *Proximity* measure used in the main specification (inverse distance).
  - Table A22 reports the results of the channels analysis on men's outcomes.

Table A1: Summary Statistics

	Full Sample				
Outcome Variable	N	Mean	SD	Min	Max
Own Health Decision	2210	0.460	0.248	0.000	1.000
HH Purchase Decision	2210	0.310	0.227	0.000	1.000
Visiting Relatives Decision	1549	0.385	0.201	0.000	0.917
All Decisions	2210	0.244	0.218	0.000	1.000
Health & HH Purchases Decisions	2210	0.257	0.215	0.000	1.000
Experiencing physical violence (12 months)	1775	0.164	0.138	0.000	0.833
Never justify wife-beating (Wom)	2210	0.775	0.183	0.125	1.000
Never justify wife-beating (Men)	2177	0.877	0.201	0.000	1.000
Cluster Characteristics	N	Mean	SD	Min	Max
Geodesic distance from health facility (km)	2210	4.411	2.676	0.056	23.979
Population Density (2000)	2210	171.653	125.959	0.695	1633.243
HIV prevalence (2000)	2210	0.174	0.054	0.090	0.326
Malaria (2000)	2210	0.406	0.105	0.155	0.694
Employment rate (Wom)	2210	0.696	0.219	0.000	1.000
Employment rate (Men)	2177	0.950	0.155	0.000	1.000
Completed primary (Wom)	2210	0.190	0.156	0.000	0.833
Completed primary (Men)	2177	0.320	0.277	0.000	1.000
Completed primary (Wom) 15-24	2210	0.277	0.212	0.000	1.000
Completed primary (Men) 15-24	2006	0.333	0.330	0.000	1.000
Polygyny	2210	0.166	0.124	0.000	0.750

Notes: Summary Statistics for the main variable included in the paper.

Table A2: Summary Statistics - High vs Low HIV prevalence

PANEL A	Balance Tables - Pre-2004							
	HIV 2000 ≥ Median			HIV 2000 < Median			Difference	
Outcome Variable	N	Mean	SD	N	Mean	SD	Diff.	p (2-tailed)
Own Health Decision	449	0.258	0.177	431	0.250	0.150	.008	.473
HH Purchase Decision	449	0.155	0.129	431	0.147	0.122	.009	.297
Visiting Relatives Decision	449	0.302	0.171	431	0.282	0.145	.02	.063
All Decisions	449	0.105	0.107	431	0.093	0.094	.012	.075
Health & HH Purchases Decisions	449	0.114	0.110	431	0.108	0.102	.006	.378
Experiencing physical violence (12 months)	223	0.172	0.106	222	0.176	0.110	-.004	.706
Never justify wife-beating (Wom)	449	0.691	0.184	431	0.620	0.187	.071	0
Never justify wife-beating (Men)	434	0.860	0.234	417	0.788	0.262	.073	0
Cluster Characteristics	N	Mean	SD	N	Mean	SD	Diff.	p (2-tailed)
Geodesic distance from health facility (km)	449	3.812	2.152	431	5.139	2.885	-1.327	0
Population Density (2000)	449	237.335	157.815	431	122.440	64.782	114.895	0
HIV prevalence (2000)	449	0.223	0.042	431	0.130	0.019	.092	0
Malaria (2000)	449	0.447	0.103	431	0.365	0.084	.082	0
Employment rate (Wom)	449	0.650	0.251	431	0.639	0.214	.011	.482
Employment rate (Men)	434	0.905	0.227	417	0.935	0.178	-.029	.035
Completed primary (Wom)	449	0.125	0.134	431	0.137	0.141	-.011	.229
Completed primary (Men)	434	0.257	0.281	417	0.263	0.290	-.006	.757
Completed primary (Wom) 15-24	449	0.210	0.205	431	0.218	0.213	-.008	.594
Completed primary (Men) 15-24	367	0.342	0.373	361	0.290	0.346	.052	.049
Polygyny	449	0.148	0.125	431	0.210	0.139	-.061	0

PANEL B	Balance Tables - Post-2004							
	HIV 2000 ≥ Median			HIV 2000 < Median			Difference	
Outcome Variable	N	Mean	SD	N	Mean	SD	Diff.	p (2-tailed)
Own Health Decision	656	0.631	0.192	674	0.563	0.188	.068	0
HH Purchase Decision	656	0.424	0.216	674	0.408	0.218	.016	.18
Visiting Relatives Decision	320	0.538	0.177	349	0.480	0.186	.059	0
All Decisions	656	0.351	0.219	674	0.330	0.223	.021	.086
Health & HH Purchases Decisions	656	0.364	0.212	674	0.344	0.215	.02	.095
Experiencing physical violence (12 months)	656	0.166	0.149	674	0.156	0.143	.01	.197
Never justify wife-beating (Wom)	656	0.888	0.111	674	0.821	0.135	.067	0
Never justify wife-beating (Men)	654	0.919	0.151	672	0.902	0.153	.017	.038
Cluster Characteristics	N	Mean	SD	N	Mean	SD	Diff.	p (2-tailed)
Geodesic distance from health facility (km)	656	3.750	2.203	674	4.988	3.008	-1.238	0
Population Density (2000)	656	217.171	140.439	674	115.065	62.961	102.106	0
HIV prevalence (2000)	656	0.214	0.040	674	0.130	0.020	.085	0
Malaria (2000)	656	0.442	0.110	674	0.369	0.091	.073	0
Employment rate (Wom)	656	0.722	0.198	674	0.737	0.205	-.015	.186
Employment rate (Men)	654	0.977	0.091	672	0.962	0.122	.015	.014
Completed primary (Wom)	656	0.221	0.147	674	0.236	0.162	-.015	.076
Completed primary (Men)	654	0.355	0.266	672	0.364	0.261	-.009	.527
Completed primary (Wom) 15-24	656	0.324	0.202	674	0.314	0.205	.01	.359
Completed primary (Men) 15-24	632	0.366	0.313	646	0.321	0.308	.045	.01
Polygyny	656	0.129	0.103	674	0.188	0.118	-.059	0

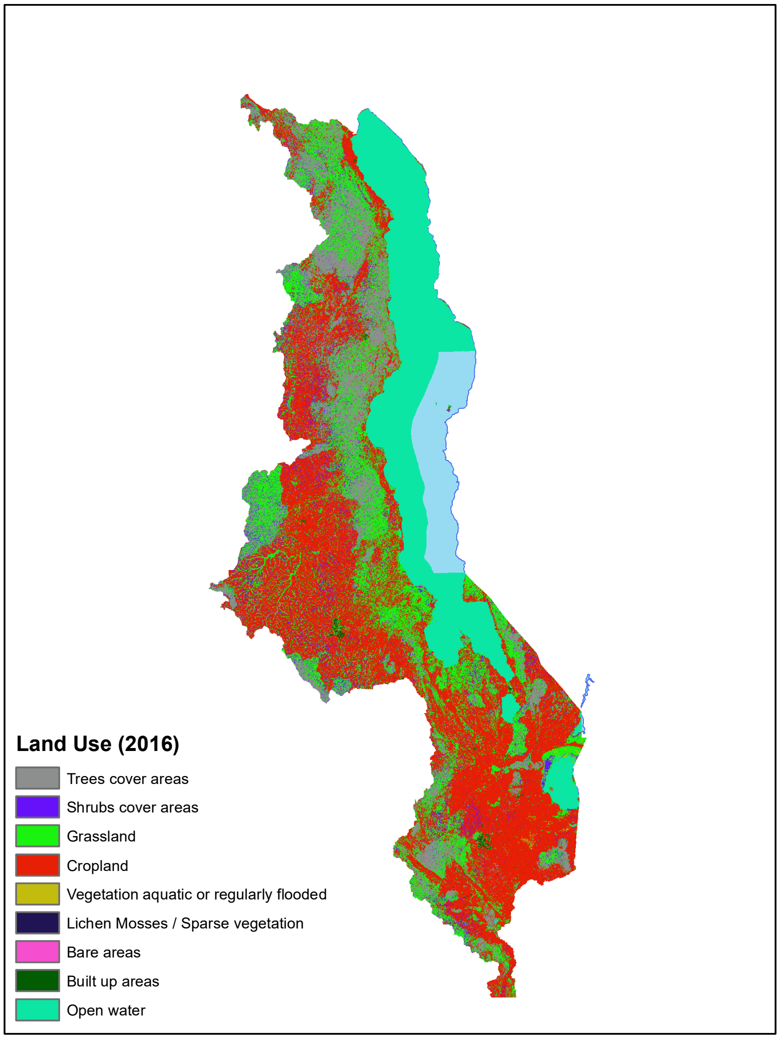
Notes: Summary Statistics for the main variable included in the paper, splitting the sample by clusters above or below the median HIV prevalence in 2000. Panel (a) reports the summary statistics for the clusters in the sample in the pre-treatment period; Panel (B) reports summary statistics for the clusters in sample after the year 2004.

Table A3: Summary Statistics - High vs Low HIV prevalence using 1998 Census data

PANEL A	Output Variables - Census 1998											
	HIV 2000 ≥ Median					HIV 2000 < Median					Difference	
Variable	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	Diff.	p (2-tailed)
Share of Women	94	0.494	0.106	0.000	0.551	93	0.508	0.016	0.467	0.541	-.014	.219
Employment	94	0.592	0.160	0.000	0.828	93	0.654	0.084	0.380	0.812	-.062	.001
Employment (Men)	94	0.589	0.139	0.000	0.795	93	0.644	0.078	0.419	0.792	-.055	.001
Employment (Wom)	94	0.592	0.198	0.000	0.858	93	0.663	0.106	0.240	0.831	-.071	.003
Prime Age Population	94	0.472	0.104	0.000	0.593	93	0.474	0.021	0.416	0.562	-.002	.862
Literacy	94	0.556	0.177	0.000	0.876	93	0.532	0.119	0.258	0.792	.023	.288
Literacy (Men)	94	0.626	0.171	0.000	0.896	93	0.597	0.102	0.352	0.811	.03	.153
Literacy (Wom)	94	0.491	0.187	0.000	0.857	93	0.470	0.136	0.178	0.794	.02	.4
Less than Primary	94	0.804	0.195	0.000	0.961	93	0.867	0.072	0.645	0.965	-.063	.004
Less than Primary (Men)	94	0.756	0.192	0.000	0.941	93	0.824	0.083	0.584	0.950	-.068	.002
Less than Primary (Wom)	94	0.849	0.199	0.000	0.978	93	0.909	0.063	0.702	0.987	-.06	.006
Years of Education	94	3.211	1.331	0.000	6.659	93	3.055	0.999	1.271	5.609	.156	.366
Years of Education (Men)	94	3.798	1.384	0.000	7.174	93	3.558	0.994	1.753	6.125	.24	.174
Years of Education (Wom)	94	2.664	1.290	0.000	6.118	93	2.571	1.005	0.803	5.042	.093	.581
HIV Prevalence	93	21.089	4.006	15.656	31.801	93	12.831	1.749	9.262	15.632	8.258	0
Population Density	94	317.169	425.598	3.966	2376.187	93	122.744	96.722	14.126	764.084	194.425	0

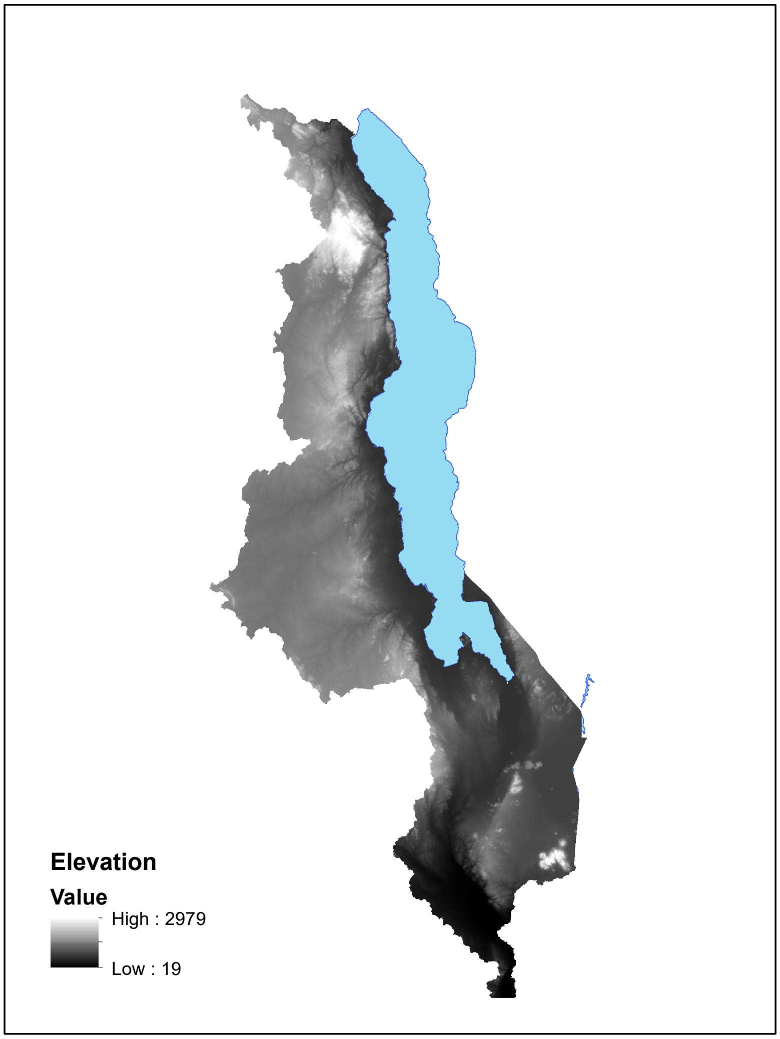
Notes: Summary Statistics for selected variables from the 1998 Census computed at Traditional Authority Area (admin 3), splitting the sample by TAs above or below the median HIV prevalence in 2000. Panel (a) reports the summary statistics for the clusters in the sample in the pre-treatment period; Panel (B) reports summary statistics for the clusters in the sample after the year 2004.

Figure A1: Land Use



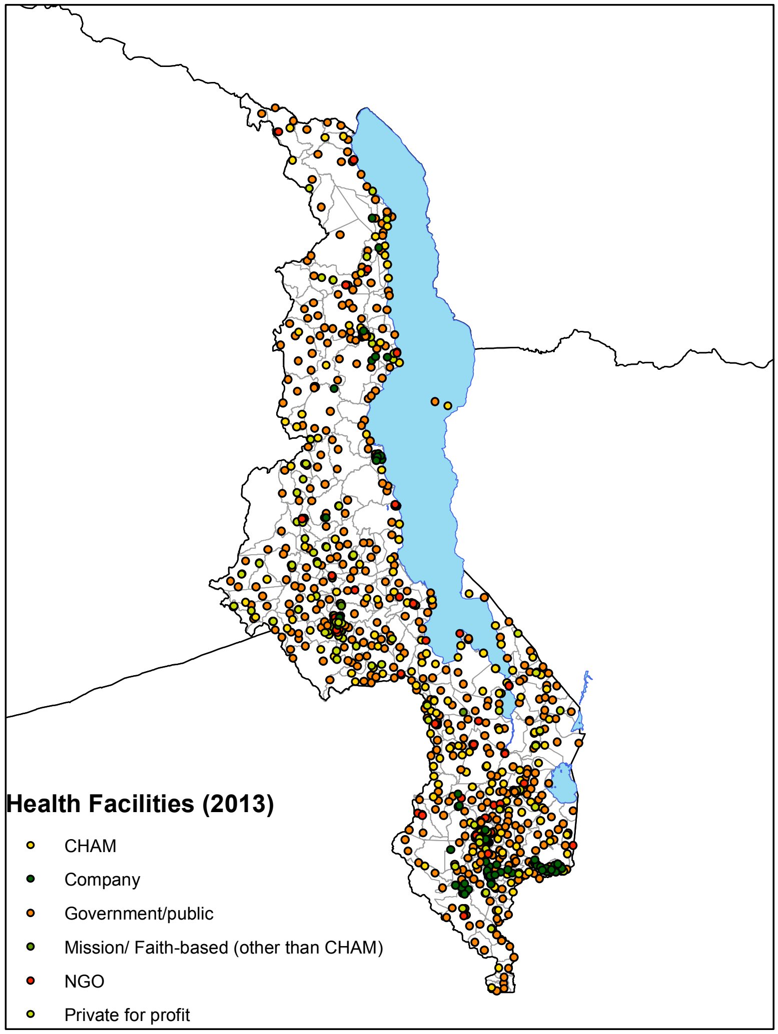
Notes: This figure shows the Land Use Map of Malawi; source: Sentinel-2 global land cover data

Figure A2: Topography



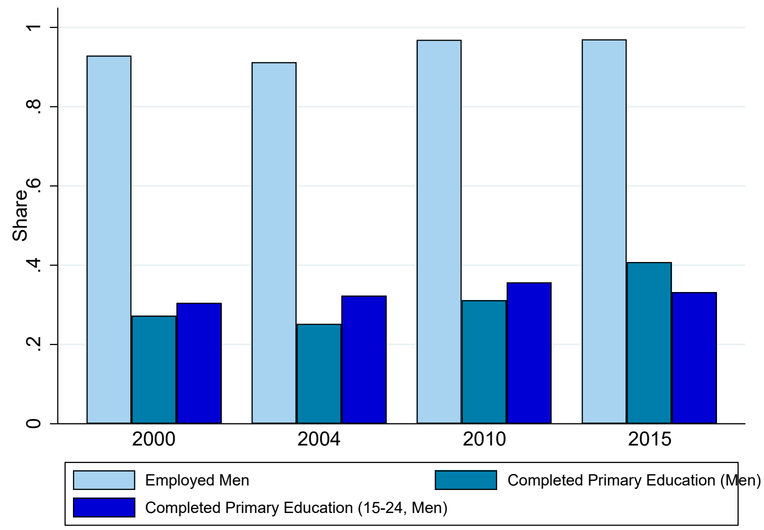
Notes: This figure shows the Digital Elevation Model of Malawi; source: Shuttle Radar Topography Mission (SRTM)

Figure A3: Health facilities



Notes: This figure shows health facility locations in the country, classifying them according to the type of facility; data source: Malawi DHS Service Provision Assessment (SPA) 2013-2014.

Figure A4: Men's Outcomes



Notes: The figure shows the time evolution of the variables used in the channel analysis but computed for the male population. Light blue bars (*Employed Men*) show the time evolution of the share of currently married men who worked in the 12 months before the interview. Bright blue bars (*Completed Primary Education*) show the time evolution of the share of currently married men who have completed primary education (8 years of schooling). Blue bars (*Completed Primary Education (15-24)*) shows the time evolution of the share of young men (15-24) who have completed primary education (8 years of schooling). Data are from DHS collected in Malawi over the period 2000-2016.

Table A4: Travel Speed

Label	Speed	Mode
Trees cover areas	2	WALKING
Shrubs cover areas	2	WALKING
Grassland	3	WALKING
Cropland	3	WALKING
Vegetation aquatic or regularly flooded	2	WALKING
Lichen Mosses Sparse vegetation	3	WALKING
Bare areas	3	WALKING
Built up areas	5	WALKING
Open water	0	WALKING
Trunk roads	5	WALKING
Secondary roads	5	WALKING
Tertiary roads	5	WALKING
Track roads	5	WALKING

Notes: Travel speed by different landscape characteristics.

Table A5: Baseline Analysis

Dependent Variable	Women Empowerment Indicators		
	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV	0.881***	0.953***	-0.333**
	(0.148)	(0.161)	(0.165)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.65	0.62	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.474***	0.568***	-0.330*
	(0.169)	(0.172)	(0.198)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,208	2,208	1,771
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.421*	0.499**	-0.444**
	(0.227)	(0.229)	(0.218)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.64	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). $Post$ is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Column (3) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A6: Baseline Analysis: Attitude towards Intimate Partner Violence

Panel A	Share of Women Never Justifying Intimate Partner Violence		
	(1)	(2)	(3)
Post × Treatment	0.786***	0.409*	0.285
	(0.239)	(0.224)	(0.263)
Treatment	HIV	HIV × Walk Time	HIV × Geodesic
Type of Clinic	NA	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,208	2,210
Clusters	204	203	204
Adj-R2	0.51	0.51	0.51

Panel A	Share of Men Never Justifying Intimate Partner Violence		
	(1)	(2)	(3)
Post × Treatment	0.063	-0.189	0.125
	(0.230)	(0.219)	(0.286)
Treatment	HIV	HIV × Walk Time	HIV × Geodesic
Type of Clinic	NA	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,176	2,174	2,176
Clusters	203	202	203
Adj-R2	0.18	0.18	0.18

Notes: OLS Estimates for effect of ART availability on Attitude towards Intimate Partner Violence. The main outcome variable captures the share of women (Panel (A)) or men (Panel (B)) who never justify IPV. I use three proxies to measure exposure to ART. Column 1 shows results for HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Columns 2 and 3 I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. *Proximity* is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Column 2); the inverse geodesic distance from the closest clinic, measured in km (Column 3). *Post* is a binary variable taking value 1 after the year 2004. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A7: Baseline Analysis: Alternative Proximity Measures (Geodesic Distance)

Dependent Variable	Women Empowerment Indicators					
	Decision Making				Physical Violence	
	All Indicators		Own Health & HH Purchases		Exp. Physical Violence (12 m)	
	(1)	(2)	(3)	(4)	(5)	(6)
Post × HIV × Proximity	0.036***	0.044***	0.040***	0.048***	-0.019*	-0.016
	(0.008)	(0.008)	(0.008)	(0.009)	(0.010)	(0.011)
Proximity Measure	Linear	Log	Linear	Log	Linear	Log
Type of Clinic	Any	Any	Any	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural	Rural	Rural	Rural
Observations	2,210	2,210	2,210	2,210	1,771	1,771
Clusters	204	204	204	204	200	200
Adj-R2	0.64	0.65	0.61	0.62	0.12	0.12
Controls	√	√	√	√	√	√
Traditional Authorities f.e.	√	√	√	√	√	√
Region × Year f.e.	√	√	√	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment. I use two proxies to measure exposure to ART. $HIVxProximity$ is the interaction between HIV prevalence and access to the clinic that combines the prevalence of HIV with access to ART. Columns (1), (3), and (5) use as proximity measure the distance from the closest clinic, measured as $Proximity_i = \max_i(dist) - dist_i$. Columns (2), (4), and (6) use as proximity measure the distance from the closest clinic, measured as $Proximity_i = \ln(1 + \max_i(dist) - dist_i)$. *Post* is a binary variable taking value 1 after the year 2004. All coefficients are standardized to make them comparable.
Dependent variables: Columns (1) and (2) share of currently married women participating in all the decisions available in each specific year; Columns (3) and (4) share of currently married women participating in decision-making about their own health and big purchases in the household; Columns (5) and (6) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A8: Baseline Analysis: Single Decisions

Dependent Variable	Share of Women Making Decisions on			
Panel A	All Indicators	Own Health	HH Purchases	Visit Friends/Relatives
	(1)	(2)	(3)	(4)
Post × HIV	0.881***	1.080***	0.926***	0.915***
	(0.148)	(0.224)	(0.172)	(0.267)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Observations	2,210	2,210	2,210	1,538
Clusters	204	204	204	193
Adj-R2	0.65	0.60	0.62	0.47
Panel B	All Indicators	Own Health	HH Purchases	Visit Friends/Relatives
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.474***	0.619**	0.506***	0.519**
	(0.169)	(0.240)	(0.187)	(0.232)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural	Rural
Observations	2,208	2,208	2,208	1,538
Clusters	203	203	203	193
Adj-R2	0.64	0.60	0.62	0.47
Panel C	All Indicators	Own Health	HH Purchases	Visit Friends/Relatives
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.421*	0.494*	0.484**	0.625*
	(0.227)	(0.292)	(0.229)	(0.329)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural	Rural
Observations	2,210	2,210	2,210	1,538
Clusters	204	204	204	193
Adj-R2	0.64	0.60	0.61	0.46
Controls	√	√	√	√
Traditional Authorities f.e.	√	√	√	√
Region × Year f.e.	√	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). $Post$ is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health; Column (3) share of currently married women participating in decision making about big purchases in the household; Column (4) share of currently married women participating in decision making about visiting friends or relatives. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A9: Robustness: Baseline controlling for Education

Dependent Variable	Women Empowerment Indicators		
	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV	0.866***	0.939***	-0.330**
	(0.147)	(0.159)	(0.165)
Primary Education (Women)	0.111***	0.106***	-0.050*
	(0.022)	(0.023)	(0.026)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.65	0.62	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.459***	0.554***	-0.334*
	(0.167)	(0.171)	(0.196)
Primary Education (Women)	0.114***	0.110***	-0.049*
	(0.022)	(0.023)	(0.027)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,208	2,208	1,771
Clusters	203	203	200
Adj-R2	0.65	0.62	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.406*	0.484**	-0.451**
	(0.223)	(0.225)	(0.217)
Primary Education (Women)	0.119***	0.115***	-0.049*
	(0.021)	(0.022)	(0.027)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.65	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment controlling for women education. *Primary Education* is the share of currently married women who have completed primary education (8 years of schooling). I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Columns (3) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A10: Robustness: Baseline controlling for Employment

Dependent Variable	Women Empowerment Indicators		
	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV	0.833***	0.897***	-0.344**
	(0.157)	(0.171)	(0.169)
Employment Rate (Women)	0.043**	0.050**	0.008
	(0.021)	(0.021)	(0.017)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.65	0.62	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.442**	0.532***	-0.336*
	(0.176)	(0.180)	(0.202)
Employment Rate (Women)	0.049**	0.056***	0.007
	(0.021)	(0.021)	(0.018)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,208	2,208	1,771
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.395*	0.469**	-0.447**
	(0.231)	(0.233)	(0.219)
Employment Rate (Women)	0.050**	0.057***	0.006
	(0.021)	(0.021)	(0.017)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.64	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment controlling for women employment rate. Employment rate (Women) is the share of currently married women who worked in the 12 months before the interview. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). $Post$ is a binary variable taking value 1 after the year 2004. Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Column (3) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A11: Robustness: Baseline controlling for Polygyny

Dependent Variable	Women Empowerment Indicators		
	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV	0.882***	0.955***	-0.341**
	(0.147)	(0.160)	(0.165)
Polygyny	-0.075***	-0.071**	0.061*
	(0.026)	(0.028)	(0.033)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.65	0.62	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.470***	0.565***	-0.337*
	(0.168)	(0.172)	(0.199)
Polygyny	-0.077***	-0.073**	0.060*
	(0.027)	(0.028)	(0.034)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,208	2,208	1,771
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.413*	0.491**	-0.466**
	(0.225)	(0.228)	(0.219)
Polygyny	-0.079***	-0.074***	0.061*
	(0.027)	(0.028)	(0.033)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.64	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment controlling for polygyny. *Polygyny* is the share of currently married women who are currently living in polygynous households. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. *Proximity* is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Column (3) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A12: Robustness: Baseline controlling for Education, Employment, and Polygyny

Dependent Variable	Women Empowerment Indicators		
	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV	0.820***	0.885***	-0.348**
	(0.154)	(0.168)	(0.169)
Employment Rate (Women)	0.043**	0.050**	0.008
	(0.021)	(0.021)	(0.017)
Primary Education (Women)	0.106***	0.101***	-0.044*
	(0.022)	(0.022)	(0.025)
Polygyny	-0.061**	-0.058**	0.054
	(0.026)	(0.028)	(0.033)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.65	0.62	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.425**	0.516***	-0.345*
	(0.173)	(0.177)	(0.200)
Employment Rate (Women)	0.048**	0.055***	0.007
	(0.021)	(0.021)	(0.017)
Primary Education (Women)	0.109***	0.104***	-0.044
	(0.022)	(0.023)	(0.027)
Polygyny	-0.063**	-0.059**	0.053
	(0.027)	(0.028)	(0.033)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,208	2,208	1,771
Clusters	203	203	200
Adj-R2	0.65	0.62	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.375*	0.450*	-0.472**
	(0.226)	(0.228)	(0.220)
Employment Rate (Women)	0.049**	0.057***	0.005
	(0.021)	(0.021)	(0.017)
Primary Education (Women)	0.114***	0.109***	-0.042
	(0.021)	(0.022)	(0.026)
Polygyny	-0.063**	-0.059**	0.053
	(0.027)	(0.028)	(0.033)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.65	0.62	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment controlling for women education, employment rate, and polygyny. Employment rate (Women) is the share of currently married women who worked in the 12 months before the interview. *Primary Education* is the share of currently married women who have completed primary education (8 years of schooling). *Polygyny* is the share of currently married women who are currently living in polygynous households. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. *Proximity* is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Column (3) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A13: ROBUSTNESS: BASELINE CONTROLLING FOR MALE EDUCATION

Dependent Variable	WOMEN EMPOWERMENT INDICATORS		
	DECISION MAKING		PHYSICAL VIOLENCE
Panel A	ALL INDICATORS	OWN HEALTH & HH PURCHASES	EXP. PHYSICAL VIOLENCE (12 M)
	(1)	(2)	(3)
Post × HIV	0.897***	0.970***	-0.282*
	(0.147)	(0.160)	(0.170)
Primary Education (Men)	0.028**	0.031**	0.005
	(0.012)	(0.012)	(0.016)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,176	2,176	1,756
Clusters	203	203	200
Adj-R2	0.64	0.62	0.09

Panel B	ALL INDICATORS	OWN HEALTH & HH PURCHASES	EXP. PHYSICAL VIOLENCE (12 M)
	(1)	(2)	(3)
Post × HIV	0.479***	0.576***	-0.301
	(0.167)	(0.170)	(0.200)
Primary Education (Men)	0.027**	0.030**	0.006
	(0.012)	(0.012)	(0.016)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,174	2,174	1,756
Clusters	202	202	200
Adj-R2	0.64	0.61	0.09

Panel C	ALL INDICATORS	OWN HEALTH & HH PURCHASES	EXP. PHYSICAL VIOLENCE (12 M)
	(1)	(2)	(3)
Post × HIV	0.445*	0.524**	-0.452**
	(0.229)	(0.231)	(0.219)
Primary Education (Men)	0.029**	0.032***	0.006
	(0.012)	(0.012)	(0.016)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,176	2,176	1,756
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment controlling for men education. *Primary Education* is the share of currently married men who have completed primary education (8 years of schooling). I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. *Proximity* is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Columns (3) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A14: Robustness: Baseline controlling for Male Employment

Dependent Variable	Women Empowerment Indicators		
	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV	0.899***	0.971***	-0.279
	(0.146)	(0.160)	(0.172)
Employment Rate (Men)	-0.021	-0.023	-0.005
	(0.023)	(0.023)	(0.025)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,176	2,176	1,756
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.480***	0.577***	-0.301
	(0.169)	(0.172)	(0.201)
Employment Rate (Men)	-0.017	-0.019	-0.007
	(0.024)	(0.024)	(0.025)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,174	2,174	1,756
Clusters	202	202	200
Adj-R2	0.64	0.61	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.446*	0.525**	-0.454**
	(0.230)	(0.232)	(0.219)
Employment Rate (Men)	-0.015	-0.017	-0.008
	(0.024)	(0.024)	(0.025)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,176	2,176	1,756
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment controlling for men employment rate. Employment rate (Men) is the share of currently married women who worked in the 12 months before the interview. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). *Post* is a binary variable taking value 1 after the year 2004. Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Column (3) share of currently married women who have experienced physical violence in the 12 months before the interview. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A15: Robustness: Baseline controlling for Population Density and Access to Health

	Decision Making		Physical Violence	
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)	Never Justify IPV
	(1)	(2)	(3)	(4)
Post × HIV	0.886***	0.960***	-0.334**	0.788***
	(0.149)	(0.162)	(0.164)	(0.238)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Additional Controls	√	√	√	√
Observations	2,210	2,210	1,771	2,210
Clusters	204	204	200	204
Adj-R2	0.65	0.62	0.09	0.51
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)	Never Justify IPV
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.479***	0.573***	-0.322	0.402*
	(0.170)	(0.173)	(0.198)	(0.222)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Additional Controls	√	√	√	√
Observations	2,208	2,208	1,771	2,208
Clusters	203	203	200	203
Adj-R2	0.64	0.61	0.09	0.51
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)	Never Justify IPV
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.438*	0.517**	-0.442**	0.284
	(0.229)	(0.232)	(0.219)	(0.259)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Additional Controls	√	√	√	√
Observations	2,210	2,210	1,771	2,210
Clusters	204	204	200	204
Adj-R2	0.64	0.61	0.09	0.51

Notes: OLS Estimates for effect of ART availability on women empowerment controlling for population density and access to health. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). $Post$ is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Column (3) share of currently married women who have experienced physical violence in the 12 months before the interview; Column (4) share of women who never justify Intimate Partner Violence. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A16: Robustness: Baseline introducing flexible controls

	Decision Making		Physical Violence	
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)	Never Justify IPV
	(1)	(2)	(3)	(4)
Post × HIV	0.960***	0.965***	-0.149	1.152***
	(0.202)	(0.221)	(0.212)	(0.272)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Additional Controls	√	√	√	√
Observations	2,210	2,210	1,771	2,210
Clusters	204	204	200	204
Adj-R2	0.65	0.62	0.09	0.52
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)	Never Justify IPV
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.489*	0.506*	-0.168	1.134***
	(0.272)	(0.288)	(0.330)	(0.343)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Additional Controls	√	√	√	√
Observations	2,208	2,208	1,771	2,208
Clusters	203	203	200	203
Adj-R2	0.64	0.61	0.09	0.52
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)	Never Justify IPV
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.536	0.521	-0.478	0.912**
	(0.346)	(0.355)	(0.321)	(0.356)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Additional Controls	√	√	√	√
Observations	2,210	2,210	1,771	2,210
Clusters	204	204	200	204
Adj-R2	0.64	0.61	0.09	0.52

Notes: OLS Estimates for effect of ART availability on women empowerment controlling in a flexible way for population density, access to health, employment rate, and primary education. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. *Proximity* is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health and big purchases in the household; Column (3) share of currently married women who have experienced physical violence in the 12 months before the interview; Column (4) share of women who never justify Intimate Partner Violence. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A17: Falsification test: replace HIV with malaria

Dependent Variable	Share of Women Making Decisions on				Physical Violence
Panel A	All Indicators	Own Health	HH Purchases	Visit Friends/Relatives	Exp. Physical Violence (12 m)
	(1)	(2)	(3)	(4)	(5)
Post × Malaria × Proximity	0.170**	-0.008	0.135	-0.014	-0.010
	(0.078)	(0.113)	(0.087)	(0.144)	(0.124)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural	Rural	Rural
Observations	2,239	2,239	2,239	1,555	1,794
Clusters	204	204	204	195	201
Adj-R2	0.65	0.60	0.63	0.46	0.08
Panel B	All Indicators	Own Health	HH Purchases	Visit Friends/Relatives	Exp. Physical Violence (12 m)
	(1)	(2)	(3)	(4)	(5)
Post × HIV × Proximity	0.088	-0.147	0.062	0.045	-0.063
	(0.108)	(0.133)	(0.112)	(0.156)	(0.109)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural	Rural	Rural
Observations	2,241	2,241	2,241	1,555	1,794
Clusters	205	205	205	195	201
Adj-R2	0.65	0.60	0.62	0.46	0.08
Controls	√	√	√	√	√
Traditional Authorities f.e.	√	√	√	√	√
Region × Year f.e.	√	√	√	√	√

Notes: OLS Estimates for a falsification analysis to show that the effect of ART-rollout campaign works through HIV and not other diseases. $Malaria \times Proximity$ is the interaction between Malaria prevalence and access to the clinic that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (A); the inverse geodesic distance from the closest clinic, measured in km (Panel B). $Post$ is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health; Column (3) share of currently married women participating in decision making about big purchases in the household; Column (4) share of currently married women participating in decision making about visiting friends or relatives; Column (5) share of currently married women who have experienced physical violence in the 12 months before the interview.. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A18: Baseline Analysis: Alternative Clinics (Walking Distance)

Dependent Variable	Women Empowerment Indicators		
	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.474***	0.568***	-0.330*
	(0.169)	(0.172)	(0.198)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,208	2,208	1,771
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.498***	0.604***	-0.413*
	(0.173)	(0.178)	(0.230)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	ART	ART	ART
Type of DHS Unit	Rural	Rural	Rural
Observations	2,208	2,208	1,771
Clusters	203	203	200
Adj-R2	0.64	0.61	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.565***	0.655***	-0.378*
	(0.212)	(0.218)	(0.203)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Public	Public	Public
Type of DHS Unit	Rural	Rural	Rural
Observations	2,204	2,204	1,767
Clusters	202	202	199
Adj-R2	0.64	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment. As proxy for access to ART, I use the interaction between HIV prevalence and access to the clinic that combines the prevalence of HIV with access to ART ($HIVxProximity$). I use three different variations of my measure exposure to ART based on inverse walking distance, measured in 20 minutes units, from different typologies of clinics. In Panel A I replicate the baseline analysis including any clinic in the sample. In Panel B I restrict the analysis only to the clinics providing ART in 2013. In Panel C I restrict the analysis only to the public clinics. *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health; Column (3) share of currently married women participating in decision making about big purchases in the household; Column (4) share of currently married women participating in decision making about visiting friends or relatives. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A19: Baseline Analysis: Alternative Clinics (Geodesic Distance)

Dependent Variable	Women Empowerment Indicators		
Panel A	Decision Making		Physical Violence
Panel A	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.421*	0.499**	-0.444**
	(0.227)	(0.229)	(0.218)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.64	0.61	0.09
Panel B	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.415*	0.515**	-0.402*
	(0.240)	(0.242)	(0.236)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	ART	ART	ART
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.64	0.61	0.09
Panel C	All Indicators	Own Health & HH Purchases	Exp. Physical Violence (12 m)
	(1)	(2)	(3)
Post × HIV × Proximity	0.686**	0.752***	-0.394*
	(0.270)	(0.271)	(0.237)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Public	Public	Public
Type of DHS Unit	Rural	Rural	Rural
Observations	2,210	2,210	1,771
Clusters	204	204	200
Adj-R2	0.64	0.61	0.09
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment. As proxy for access to ART, I use the interaction between HIV prevalence and access to the clinic that combines the prevalence of HIV with access to ART ($HIVxProximity$). I use three different variations of my measure exposure to ART based on inverse geodesic distance, measured in kilometers, from different typologies of clinics. In Panel A I replicate the baseline analysis including any clinic in the sample. In Panel B I restrict the analysis only to the clinics providing ART in 2013. In Panel C I restrict the analysis only to the public clinics. *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women participating in all the decisions available in each specific year; Column (2) share of currently married women participating in decision-making about their own health; Column (3) share of currently married women participating in decision making about big purchases in the household; Column (4) share of currently married women participating in decision making about visiting friends or relatives. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A20: Channels

Dependent Variable	Share of Women			
Panel A	Employed	Completed Primary	Completed Primary (15-24)	in Polygynous HH
	(1)	(2)	(3)	(4)
Post × HIV	1.113***	0.133	0.558**	0.017
	(0.414)	(0.160)	(0.237)	(0.151)
Proximity Measure	NA	NA	NA	NA
Type of Clinic	NA	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural	Rural
Observations	2,210	2,210	2,210	2,210
Clusters	204	204	204	204
Adj-R2	0.22	0.37	0.26	0.29
Panel B	Employed	Completed Primary	Completed Primary (15-24)	in Polygynous HH
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.658**	0.130	0.630**	-0.044
	(0.330)	(0.178)	(0.248)	(0.150)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural	Rural
Observations	2,208	2,208	2,208	2,208
Clusters	203	203	203	203
Adj-R2	0.21	0.38	0.27	0.29
Panel C	Employed	Completed Primary	Completed Primary (15-24)	in Polygynous HH
	(1)	(2)	(3)	(4)
Post × HIV × Proximity	0.517	0.127	0.907***	-0.100
	(0.367)	(0.216)	(0.289)	(0.187)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural	Rural
Observations	2,210	2,210	2,210	2,210
Clusters	204	204	204	204
Adj-R2	0.21	0.36	0.26	0.29
Controls	√	√	√	√
Traditional Authorities f.e.	√	√	√	√
Region × Year f.e.	√	√	√	√

Notes: OLS Estimates for the channels through which ART availability affects women empowerment. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. $Proximity$ is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). $Post$ is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married women who worked in the 12 months before the interview; Column (2) share of currently married women who have completed primary education (8 years of schooling); Column (3) share of young women (15-24) who have completed primary education (8 years of schooling); Column (4) share of currently married women who are currently living in polygynous households. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A21: Channels: Alternative Proximity Measures (Geodesic Distance)

Dependent Variable	Share of Women							
	Employed		Completed Primary		Completed Primary (15-24)		in polygynous HH	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post × HIV × Proximity	0.044**	0.055**	0.007	0.008	0.036***	0.034***	-0.005	-0.003
	(0.018)	(0.021)	(0.008)	(0.008)	(0.012)	(0.012)	(0.008)	(0.009)
Proximity Measure	Linear	Log	Linear	Log	Linear	Log	Linear	Log
Type of Clinic	NA	Any	NA	Any	NA	Any	NA	Any
Type of DHS Unit	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural
Observations	2,210	2,210	2,210	2,210	2,210	2,210	2,210	2,210
Clusters	204	204	204	204	204	204	204	204
Adj-R2	0.22	0.22	0.37	0.37	0.27	0.27	0.29	0.29
Controls	√	√	√	√	√	√	√	√
Traditional Authorities f.e.	√	√	√	√	√	√	√	√
Region × Year f.e.	√	√	√	√	√	√	√	√

Notes: OLS Estimates for effect of ART availability on women empowerment. I use two proxies to measure exposure to ART. $HIVxProximity$ is the interaction between HIV prevalence and access to the clinic that combines the prevalence of HIV with access to ART. Columns (1), (3), (5), and (7) use as proximity measure the distance from the closest clinic, measured as $Proximity_i = \max(dist) - dist_i$. Columns (2), (4), (6), and (8) use as proximity measure the distance from the closest clinic, measured as $Proximity_i = \log(1 + \max(dist) - dist_i)$. $Post$ is a binary variable taking value 1 after the year 2004. All coefficients are standardized to make them comparable.
Dependent variables: Columns (1) and (2) share of currently married women who worked in the 12 months before the interview; Columns (3) and (4) share of currently married women who have completed primary education (8 years of schooling); Columns (5) and (6) share of young women (15-24) who have completed primary education (8 years of schooling); Columns (7) and (8) share of currently married women who are currently living in polygynous households. More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.

Table A22: Channels: Men's Outcomes

Dependent Variable	Share of Men		
Panel A	Employed	Completed Primary	Completed Primary (15-24)
	(1)	(2)	(3)
Post × HIV	0.258	-0.142	0.161
	(0.280)	(0.289)	(0.423)
Proximity Measure	NA	NA	NA
Type of Clinic	NA	NA	NA
Type of DHS Unit	Rural	Rural	Rural
Observations	2,176	2,176	2,006
Clusters	203	203	204
Adj-R2	0.12	0.17	0.07
Panel B	Employed	Completed Primary	Completed Primary (15-24)
	(1)	(2)	(3)
Post × HIV	-0.126	0.119	0.389
	(0.211)	(0.341)	(0.409)
Proximity Measure	Walking Distance	Walking Distance	Walking Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,174	2,174	2,004
Clusters	202	202	203
Adj-R2	0.12	0.18	0.08
Panel C	Employed	Completed Primary	Completed Primary (15-24)
	(1)	(2)	(3)
Post × HIV	-0.456*	0.258	0.291
	(0.271)	(0.444)	(0.528)
Proximity Measure	Geodesic Distance	Geodesic Distance	Geodesic Distance
Type of Clinic	Any	Any	Any
Type of DHS Unit	Rural	Rural	Rural
Observations	2,176	2,176	2,006
Clusters	203	203	204
Adj-R2	0.12	0.18	0.07
Controls	√	√	√
Traditional Authorities f.e.	√	√	√
Region × Year f.e.	√	√	√

Notes: OLS Estimates for the channels through which ART availability affects men's outcomes. I use three proxies to measure exposure to ART. In Panel A is HIV prevalence in 2000 (HIV) meant to capture the number of potential recipients of the treatment. In Panel B and C I use the interaction between HIV prevalence and access to the clinic ($HIVxProximity$) that combines the prevalence of HIV with access to ART. *Proximity* is measured as: the inverse walking distance from the closest clinic, measured in 20 minutes units (Panel B); the inverse geodesic distance from the closest clinic, measured in km (Panel C). *Post* is a binary variable taking value 1 after the year 2004.
Dependent variables: Column (1) share of currently married men who worked in the 12 months before the interview; Column (2) share of currently married men who have completed primary education (8 years of schooling); Column (3) share of young men (15-24) who have completed primary education (8 years of schooling). More details on the outcomes variables are provided in Section 3. */**/*** indicate significance at 10%/5%/1%, respectively; standard errors in parentheses clustered at the Traditional Authorities Areas level.